NEW POSSIBILITIES TO IMPROVE AIR QUALITY IN LOW INCOME HOUSING AND REDUCE GREENHOUSE GASSES

DR A S VAN NIEKERK[1], MR P A SWANEPOEL[2] and MR G KORNELIUS[3]
1. NOVA INSTITUTE, P O Box 38465, Garsfontein East, 0060
2. KONDITEK (Pty) Ltd., P O Box 75468, Lynnwood Ridge, 0040
3. SASOL SYNTHETIC FUELS, Private Bag X1000, Secunda, 2302

1. INTRODUCTION

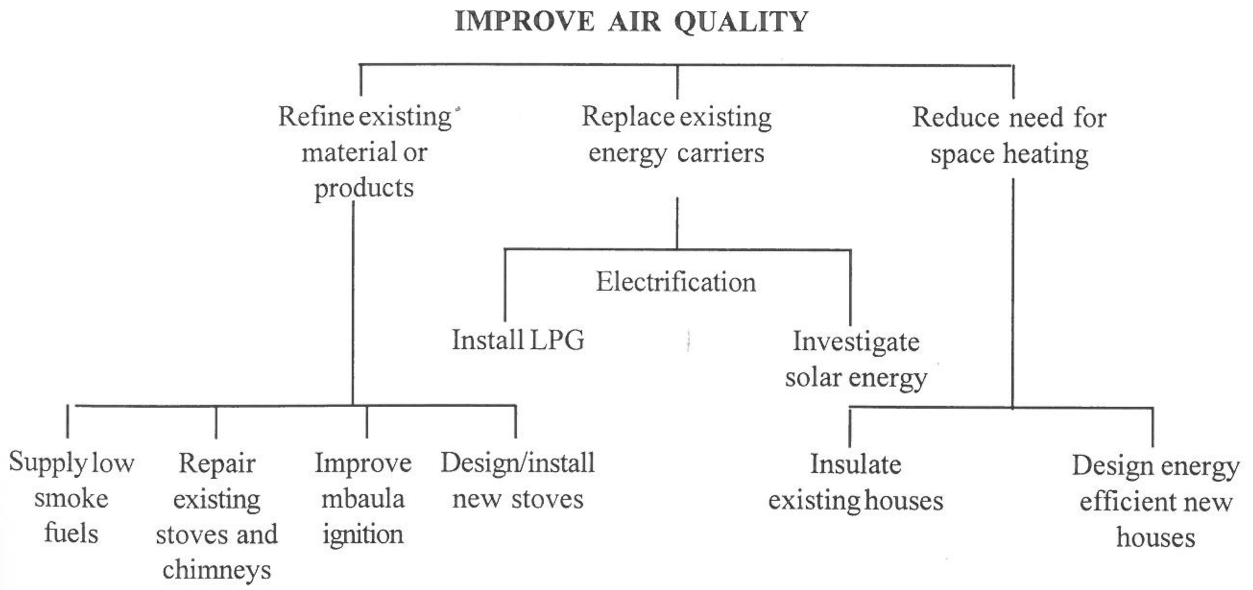
The eMbalenhle Air Quality (EAQ) Project, Phase Two, that NOVA Institute conducted on behalf of SASOL Synthetic Fuels in 1998, has produced results, for the first time since the 1960's, that indicate that there may be affordable, desirable, effective and sustainable solutions in sight for air pollution in low income residential areas.

The extent of air pollution in townships in South Africa is a serious and growing problem. Indoor pollution levels caused by the burning of coal amounts to 2-3 times the acceptable World Health Organisation (WHO) levels in summer, and 6-7 times in winter. With wood use, levels of up to 26 times the acceptable WHO levels have been measured. By 1993, about 3 million (mostly rural) households were burning up 10 million tons of wood p.a., and 950 000 households were burning up 4 million tons of coal (Department of Minerals and Energy (DME) 1996). The 4 million tons of coal could represent 9 768 000 tons of greenhouse gasses (cf Holm et al, 1994).

Measurements taken by SASOL Synthetic Fuels in eMbalenhle during 1999 indicate that outdoor air pollution levels during the worst 10 hours of the day (from 05:00 to 10:00 and from 15:00 to 20:00) can go up to 666μg/m^3, depending on wind conditions. The EPA prescribes a maximum of 65 μg/m^3 over a 24 hour period.

The implementation proposals are brought together in the decision making process reflected in Figure 1.

Figure1: Framework of possible solutions



2. OVERVIEW OF PREVIOUS STRATEGIES TO REDUCE AIR POLLUTION

Previous strategies to reduce air pollution in the target community have been summarised as follows;

"During 1960's, low-smoke fuel was investigated but without much success. The 1970's brought the low-smoke stove, but in spite of good sales, this initiative was largely unsