13/62

FUEL RESEARCH INSTITUE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 13 OF 1962.

SOME ECONOMIC IMPLICATIONS OF THE INTRODUCTION OF CLEAN AIR LEGISLATION.

oOo

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO.13 OF 1962.

SOME ECONOMIC IMPLICATIONS OF THE INTRODUCTION OF CLEAN AIR LEGISLATION.

INTRODUCTION:

The Fuel Research Board greatly appreciates the opportunity to place certain views about the proposed Atmospheric Pollution Prevention Bill before the Honourable, the Minister of Health.

The Board would stress at the outset that it is not its intention to argue about the fundamental principle embodied in this Bill. Its individual members are as desirous as any citizens of the Republic to ensure a clean healthy atmosphere in the Republic's cities and industrial centres.

The Board did, however, gain the impression, during the study of the first draft Bill, that the far-reaching economic, commercial, technical and even social implications involved in this measure had not received adequate consideration during the drafting of the Bill. Its concern was communicated to the Honourable, the Minister of Economic Affairs, offering its services to undertake any desired investigations.

The Board is aware that this draft Bill was referred to a Select Committee and also that the Director of the Fuel Research Institute had been asked by the Select Committee to present certain, specified, technical facts to that Committee.

As it was informed, however, that the Select Committee had subsequently been transformed into a Commission of Enquiry, it did not take further steps, awaiting the invitation of the Commission to the public to submit memoranda or evidence.

The .../

The Board is not aware that such an invitation was ever published in the daily press or the Government Gazette, and it was not invited directly to submit evidence. The only intimation it obtained that the Commission's work was completed and a revised Bill had been drafted, was a report by its Chairman that a revised Bill had been received by the Department of Commerce and Industries. Efforts were made immediately (February) to secure copies of this Bill, but the Board was informed that no copies were available.

The information that could be obtained about the revised Bill was not calculated to change the Board's previous opinion that insufficient attention had been given to the economic, technical and social implications. Furthermore, it appeared that powers might be given to local authorities that in the Board's opinion, would tend to aggravate rather than to alleviate matters.

The object of this memorandum and the Board's representations, therefore, is to draw attention to these implications.

Some General Aspects of Clean Air Legislation:

The interest in atmospheric pollution is world wide.

Agitation to improve conditions in "black areas" in Britain dates e.g. from the latter half of the 19th. century, yet little progress was made until comparatively recently.

The most spectacular change, due to the control of smoke and grit emission, has probably occurred in cities such as Pittsburgh. The Readers Digest (June 1955, p.68) relates:

> "Pittsburgh had passed an ordinance against smoke in 1941, but it was not applied because both industry and citizens who burned coal at home had 'exploded in opposition'. Even in 1946, when the city had already awakened to the necessity of reforms .....

'advisers .../

'advisers warned the Mayor, David D. Lawrence, that smoke removal would prove his political tombstone' ".

Progress was finally made, from 1946 onwards, not because of the forceful implementation of the ordinance but due to the spontaneous efforts of the community as a whole who had become convinced that action was necessary. According to the above source, the industry in Pittsburgh spent 200 million dollars to prevent contamination of the atmosphere — The expenditure by private citizens is not mentioned. It is very clear that clean air can only be had at a price. To what extent this is a hardship depends on local conditions, income levels, and available alternative energy sources, and the adopted policy.

When the decision was taken in Great Britain to pass a Clean Air Act this aspect was not overlooked.

According to the Peech Committee's Report, (Cmnd.999, publ. by H.M.Stat. office) it was provided in the Act that (§8 of Peech Com. Report): "When a local authority establishes a smoke control area, a grant of 70% of the cost of the reasonably necessary adaption of appliances is available to householders. The full grant is payable for the conversion of an existing living-room fireplace designed for coal to enable coke to be used, but for the more costly alternative of replacing an open fire with a closed stove only the amount of the grant calculated on the fireplace conversion would normally be payable. Where coal is used for cooking and heating water a grant is available for the necessary conversion or replacement of appliances."

Later in this report this Committee specifically recommends (§ 74), "Because of the better availability in relation to estimated demand of fuels suitable for the improved open grate we regard it as most important that full use should be made of the provisions of the Clean Air Act under which grants are available for the installation of these grates in smoke control areas. It might be fatal to the progress of clean air if people living in smoke control

areas .../

areas did not have reasonable freedom of choice in their selection of fuel and this freedom of choice could not exist if the grates installed in their homes were unable to burn coke and low volatile steam coals of suitable quality".

Both examples quoted serve to show that the success of any clean air action is largely dependent on co-operation that can be obtained and not on the ruthless exercise of powers conferred on an authority by an Ordinance or an Act. Once the co-operation has been established, an Ordinance or Act or regulations framed thereunder will naturally be useful to ensure orderly development.

To what extent the availability of suitable alternative sources of energy affect the issue, will be indicated when discussing developments in Great Britain.

A Comparison between Conditions in Great Britain and South Africa.

The Fuel Research Board has gained the impression, during the study of the draft Bill (i.e. the original version being the only one that has been available to it) that this Bill is largely framed along the lines of the British Clean Air Act.

While such an approach may be convenient, it may be submitted that it can only be justified if the conditions obtaining in the two countries are identical or at least very similar.

A comparison is, therefore, not out of place in this memorandum.

At the Oxford meeting of the British Association in September, 1954, Dr. A. Parker gave the following estimate of the use of coal in Great Britain:

TABLE 1. .../

TABLE 2.

Consumption of Fuels in South Africa.

Type of Fuel	Consumer Category	Quantity Consumed 1952 Mill. tons	1952 %	1958 Mill. tons	1958 %
Coal.	Domestic	3.3	11	3.1	8
	Electricity Generation	11.7	39	17.2	44
	Railways	6.4	21	7.6	19
	Mines	1.6	5	1.6	4
	Other Industries	4.3	14	6.5	17
	Carbonisation	2.5	8	2.9	7
	Export & Bunkers	0.7	2	0.3	1
		30.5	100	39.2	100
Petroleum * Products:					
Petrol all types		-		2.26	57
Illuminating Paraffin		-		0.28	7
Power Paraffin		-		0.46	11
Gas Oils & Fuel Oils		-		0.98	25
				3.98	100

*Source: Shell Company annual reports on sales of petroleum products. The figures have been converted to equivalent coal tons.

These figures are quoted to give a general idea of the relative position of the domestic fuel, in the general (mainly solid) fuel pattern of the countries named.

In the planning for clean air in Great Britain the domestic fuel problem commanded much attention as it was recognised that industrial consumers of bituminous coal would be able, by applying existing technical knowledge,

by .../

by using suitable equipment and by adopting good operating technique, to burn coal with a minimum of smoke production.

Much has, in fact, been achieved in this respect by the issue of educational pamphlets and other matter, stoker training courses etc. An incentive to the industry to install additional equipment or to modernise plant, is the fuel savings attainable by the more efficient operation, and in considering these matters they have available, the services of the specially instituted Fuel Efficiency Service.

A similar approach to the problems of industry in South Africa should very largely reduce any smoke nuisance arising from this source, and the Fuel Research Board is of opinion that very few industrial concerns need be seriously considered when attention is given to the provision of alternative solid fuels.

As in Great Britain the domestic consumption of solid fuels presents the greatest problems and this memorandum will, therefore, be confined to this aspect. —

Domestic Fuel Consumption in Great Britain.

As shown in Table 1, some 36 million tons of coal were used in Great Britain by domestic consumers in 1952. This was by no means the total domestic energy consumption at that time. Table 3 (abstracted from the Peech Commission Report Cmnd. 999) gives an assessment of the various types of fuel or energy used in Great Britain in "equivalent coal tons".

TABLE 3 .../

TABLE 3.

DOMESTIC FUEL SUPPLIES IN GREAT BRITAIN
1952 - 1958

Million tons of coal equivalent (a)

	1952	1954	1956	1958
House coal	30.2	31.5	30.6	29.4
Miner's coal	5.2	5.3	5.3	5.1
Anthracite & Boiler Fuel	2.1	2.1	2.1	2.2
Specially reactive Manufactured Fuels (b)	0.5	0.6	0.6	1.0
Total solid fuels	41.9	44.4	43.6	42.0
Electricity	8.1	9.1	11.2	13.3
Gas	11.4	11.3	11.2	11.0
Oil	2.4	2.5	3.5	4.8
Total non-solid fuels	21.9	22.9	25.9	29.1
TOTAL FUEL	63.8	67.3	69.5	71.1

Peech Comm. Rep. p. 26:

(a) 1 ton of coal is taken as being the equivalent of 2/3rd ton of coke, 120 therms of gas, 2,000 kWh of electricity, ½ ton of gas oil and ¼ ton of paraffin.

(b) These comprise "Coalite", "Rexco", "Cleanglow" and "Phimax" and have been converted to coal equivalent by taking 0.8 ton equivalent to 1 ton of coal.

Some idea of the use to which this energy was put in 1952 was obtained from a survey made by the Coal Utilisation Council, the results of which were summarised by W.F.B. Shaw as follows:

TABLE 4.

Domestic Usage of Fuels for Different Purposes
in Great Britain in 1952.

("Air Pollution". Edited by M.W.Thring,p.130)

Fuel	Space Heating		Water Heating		Cooking
	Main	Ancillary	Main	Ancillary	
Solid fuel	98	1	47	36	15
Gas	1	2	44	50	72
Electricity	1	13	9	14	14
Oil	-	-	-	-	1

Note: Figures are expressed as percentages of all households, and some householders quoted more than one "preferred" fuel for cooking.

These tables show clearly that there was a wide choice of fuel or energy available in Great Britain and one can infer that most households used more than one type e.g. solid fuel mainly for space heating and electricity or gas for cooking.

The climatic conditions in Great Britain are such that central heating of the house is generally not considered imperative and heating of one or two rooms is the general practice. A solid fuel fire appears to be generally preferred to gas or electric heating.

Nevertheless, there has been a trend, since 1938, towards more sophisticated sources of energy, e.g. gas and electricity. In an effort to counteract this trend much development work was done by appliance makers and coal interests on all types of solid fuel burning appliances, and it would seem that at present cooking appliances offered in Great Britain are mainly well insulated appliances generally serving the double purpose of providing cooking and baking facilities and hot water. Space heating stoves have been developed for burning both coal and various types of manufactured solid fuels (coke, low temperature coke etc.).

When the Clean Air Act was being considered it was estimated that some 30 - 38 million tons of bituminous coal would have to be replaced by solid smokeless fuels; or at least the 19 million tons used for domestic purposes (in the main for domestic space heating) in those parts of the country designated as "black" areas. While it was hoped that gas works coke would largely serve as alternate fuel, it was realised that the provision of 19 million tons of smokeless solid fuel would be a major task that could only be accomplished in 10 - 15 years. Replacing all the coal would require a capital investment of some £200 million in smokeless fuel producing plant.

While various producers of smokeless fuels have since stepped up production and reactive coke is being made in gas works, the National Coal Board alone has spent £8 million since 1956 in research and development to devise an economically sound process for the manufacture of acceptable smokeless solid fuels but is

not .../

not yet in a position to go into large scale production with any new process.

Experience has shown that the normal gas works coke, while suitable for certain closed stoves and water heating appliances has not been accepted by the population for space heating (in open fires) to any appreciable degree.

Some of the difficulties experienced with coke, whether made from coking or non-coking coal can be ascribed to its inherent properties.

Thus the coke is generally less easy to ignite than coal (lighting by gas poker is, therefore, recommended) and it is more difficult to sustain a small coke fire. The radiation from the fire is affected by the ash content and it is, therefore, deemed advisable to use rather low-ash coal for domestic coke manufacture. Finally the coke has a lower bulk density than coal and more frequent refuelling is necessary when using it.

The object of much of the research has been to increase the reactivity of such smokeless fuels, thereby improving the ignitability and ensuring continuous combustion. While satisfactory results have been obtained when using special coals for the manufacture of the smokeless fuel, this coal is in relatively short supply and research has been undertaken to widen the choice of coals used for carbonisation.

Progress in the establishment of smoke control areas has been much slower than anticipated, one reason being the inability to provide sufficient quantities of acceptable smokeless solid fuels to replace household coal.

Towards the end of 1960 the position appears to have been:

> Smoke control areas created: 470
> involving the use of only 750,000 tons of smokeless fuel (Iron and Coal, March 24, 1961 p.607)
> Actually only 238 smoke control areas appear to have then been in operation involving some 420,000 tons of smokeless fuel. (Coke and Gas May 1961, p.177).

An .../

An analysis of the position shows that the demand for the premium highly reactive smokeless solid fuels is increasing rather more rapidly than anticipated and although producers, using a proved process, have stepped up their production even more rapidly than estimated in 1958, there may be some doubt about their ability to meet the demand in 1963-1965, and considerable capital expenditure in new plant (using proved or new processes) would be required to achieve the objects of the Clean Air Act.

In fact, there are signs that smoke control regulations have even been relaxed in various areas in 1962, one reason being inability to provide suitable alternative fuel.

It may be argued that either oil, gas or electricity might be used more widely to replace the solid fuel. However, this does not provide a ready solution.

From the country's point of view the capital investment in e.g. extra electric generating capacity would be high, especially if provision had to be made for a high domestic peak load — (in 1952 the capital cost of generating equipment was £70/kW installed) — the disadvantage of electricity being that it cannot be stored.

From the consumer's point of view the cost of heating with solid fuel is so much lower even at the price paid for solid fuel in Great Britain that there is no incentive to change to another source of energy. The following figures taken from the Coal Utilization Council's leaflets illustrate this point.

TABLE 5.

Average All-Year Round Weekly Cost of the Fuel Prices Shown for Heating and Hot Water Production in Great Britain.

	Price of Fuel	2-3 Radiators & hot water	6-7 Radiators & hot water
Coke (in independent boiler)	10/6/ cwt.	11/8	17/6
Small Anthracite (Gravity feed boiler)	13/-/ cwt	-	15/3
Gas	1/4/Therm	16/5	23/10
		(including 3/- a week, typical standing charge)	
Electricity	1.1d/ unit	20/-	32/10
		(no standing charge included)	
Oil	1/7½/ gal.	16/5	27/8
		(including 2/- a week minimum maintenance cost).	

One final point may be made in regard to solid fuel prices in Great Britain.

The Committee on Air Pollution (The Beaver Committee) gave the prices shown in Table 6 for coal and alternative fuel or energy as at 1st. October, 1954, while the Peech Committee gave comparative prices as at September, 1959, as shown in Table 7.

Taking London as an example from these tables and giving the coal a price index of 100 in each case, the relative prices of other solid fuels are as shown in Table 8.

TABLE 8.

Relative Price of Coal and Other Solid Fuels.

	1954		1959	
	Price per ton.	Relative Index	Price per cwt.	Relative Index
Coal	130/2	100	(say) 8/-	100
Coke	126/6	97	(open fire gas,coke) 10/4	130
Coalite 1)	176/-	135	(large) 12/4	152
Rexco ⊙	177/9	136	(large) 13/2	164
Cleanglow ♀	-		12/2	152
Warmco*	-		12/4	152
Gloco ♀	-		10/4	130
Phimax ♀	-		-	

1) Low temperature coke made from coking coal.

♀ Gas works coke made from less mature coals, under conditions of increased throughput of the charge through the carbonisation retorts while maintaining a lower flue temperature.

* Activated coke made by carbonising coal, impregnated with e.g. Na_2CO_3, in coke ovens.

⊙ Low-temperature char made from sized non-coking coal in retorts applying internal heating.

This table serves to show that even the premium solid smokeless fuels are only from 30% to 60% more expensive than the bituminous coals. Considering the processing involved this increase is not large. In the case .../15

TABLE 6.

PRICES AND TARIFFS USED IN CALCULATING COSTS.

Note:- The prices used are those current at 1st.October, 1954, except for coal, "Coalite" (large), and "Rexco" (large), where the basic price is used (i.e., the price before adjustment is made for summer rebate or winter surcharge).

		London	Birmingham	Cardiff	Glasgow	Leeds	Liver-pool	Man-chester	Newcastle on-Tyne	Sheffield
ELECTRICITY	per unit (assuming all heating is at the follow-on rate in a block tariff)	1d.	1d	0.85d	0.875d.	0.875d.	0.85d.	0.875d.	0.875d.	0.875d.
GAS I.	Flat rate per therm	19.1d.	17.5d.	19.7d.	19.5d.	20.75d.	19.25d.	19.25d.	16.5d.	14.7d.
II.	2-part, or lower block rate (see Table 3)	15.1d.	15.7d.	14.0d	17.5d.	18.0d.	15.75d.	14.75d.	11.0d.	12.0d.
COAL (Group 4)	PER TON- basic price (heat content 280 therms.)	130/2d.	108/11d.	106/7d.	106/6d.	101/10d.	109/1d.	108/3d.	97/10d.	101/10d.
	pence per therm.	5.58	4.67	4.57	4.56	4.36	4.68	4.64	4.19	4.36
COKE	per ton (heat content 265 therms)	126/6d.	120/-	113/9d.	110/1d.	111/3d.	111/8d.	114/-	107/7d.	115/-
	pence per therm	5.73	5.43	5.15	4.98	5.04	5.06	5.16	4.87	5.21
"Coalite"	per ton (heat content 280 therms)	176/-	158/10d.	175/6d.	175/-	146/8d.	157/2d.	155/10d.	167/4d.	145/2d.
	pence per therm	7.54	6.81	7.52	7.50	6.29	6.74	6.68	7.17	6.22
"Rexco"	per ton (heat content 280 therms)	177/9d.	164/-	not sold	not sold	163/10d.	161/4d.	154/11d.	178/6d.	153/7d.
	pence per therm	7.62	7.03	-	-	7.02	6.91	6.64	7.65	6.58

*Committee on Air Pollution (The Beaver Committee Report) (November 1954) Table 2. Page 65."

TABLE 7*

"Prices of Solid Smokeless Fuels for the Open Fire.

Representative Prices in Certain Large Towns.

Retail prices of solid fuels are fixed by merchants and are liable to variation. The following representative prices for one hundredweight delivered sacks, are based on prices ruling in September, 1959, adjusted for the summer price reductions in force then. They give some indication of the winter price range among the various open fire smokeless fuels available and the effect of location on price. During the summer period the price relationships might be different because of the varying effect of the summer price reductions. Consumers may find merchants' winter prices higher or lower than those shown below, due to local circumstances.

	London		Bristol		Cardiff		Birmingham		Manchester		Glasgow	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Large "Coalite"	12	4	12	6	12	5	11	4	10	11	12	6
Large "Rexco"	13	2	-		-		11	9	11	2	13	2
"Phimax"	-		-		-		-		10	6	-	
"Cleanglow"	12	2	-		-		-		-		-	
"Warmco"	12	4	12	6	-		11	1	10	10	-	
Low Volatile Steam Coal	-		-		8	5 (a)	-		-		-	
Gas Coke No.2 (Open-fire coke)	10	4	10	3	9	10	8	9	8	7	8	10
"Gloco"	10	9	10	5	-		-		-		-	

(a) Cobbles: price varies according to pit.

*Report of the Committee on Solid Smokeless Fuels (The Peech Committee Report) (Appendix A. Page 26.) "

case of the gas works and coke oven coke, part of the processing cost is, of course, borne by the sale of by-products (gas and tar products) but the Rexco process produces only small quantities of saleable by-products. However, the capital cost of this plant is relatively lower than that of a coke oven plant or gas works.*

Under conditions where the price difference is only of this order one can understand the tendency of the public to prefer the premium fuel which i.al. has the advantage that it can be used in existing grates and, therefore, no capital expenditure is necessary for the purchase of new domestic heating appliances that are needed to burn the less reactive smokeless solid fuels effectively.

The Comparative Position in the Republic of South Africa.

A survey of coal usage in the industrial area Pretoria - Rand - Vereeniging was made by the C.S.I.R. in 1960 and the results may be summed up as shown in Table 9.

Table 9.

---

* The point is that where the basic (coal) price is of the order of that in Great Britain the additional carbonisation cost represents a relatively lower percentage increase in the final cost of the smokeless fuel than it would if the coal cost were low. This will again be discussed when dealing with South African coal.

TABLE 9.

Usage of Coal in 1960 in the Transvaal Industrial Area.

		tons.	
(a)	Power Stations	7,460,537	
	Iron and Steel	2,200,594	
	Gas Works	95,053	
	Efficient use of coal		9,756,184
(b)	Engineering Industries	190,456	
	Mines	728,996	
	Ceramics Industries	319,562	
	General Industries (large)	917,545	
	General Industries (small)	380,795	
	Institutions & Buildings	222,561	
	European Householders	538,887	
	Non-Europeans	660,555	
	Less efficient use of coal		3,959,357
			13,715,541

The group (b) was held to comprise less efficient users of coal i.e. users more generally responsible for smoke production.

Their relative consumption of the approximately 4 million tons of coal is:

	Percentage of 4 million tons approx.	
Engineering Industries	4.8	
Mines	18.4	
Ceramics Industries	8.1	
General Industries (large)	23.3	
General Industries (small)	9.6	
Institutions & Buildings	5.6	
European Households	13.5	30.2
Non-european households	16.7	
	100	

In an attempt to determine what tonnage of coal might have to be replaced by smokeless fuels it may be assumed that all the larger industries including mines and at least fifty percent of the smaller industries could

modify .../

modify their combustion appliances and their operating technique to burn coal smokelessly.

This would leave for possible replacement:

	Quantity.	
	%	Approx. tonnage for the whole Republic of S.A. Mill. tons.
Industrial consumption (about)	11.2	1.1
Institutions & Buildings	5.6	0.6
European Households	13.5	1.4
Non European households	16.7	1.7
		4.8

Assuming that this ratio can be applied to these consumer groups throughout the country and remembering that their total consumption of coal now is of the order of 10 million tons, the tonnage of coal that may have to be replaced would lie between 4.5 and 5 million tons p.a.

As far as domestic consumers are concerned, it is of interest to refer finally to the monthly consumption of coal as given in the survey:

TABLE 10.

Monthly Domestic Coal Comsumption in the Pretoria-Witwatersrand-Vereeniging Industrial Area.

	EUROPEAN		NON EUROPEAN	
	Tonnage	Relative Index	Tonnage	Relative Index.
January	29,241	80	39,987	82
February	34,729	95	46,204	95
March	49,557	136	51,072	103
April	48,126	132	53,909	105
May	64,180	173	63,875	130
June	55,106	150	61,322	126
July	71,470	196	74,762	152
August	44,345	122	66,505	136
September	37,152	101	50,203	102
October	34,820	95	53,523	105
November	33,517	92	47,744	98
December	36,644	100	51,449	103
TOTAL	538,887		660,555	
Average for Summer Months	36,522		48,598	

Taking the average consumption during the months of September to December and January to March as 100, the index figures shown have been worked out.

The effect of the winter space heating load is evident during June and July, but this does not represent a very high rise in consumption by the non-European households. Overall, the coal consumption is fairly steady and as space heating would definitely not be necessary during say, November - March, one is justified in concluding that the coal is used throughout the year mainly for cooking and for heating water. The use pattern of coal is, therefore, very different from that in Great Britain.

This difference becomes even more evident when considering the general domestic energy consumption in the Republic. The analysis will have to be confined to the fuels coal, anthracite, (and coke), some manufactured liquid fuels, gas and electricity as no figures are available for fuels such as wood and animal dung which are largely used in rural areas. In some of these rural areas "liquid gas" is becoming popular, but one can probably assume that much of this "liquid gas" is replacing wood and dung rather than coal.

Full details of the consumption of the fuels mentioned are unfortunately also not available and the figures (in terms of equivalent coal tons based on the conversion factors used in the Peech Report), given in Table 11, must be regarded as approximations, which, nevertheless, give the order of magnitude of the various contributions. Fuel or energy such as electricity, illuminating paraffin (and liquid gas) are, of course, used to an unknown extent for house lighting.

TABLE 11.

Domestic Fuel Consumption in the Republic.

(Millions of equivalent coal tons)

	1952	1954	1956	1958	1960/61.
Domestic coal	3.3	2.9	3.6	3.1	3.2
Gas works coke	-	-	<0.02		<0.02
Anthracite	-	-	-		0.16
Electricity	1.1	1.2	1.4	1.7	2.1
City gas	-	-	0.051	0.052	0.053
Liquid gas	-	-	0.001	0.012	0.041
Illuminating paraffin*					
Other oil*					

* No information of domestic consumption per se could be obtained from Oil Companies.

This .../

This tabulation shows that coal, electricity and anthracite practically carry the total domestic energy demand, which is again in striking contrast to conditions in Great Britain.

Replacement of Coal by Presently Produced other Energy Sources.

It may now be considered briefly to what extent household coal could be replaced by other fuels mentioned in Table 11.

Gas and Gas works Coke.

It will be noted in Table 11 that gas makes a very minimal contribution to the South African household energy demand while it is of considerable importance e.g. in Great Britain.

There are only five gas works in South Africa, viz. at Cape Town, Johannesburg, Port Elizabeth, Grahamstown and Springs. With the exception of Johannesburg and Grahamstown these are catering mainly for the commercial and industrial market.*

It is very doubtful that other gas works will be established in the Republic and even if this did happen the incentive would be the demand of industry. Thus the Springs gas works was established to supply industrial consumers and domestic sales are now of the order of only 0.3%.

A gas supply by Sasol or the Refineries at Durban would probably also be used by industry rather than for domestic purposes.

One reason advanced for the lack of interest in supplying domestic consumers is the heavy capital cost required for reticulation in the widely spread South African residential areas.

The position in regard to gas coke is even worse as the trend of city gas production in South Africa is to total gasification of coal instead of carbonisation.

The .../

*Percentage of gas sold for domestic purposes being - Johannesburg 67%

Johannesburg	67%
Springs	0.3%
Port Elizabeth	15%
Cape Town	18%
Grahamstown	98%

The scarcity of caking (gas) coal may be one reason for this trend.

Anthracite.

Total anthracite sales in the Republic were about 449,000 tons in 1961, of which 159,000 were used for domestic purposes.

The anthracite is almost exclusively supplied by three collieries all situated in the N'Gwibi mountain, Natal.

Reserves of anthracite, having an average volatile matter content of 9%, in this mountain are estimated to be about 35 million tons.

The specifications for anthracite are stringent (quality, size grading) and in order to produce the approximate 500,000 tons of saleable anthracite, some 150,000 tons of anthracite fines have had to be dumped as unsaleable. The producers have also found it necessary to install cleaning plant to reduce the ash content of the product to an acceptable level.

All these factors combine to make the production cost of anthracite rather higher than that of bituminous coal viz. pithead about R4.50 per ton as against about R1.60 for Natal coal.

The existing collieries might increase their production, but an appreciable increase would only be possible by investing more capital and this may not be considered justifiable considering the reserve position.

With increased output at the anthracite collieries the unavoidable production of unsaleable fines at the rate of about 20% of the output would increase. It may be argued that this material could be utilized by making briquettes. This presents no technical difficulties, but the capital cost of plant may be taken to be about R70 per ton of production and the cost of briquetting is of the order of R3.25 per ton including the cost of the pitch required, but excluding the cost of the anthracite fines used. If manufactured at the colliery, the saleable briquettes would,

therefore, .../

therefore, be at least as expensive as the sized anthracite currently sold.

There have been other producers of anthracite in Natal, but most of these collieries were closed down and only one reasonably large colliery, in the Elandsberg, was opened up.

The estimated "in situ" reserves of anthracite, having a volatile matter content of less than 9%, in the Vryheid coal field is about 235 million tons, but comparatively little is known about the quality of much of this anthracite. In any event it may be assumed that at this lower volatile matter content this anthracite will be more difficult to ignite and will be more slow burning than the anthracite currently mined.

In the area around Dundee there may be a reserve "in situ" of some 66 million tons of anthracite and semi-anthracite. The quality is variable and ash contents may exceed 20%.

No anthracite is presently mined in the Transvaal. Although partially devolatilised coal is found in various Transvaal coal fields it is not known whether there is any deposit that would justify the establishment of an anthracite colliery in this province.

Although other anthracite collieries may be opened up, it appears very doubtful that the present domestic supply of some 159,000 tons of anthracite could be increased to anything like one million tons in the near future.

Electricity.

By world standards South Africa already has one of the highest per capita consumptions of electricity and the consumption is still increasing overall at some 8% per annum.

Organisations such as Escom are faced with the problem of keeping pace with the increasing demand by increasing generating capacity.

Nevertheless, .../

Nevertheless, present domestic consumption represents only about 10% of the total power generated (although city power stations may distribute 30% to 40% of the power generated to domestic consumers).

For economic reasons generating stations must be operated at the highest possible load factor (Escom overall 80% load factor). However, as electricity cannot be stored, every station must be designed for the highest estimated peak demand. If the difference between peak demand and average demand is large then it is obvious that very considerable capital sums must be invested in largely idle plant.* Now the domestic load is highly variable with comparatively short periods of peak demand. Because of this, one must conclude that a generating station erected specifically for domestic demand would probably be highly uneconomic even if exorbitant prices were charged for electric power. (Many small towns have, therefore, abandoned their own generating station and obtained a bulk supply from Escom, whose stations cater in the main for large bulk consumers such as the mines.)

One can, therefore, not expect any authority to cater specifically for the domestic demand in order to replace household coal.

Liquid Gas.

Liquid gas has the advantage that it can be stored and that it is a convenient, clean fuel. However, at present prices it cannot compete with electricity in the larger cities, but it has become popular in smaller towns and rural areas.

As far as could be established about 50% of the liquid gas sold is used in households.

Although sales have increased about thirty-fold since 1956 they still represent the equivalent of

only .../

---

*For stations of at least 500 Megawatt capacity the capital cost is of the order of R100 per kW installed, but this may increase to beyond R300 per kW installed in stations of less than say 30 Megawatt capacity.

only about 80,000 tons of coal (half for domestic consumption) and even if the supply should be very greatly increased with the expansion of petroleum refining in South Africa the potential energy in terms of equivalent tons of coal cannot be expected to reach even half a million tons (coal equivalent) in the near future.

Petroleum Products.

The total inland sales of petroleum liquid fuels are of the order of 3.98 million/equivalent tons of coal of which 2.26 million represent petrol of all types. The present domestic consumption of these fuels could unfortunately not be obtained. It is probably confined to illuminating paraffin of which the total inland consumption in 1958 was about 0.28 million tons (coal equivalent).

Semi-Anthracite
(i.e. Coal with a Volatile Matter Content Ranging from about 12% to 16%)

In order to complete this brief survey of fuel sources attention must finally be given to semi-anthracite.

Semi-anthracite coal is found in various localities in South Africa, but very little is specifically mined to provide a coal having this volatile matter content as the demand has been very small. The production may be of the order of 400,000 tons per annum, the coal having an ash content in the neighbourhood of 20%. This coal is, therefore, not comparable with the Welsh dry steam coal which is a very popular domestic fuel in Great Britain.

It may be possible to extract such coal separately at some collieries, but in that event, and because the coal may have to be drastically cleaned, the price of such a product would be at least as high as that of anthracite, while the annual tonnage would not be very high.

An appreciably higher tonnage could only become available by opening up collieries for this purpose.

At a rough estimate there may be an "in situ" reserve in Natal of some 87 million tons of this coal of

reasonable ..../

reasonable quality and in blocks sufficiently large to justify the opening up of small to medium sized collieries. In addition some 80 million tons (in situ) of coal of lower quality may also be available, but this coal would only be marketable after drastic cleaning. There is also the possibility of other reserves but too little is known about them to assess their possible value.

Such coal is also found in the Wakkerstroom district of the Transvaal. The "in situ" reserve may exceed 100 million tons, but too little is known about the quality of the coal and the continuity of seams to determine whether economic mining is possible. The area is fairly inaccessible and a colliery situated in this coal field may, therefore, have great difficulty in delivering its product to the markets.

One must, therefore, conclude that the areas: Eastern Elandsberg, the vicinity of Utrecht and an area east of the former Cambrian Colliery hold out most promise as far as semi-anthracite mining is concerned.

Such semi-anthracite collieries would be faced with the same problem as anthracite producers in that this coal has, so far, not found acceptance as a general purpose fuel and, inland, the producer would have to cater almost exclusively for the domestic market and any size grades not acceptable in this market would be practically unsaleable.

Production costs would, therefore, probably be of the same order as those for anthracite. As both anthracite and semi-anthracite can, so far as present knowledge goes, only be produced in Natal, consumers outside this province must, therefore, also bear a heavy railage charge on their fuel. ---

Summarising this review, one has to conclude that not one of the presently available sources of energy holds out promise of replacing the approximate five million tons of bituminous coal that, according to estimates, should be replaced to ensure freedom from smoke.

If ..../

If this bituminous coal must be replaced it will be necessary to consider the production of smokeless fuel from bituminous coal that is the cheapest and most readily available raw material for this purpose in the Republic.

It has, however, been mentioned that anthracite (and possibly semi-anthracite) fines might be briquetted to increase the availability of smokeless or reasonably smokeless fuel.

This aspect may, therefore, be considered first when considering some of the economic factors of smokeless fuel production.

The Briquetting of Solid Fuels:

By making briquettes one can utilise fine solid fuels that may otherwise not be acceptable to consumers.

All types of solid fuels fines: anthracite, coke or char breeze, semi-anthracite and bituminous coal can be briquetted but the amount of binder required will vary. Furthermore, depending on the binder and the solid fuel used, the briquette may or may not burn smokelessly and the combustibility will also vary with the properties of the solid fuel used.

It has been stated that briquettes having a volatile matter content of up to 24% can be burnt smokelessly but this will only be possible under careful operating conditions and it appears safer to assume that the volatile matter content must be below 20% for smokeless combustion.

Various types of binder have been suggested, but the only one that has been found to be generally acceptable in other countries is coal tar pitch.

The quantity of binder required depends on the type of solid fuel used and up to 10% of pitch may be needed, although it is claimed that by using pitch emulsions the quantity may be reduced to as low as 4%.

In this discussion it will be assumed that 6% pitch is sufficient.

On .../

On this basis only anthracite and char or coke fines could be briquetted and the briquettes used as such. Briquettes from other solid fuels would have to receive a subsequent heat treatment with or without an oxidation treatment to reduce the tendency to smoke to an acceptable level. The additional cost of such a treatment will be discussed in the following section on carbonisation.

According to information obtained in Germany in 1956/57 the capital cost of[a] briquetting plant producing 1,000 tons per month of briquettes was estimated to be R70,000

The production cost of briquettes (exclusive of the cost of the solid fuel fines) are then estimated as follows (also based on the above information)

TABLE 12.

Cost of Briquetting Solid Fuel Fines.

Pitch 60 tons (at say R14.00/ton)	R 840
Wages (4 Europeans 2 Bantu)	1200
Power (52 kWh/ton at R0.005)	260
Steam (50 kg/ton at R0.40/ton)	20
Capital Charges (10% Depr.6% interest) $\frac{16}{12} \times 70,000 \times \frac{1}{100}$	930
	R 3,250
or per ton	R3.25

The factory price of such briquettes will depend on the cost of the solid fuel fines and the gross profit required to make the operation attractive. It can hardly be expected that the price would be lower than the pit head price of anthracite presently sold, even if operation were on a larger scale than 1,000 tons per month, and economies were affected thereby.

If the briquettes have to be subsequently carbonised the cost would be appreciably higher.

The .../

The Production of Smokeless Fuel from Bituminous Coal.

The Use of Coking Coal:

As stated earlier in this memorandum, the estimates of smokeless fuel production to replace household coal in Great Britain were originally based on the availability of gas works coke manufactured from caking coal. A very large proportion of the smokeless solid fuel now sold in Great Britian is still made from caking coal. This is possible because such coals represent a large percentage of the British coal output.

In South Africa there is a definite scarcity of caking coals, and although the present demand for coking coals by the steel industry can be met, the known reserves of coking coal are inadequate by comparison with the available reserves of high grade iron ore in the Republic,

It is, therefore, the Government's policy, accepted also by the coal industry, to reserve as far as it is possible to do so, the coking coal reserves for the steel industry. Even the gas works have had to be satisfied with weakly coking coals.

One cannot, therefore, consider the use of caking coals for the manufacture of smokeless fuels in the Republic.

One can, therefore, only consider processes which can produce an acceptable smokeless solid fuel by treating very weakly caking or entirely non-caking coals.

(The production of liquid fuels from coal will not be considered in this memorandum.)

Low-Temperature Carbonisation Processes that are Designed to process weakly or non-coking coal.

Three processes that have been operated on a large scale and proved, may be mentioned. They illustrate the basic principles that may be adopted.

1. The Rexco .../

1. <u>The Rexco Process:</u>

This is a batch process. Closely sized non-coking coal (e.g. 2" to 3") is charged to a cylindrical retort and the charge is heated by passing hot gases through it from top to bottom. The hot gas is obtained by the partial combustion of the volatile matter evolved from the coal or by burning producer gas.

Some tar can be recovered from the gas leaving the retort. The retort gas has a low calorific value and is not suitable as a town gas.

The process is flexible. A char having either a volatile matter content of only about 2% or one of say 10% can be produced (the higher volatile matter content is preferred if the fuel is to be used for domestic purposes.) The char is said to be highly reactive and is a popular smokeless fuel.

During this heat treatment the lumps of non-coking coal retain their shape but shrinkage cracks may occur and the final product is not as strong as the original coal. The product has to be screened and a certain amount of undersize, not saleable as domestic fuel, is formed, the amount depending on the properties of the coal.

2. <u>The Lurgi Spülgas Process:</u>

This is a process developed in Germany. The retort is a vertical shaft and operation is continuous, the coal being carbonised by internal heating, (the hot gas is obtained by partial combustion of the volatile matter driven from the coal).

The process yields a char, similar to that produced in the Rexco process, tar and a lean gas.

3. <u>The Coker Stoker:</u>

This process was developed in Canada to produce char for electro-metallurgical processes.

The coal is charged on to a travelling grate which .../

which moves through the retort. The volatile matter evolved is completely burnt and carbonisation is largely effected by radiant heating (heated arch of the retort).

No by-products are recovered but there is a large excess of heat that could be used for steam and electric power generation.

All three processes can operate on well sized non-coking coal or on briquettes that will not soften when heated.

Capital Costs of Plant and Production Cost of Smokeless Fuel.

General:

The following general estimates of the capital cost of carbonising plants were given to officers of the Institute in 1958 (private communication):

TABLE 13.
Capital Cost per Million tons per Annum Throughput.

	Million Pounds Stg.
Rexco Process	3
Coalite Process	8 to 9
Spülgas Process	10
Nat. Gas Board United Kingdom Processes	10 to 11
Met. Coke Ovens	12 to 15

It is not known what the size of an economic unit is in every case. It will depend on the process used and may be of the order of 40,000 tons per annum for a process like the Rexco and may exceed 200,000 tons per annum for others.

Rexco Process:

It is quoted in Gas World (12/5/56 p. 1076) that a Rexco plant for producing five million tons of smokeless solid fuel would cost £15 million while a later figure

(Woodall-Duckham) .../

(Woodall-Duckham Tech. Press Report No. 1342 (Dec. 1959, p2) gives a figure of £250,000 for a plant producing 100,000 tons per annum of smokeless fuel.

The figure of R6 million per 1 million tons of smokeless fuel production, therefore appears to be reliable.

Unfortunately no production cost figures could be obtained for this process.

Lurgi Spülgas Process:

In a private communication to the Institute given in 1954, the following information was provided:

The Lurgi retorts are built in sizes having throughputs of 50-80, 200-300, 300-450 tons (metric) per day. The following data apply to a cluster of 4 small and of 2 medium sized retorts.

TABLE 14.

Operating Data of Lurgi Spülgas Process.

		Scheme 1. 4 Small Retorts	Scheme 2. 2 Medium Retorts
Capital Cost (Approx.)		R675,000	R 1 million
Input tons/day		330	600
Output at 5% V.M.	(case 1)	220	400
Output at 15% V.M.	(case 2)	275	500
Gas (Therms/day)	(case 1)	6,000	11,000
	(case 2)	3,000	5,500
Tar (tons/day)	(case 2)	12	22
Consumption of:			
Electric Power (kWh/day)		3,600	6,600
Steam (tons/day)		14	14(?)
Cooling Water make-up (tons/day)		220	320
Staff - European		15	10
Bantu		36	32

Using this information one can estimate the monthly operating costs as follows (not providing for maintenance and repairs).

TABLE 15.

Production Cost of Char by Lurgi Spülgas Process.

	Scheme 1.	Scheme 2.
Power at 0.005 cts./kWh.	R 540	R 990
Steam at 0.40 cts./ton.	150	150
Water at 0.05 cts./ton	330	480
Staff: European	1,800	1,500
Bantu	1,080	960
plus 10% spare	290	250
Capital Charges		
(Depr.10%, Intr. 6% p.a.)	9,000	13,300
	13,190	17,630
Per ton of Char produced	R 1.62	R1.18
Products:		
Char (t/m)	8,150	15,000
Gas (case 2) (Therms.)	90,000	165,000
Tar (case 2) (tns/m.)	360	660

A plant comprising two retorts each having a daily throughput of 400 metric tons was actually built in South Africa at a cost of about R2 million.

This plant yields about 318,000 cub. ft per hour of gas having a calorific value of 140 B.T.U./cu.ft., or 10,650 Therms of gas per day and some 50 tons (S.A.) of tar are produced daily.

These figures check reasonably well with those of the above estimate.

As regards operating charges it would appear that less staff is required, but at current rates in South Africa the figure given for salaries and wages in the estimate (Table 15) can be maintained as quite reasonable. About R1,000 per annum would have to be added to the estimate for materials and maintenance, raising the production cost per ton of char to about R1.72 and R1.24, respectively

In .../

In this plant some 20% of the product was found to be smaller than ¾" in size. Accepting this as an indication of the amount of rejects from a plant producing domestic fuel, the saleable coke in the above case would be 6,510 and 12,000 respectively, and the production cost per ton of saleable coke would be -

$$\frac{14,190}{510} = R2.18$$

and

$$\frac{18,630}{12,000} = R1.55$$

A reduction in this cost can only be achieved if revenue can be earned on the by-products.

There appears to be at present, no demand for the Lurgi-type of tar except possibly as a fuel for boiler plant.

The gas has such a low calorific value that it may not be worth the trouble to purify it adequately for distribution in a grid system.

If the Lurgi plant can be situated near, say, a large industrial plant or an electric power station, both the tar and the gas could possibly be profitably used as ancillary boiler fuel (with coal).

The unsaleable char fines might then also be used as boiler fuel (if sandwich-charged with the coal). The industry or power station would probably be prepared to accept such fuel at an equivalent coal price. Therefore, converting the yields given in the above estimate on the basis of 1 ton of tar equivalent to 2 tons of coal and 120 therms of gas equivalent to one ton of coal and assuming the plant to be situated in the coal field where coal costs are R1.25 per ton, one finds:

TABLE 16.

Effect of Revenue from by-products on the Production cost of Char.

	Equivalent Coal tons. Scheme 1.	Equivalent Coal tons. Scheme 2.
Tar	720	1,320
Gas	750	1,375
Char fines (no conversion) (20% of char output)	1,630	3,000
	3,100	5,695
Revenue at R1.25/ton	R 3,870	R 7,100
Monthly costs as in Table 15 (plus maintenance and repair R1,000)	R14,190	R17,630
Less by-product revenue	3,870	7,100
	R10,320	R10,530
Saleable char (80% of production) tons	6,510	12,000
Cost per ton of char (R/ton)		
without receiving revenue from by-prod.	R 2.18	R 1.55
with revenue from by-products	R 1.59	R 0.88

A probable price of char may now be estimated as follows:

Assume that the charring plant is at or near a colliery in the Witbank coal field so that the coal price is at a minimum. The coal should have a reasonably low ash content and would, therefore, have to be a washed coal. Assume that it can be had for R1.40 per ton at the plant. Assume further that the raw char yield is 80% of the coal charged to the retorts and that the loss in unsaleable small char is 20%. -

Then 1.25 tons of coal must be carbonised to yield one ton of raw char and the coal cost will be 1.25 x 1.40 = R1.75. Therefore the coal cost per ton of saleable char is

$\frac{100}{80}$ x 1.75 = R2.17.

This sum has to be added to the production cost figures shown above and it is not unreasonable to add 25% to the total to represent administrative charges and profit. The price of the saleable char would then be approximately as follows:

TABLE 17.

Probable Factory Price of Saleable Char.

	Without Revenue for By-products		With Revenue for By-products	
	Scheme 1	Scheme 2	Scheme 1	Scheme 2
Production cost of Char (R/tn.)	2.18	1.60	1.59	0.88
Coal Cost (R/tn.)	2.17	2.17	2.17	2.17
Add 25% on total cost	1.09	0.94	0.94	0.76
Factory Price of saleable Char	5.44	4.71	4.70	3.81

It is obvious that considerable benefits accrue by placing the char production plant in the proximity of a large consumer of fuel who can use the by-products as ancillary fuel.

As the cost of coal is practically doubled by a rail journey of about 80 miles and in this case only 64 tons of saleable char are produced for every 100 tons of coal input, it also appears advisable to prepare the char as close as possible to the collieries that can supply suitable coal. ---

If .../

If bituminous coal briquettes are to be carbonised, one can assume that some 1.43 tons of briquettes would be needed to produce 1 ton of charred product.

Assuming very favourable conditions, i.e. briquettes at the bare production cost with no price on the coal fines used, ready sale of by-products, practically no loss of solid fuel as fines, a charring cost of only R1.00 per ton and a charge of R0.8 for administration and profit, the price of charred briquettes would still be approximately:

Production cost of char	R1.00
Cost of input briquettes (1.43x3.25)	R4.65
Plus administration and profit	R0.80
Very conservative price of charred Briquettes (R/ton)	R6.45

These cost prices can be compared with some figures applying to conditions in India.

In that country there is a need for a reactive smokeless solid fuel to replace, very largely, animal dung and wood.* The technical and economic problems have been studied for a period of some 10 years (Coke and Gas, March 1962, 24, p.119-24, and Indian Jnl. of Mines, Metals and Fuels, 1 Jan. 1961, p.24). Although there is no definite commitment yet to use any process, it can be inferred from the publications that the following figures apply to the Lurgi Spülgas process. Furthermore, it can be assumed that possible revenue from by-products has been brought into account as this aspect received much attention.

It is estimated that capital costs and the cost of char would be as follows (converting Rupees to Rand):

TABLE 18.

Estimated Cost of Smokeless Solid Fuel in India.

	Plant throughput (tons per day).	
	800	1,600
Capital cost of plant	R 2,625,000	R 4,590,000
Cost of char		
ex Singareni coal (R/tn.)	7.52	7.06
ex Jambad " (R/tn.)	5.12	4.68

No .../

*Very little coal is apparently used in India for domestic purposes.

No information is given in these articles on the pithead price of this coal* or to what extent the coal is pretreated and the distance it may have to be transported by rail to the char production plant. No information is also available on the credit brought into account for byproducts. One cannot, therefore, analyse these figures fully. Nevertheless, they suggest that the estimate given in Table 17 is reasonable and probably conservative. (It may be noted that no provision was made in the estimates of Capital Expenditure for standby plant. It would be advisable in practice to have at least 30% standby retort capacity.)

The Coker Stoker Plant.

A plant of this nature with an output capacity of about 45,000 tons of char per annum (3 shift operation) was erected in South Africa some fifteen years ago at a cost of R260,000. The plant operates comparatively economically requiring only about 6 kWh of electric power per ton of input coal and some water for quenching the char.

The plant is presently producing char with a volatile matter content of approximately 2% or less, and as some combustion of solid carbon occurs, the yield of raw char is only about 60% of which about 25% is fines.

Assuming that under operating conditions, where the final char has a volatile matter content of about 10%, the yield is 70% and that the percentage of unsaleable small char is 20%, when using large nut coal for charring, the production cost may be estimated as follows:

TABLE 19.

Estimated Production Cost and Factory Price of Char Produced in a Coker-Stoker Plant

			Costs per Annum
Staff: Per shift $\frac{1}{3}$ European	R1,000		
$2\frac{1}{2}$ Bantu	R1,500		R 7,500
	R2,500		
Power @ 5 kWh per ton input and @ 0.005 R/kWh			R 1,929
Water		(say)	R 240
Maintenance & materials		(say)	R 2,600
Capital Charges Depr. 10% and Interest 6%			R41,600
			R53,869 p.a.
Production cost of raw char	$\frac{53,869}{45,000}$	=	R 1.20 per ton
Add cost of coal: 1.43 tons of coal @ 1.4 R/ton.		=	R 2.00 " "
			R 3.20 " "
Cost of saleable char (assuming 25% fines loss) $\frac{100}{75}$ x 3.20		=	R 4.27 " "
Add 25% for administration & profit			R 1.05 " "
			R 5.32.

* According to private information the Government controlled pithead price of coal in India is about R3.45/ton.

The plant could provide heat or process steam and thus derive some revenue from that source if it were in close proximity to a factory or works requiring process steam. The 9,000 tons of small char not suitable for domestic purposes might also find an outlet, e.g. in electro-metallurgical processes or for steam raising. But the disposal of these products from a small works at an attractive price may be difficult. No calculation of the benefits accruing will be made here as the trend would be similar to that shown for the Spülgas process. ---

Summarising these considerations, one may state that the price of char from works producing up to about a quarter of a million tons of saleable char per annum in the coal field would be in the region of R4.00 per ton in comparison with a price of bituminous coal from the same field at R1.25 -

i.e. a price ratio of 320 : 100

This ratio may be compared with that in Great Britain (Table 8) of, at worst, some 160:100. The unfavourable ratio in South Africa is due to the very low price of coal in the Republic which tends to accentuate the effect of any processing cost.

If, therefore, it is deemed to be important to reduce the processing cost in Great Britain so as to make the price of char more attractive (that is the prime object of the National Coal Board's research and development effort on this smokeless fuel production problem) then, a fortiori, an effort should be made in South Africa to produce a suitable char at the lowest possible cost.

Large carbonisation or charring plants should be able to produce at a lower figure. However, if large scale production is contemplated, rather more serious consideration will have to be given to the disposal of by-products. They might become such a burden that any benefit accruing from larger scale operation is outbalanced by disposal costs. On the other hand if some of the by-products are available in sufficient quantity their

processing ..../

processing by a chemical industry may become economically feasible and the by-products may become a valuable asset. Nothing positive about these matters can be said without a detailed study of all possibilities. —

It is also clear from this discussion of carbonisation processes, bearing in mind that no plant is at present available in the Republic to produce such domestic smokeless fuel, that a capital investment of at least R30 million would be necessary to provide the approximately 5 million tons of smokeless solid fuel that may be required.

Even if this money were readily available and the decisions about the type of plant, the locality or localities where it was to be erected etc. had been made, it would take at least 24 months before the first sections would be ready for production. —

It is impossible, in such a preliminary study, to discuss every aspect of the problem. But enough has been said to indicate that the whole matter of char or smokeless solid fuel production merits close study.

It has been shown that the economies of the processes will, to a large extent, depend on the most economical utilisation of by-products and to that end the co-operation of chemical and other industries and electric power producers will have to be sought as early as possible in the planning stage.

The size of the most economic unit under conditions prevailing in the Republic will have to be determined as well as the most suitable locality for production and who should be responsible for this production.

There is no ready, practical, economic solution to these problems even if technically sound processes exist. This is borne out by the research effort of the National Coal Board of Great Britain that has spent some £8 million during the past 8 - 10 years on research and development to find a more economical process to produce a solid smokeless fuel of the required quality at an acceptable price — without having as yet found a definite solution, and the 10 year technical and economic study in

India .../

India that is, even now, "not yet committed to any process".

The Relative Cost of Fuel and Appliances.

If smokeless solid fuel had to be made in the Republic now, the factory price of the fuel would be of the order shown in the previous tables. This implies that it would be as, or more expensive than anthracite.

Under conditions of free choice the domestic consumer in the Republic would then have the choice of wood, coal, anthracite and manufactured solid smokeless fuel, liquid fuels, such as illuminating paraffin, liquid gas, city gas (in restricted areas) and electricity.

His choice will depend on the relative cost, the labour involved, cleanliness and the convenience offered by these fuels or sources of energy. The latter aspects will carry most weight with those who can afford to pay less attention to relative costs.

At the Lagos-Bukavu Conference of the C.C.T.A./C.S.A. in November, 1960, a relative economic assessment was made of various types of energy, each used in the appropriate type of cooker. The following Table 20, is largely based on this assessment (the data for which were supplied by the Shell Company of South Africa Ltd.) but some of the prices have been brought more in line with those obtaining in the Pretoria-Witwatersrand industrial area, and figures for anthracite have been added:

TABLE 20.

Relative Assessment of the Economics of Alternative Sources of Energy for Domestic Cooking in the Republic of South Africa.

Fuel	Cal.Val. (B.T.U. per Unit)	Approximate cost* (cts. per Unit)	Cost Price per 100,000BTU (cts.)	Efficiency of Appliance	Cost per 100,000BTU. effectively used (cts.)
Wood	8,000/lb.	44/100 lb.	5.5	15	36.6
Coal	12,000/lb.	21.3/100 lb.	1.8	15	12.0
Anthracite	13,400/lb.	47.5/100 lb.	2.8	15	18.8
Anthracite	13,400/lb.	47.5/100 lb.	2.8	22	12.7
Coal gas	500/cu.ft.	20/Therm	20	55	36.4
Liq. gas	20,000/lb.	10/lb) R10/100 lb.)	50	60	83.3
Electricity	3,400/kW	0.8/unit	23.6	65	36.3
Ill. Paraffin.	130,000/gal.) 18,000/lb)	28.75/gal.	22	40	55.0

*Approximate retail prices in the Pretoria-Witwatersrand industrial area.

This .../

This table shows clearly that coal has a great economic advantage over the other fuels and electricity. The efficiency of a good anthracite burning stove was not known, but it was assessed on the basis of the relative fuel consumption quoted by appliance makers. The figure thus obtained is 22% if that of the coal stove is 15% (admittedly the anthracite stove is available 24 hours per day while the coal stove has to be relit at least every morning).

If this efficiency value is used, the "useful cost" of coal and anthracite are comparable. However, such a well insulated anthracite stove is more expensive than most coal stoves (Table 21). A less expensive stove that may still be able to operate on anthracite would have a lower efficiency, making the useful cost of anthracite higher than that of coal.

Such facts and the greater availability of bituminous coal are probably responsible for the fact that coal is presently widely used even in slow combustion, water heating stoves that should really be operated on anthracite or a reactive coke.

Such a use of coal is possible in many cases while the opposite procedure is generally not possible i.e. most of the currently available coal stoves will not operate satisfactorily on anthracite or a manufactured smokeless fuel.

The greater economy of coal does not end here. Table 21 lists approximately the price range of various cookers and water heaters offered for sale in Pretoria.

It will be noted that a reasonably adequate coal fired appliance for cooking and some baking can be had for R22-R30 and a more suitable unit with provision for hot water generation can be had for R50 or say R60 allowing for tanks and plumbing.

Such stoves will operate on coal or wood, but indifferently on anthracite or coke.

TABLE 21 .../

TABLE 21.

Price Ranges of Currently Available Cookers (Pretoria).

Coal Stoves:		
Simplest current design (about 3 hot plates and oven).	R22-10	- R30
ditto with enamel finish.	R31	- R44
More refined stoves (without boiler for heating water).	R39	- R175
(with hot water boiler).	R49	- R186
Insulated Coal Stoves:		
(For 24 hour operation)	R129-15	
With bolsters to cover hot plates not in use	R160	
With bolsters and hot water boiler	R170	
Anthracite Burners:		
Cheapest types.	R193	- R248
More refined	R331	- R490 and higher
Electric Stoves:		
Simple design, 3 plate and oven.	R96	
Four plates and oven.	R220	
Liquid Gas:		
Simplest twin hot plate and grille.	R24	
Three - Four plate stove with oven.	R96	- R230
Hot Water Units:		
Simple slow combustion stove.	R27*	
Dual purpose (some cooking).	R47*	
Thermostatically controlled stove	R97*	
Electric geyser (30 gallon tank)	R100*	(Installed avg.cost)
Gas or liquid gas heated geyser	R44*	- R70

*Unit only, cost of installation varies with amount of plumbing required).

While the solid fuel burning stoves costing more than about R50 can be had with a boiler to provide hot water, there is no such possibility with electric or gas heated stoves and an additional unit (slow combustion stove or geyser) must be acquired to provide hot water for the household.

The .../

The simple coal stove generally also supplies all the space heating required in the homes of many coal users.

Although this simple appliance meets various demands it is not very efficient and requires rather more attention and labour (tending fire, ash removal, dust and smoke nuisance) than the higher priced appliances using smokeless fuels. It is, therefore, probably safe to say that in and around the larger centres, where the facilities exist, the housewife prefers to use an electric, gas and an anthracite burning stove for cooking and baking, if she can afford it at all and coal may only be used for hot water generation — and space heating during the coldest months of the year.

Referring again to Table 10, it will be noted that the winter coal demand of Europeans may be almost twice as high as the average for the summer months, whereas that of non-European consumers increased by only about 50% (maximum).

The point is, therefore, that "100% coal use" is practically confined to the lowest income groups and they should therefore command most attention when the replacement of domestic coal by some smokeless fuel is under discussion. Those in the higher income groups could possibly afford to use a more expensive fuel and, possibly, to acquire the necessary appliance. They could also be convinced by suitable "education" that such a step is in their own interests and may, therefore, be prepared to make sacrifices. Such provisos could hardly apply to the low income group.

<u>The Position of the Low Income Groups.</u>

It is impossible to establish from figures such as those given in Table 10, what the coal demand of the European low income group may be. The minimum monthly coal demand of Europeans in the Pretoria-Witwatersrand-Vereeniging industrial area appears to be at least (approximately) 30,000 tons, a large proportion of which is probably used in slow combustion water heating stoves.

The coal comsumption by the Bantu population in

this .../

this area, excluding space heating appears to be in the region of 50,000 tons per month and one can conclude with a reasonable amount of confidence that this coal is required primarily for cooking and only to a minor extent for heating water. Some confirmation of such a conclusion can be obtained by considering the coal needs of a community. Thus, in the native townships around Pretoria (Vlakfontein, Attridgeville, Lady Selbourne and Eastwood), there are about 22,000 houses. Assuming that each household requires about 5 tons of coal per annum for cooking food, the coal consumption for this purpose would be 110,000 tons per annum; or say 10,000 tons per month, which is one fifth of the quantity given above for the whole industrial area. As the number of Bantu houses in the vicinity of Johannesburg, Vanderbijlpark and Vereeniging is much greater than that at Pretoria, one can safely assume that the Bantu cooking load is at least 50,000 tons of coal per month. —

As far as could be established the authorities responsible for Bantu housing do not presently supply cooking or heating appliances. The Bantu must provide his own appliance and some of these are, admittedly, very primitive. Very few could probably afford even the more refined and, therefore, more expensive types of coal stoves.

If, therefore, the use of coal should be banned at the present time, the European low income groups and the majority of the Bantu in the industrialised area would be faced with the necessity of paying at least twice as much for their fuel — if they could get adequate supplies, (compare a demand of about 50,000 tons per month for Bantu and, say, 15,000 tons per month for Europeans dependent solely on coal as fuel, or some 780,000 tons per annum with the present total anthracite sales of some 449,000 tons or 159,000 tons domestic sales)— and the fact that the smokeless fuel would not give satisfactory operation in the available appliances.

Under such circumstances, the low-income community would be placed in an intolerable position and could not be blamed for feeling frustrated. However well-meant such a step might be, the withholding of coal from

these .../

these communities might, therefore, provide very welcome propaganda "fuel" to the Republic's enemies. —

As far as the Board is aware the Draft Act makes no provision to pay even the domestic fuel consumer any compensation for redundant equipment or to replace such equipment with an appliance more suitable for use with a smokeless fuel.

The British Clean Air Act does provide for a grant of 70% of the cost of the reasonably necessary adaptation of space heating appliances to householders and grants are available for the conversion or replacement of cooking appliances.

The South African need would be for replacement of cooking appliances (adaptation can be excluded).

As far as could be established, the cheapest presently commercially available stove that would burn anthracite or coke effectively costs about R130. Considering that there are probably about 110,000 Bantu houses in Bantu townships in the Pretoria - Witwatersrand - Vereeniging industrial area alone, the sum involved for replacement would be of the order of R41.3 million. The suggestion of such a replacement may be regarded to be preposterous, but at the present time there is hardly an alternative.

One can only conclude that it should be a prerequisite of any move to replace domestic bituminous coal by a smokeless solid fuel to have available, commercially, a rather less expensive cooker that will operate satisfactorily with anthracite or a manufactured solid smokeless fuel, — preferably an appliance that can use both coal and solid smokeless fuel so that it could possibly be acquired now and no serious appliance problems would arise when a change of fuels becomes essential.

Valuable steps have been taken in this direction by the Department of Architecture of the University of Natal, but no firm has as yet taken up commercial production of the stove developed there. Even if that decision were made now, it would take time for a factory to produce such a stove in quantity.

Conclusion: .../

Conclusion:

Although only some pertinent facets of the problem of preventing atmospheric pollution have been dealt with in this memorandum, it is trusted that the Board's concern regarding the effect of overhasty action by local authorities will be understood.

The Board is, therefore, of opinion that no local authority should be empowered to take any action except by the written consent of the Minister of Health and the Minister of Economic Affairs.

The Board is of opinion that a number of very important and practical problems have not yet been solved and some of these have been mentioned in the memorandum. The Board would submit that their solution is a prerequisite to the success of any effort to obtain cleaner air.

The Fuel Research Board, therefore, supports all sections of the Draft Bill providing for the creation of a central authority to be responsible for the study of all the facets of the problem and creating the machinery for action by such a body. The Board is prepared to co-operate with such a body in an effort to find satisfactory solutions.

PRETORIA.

15th. AUGUST, 1962.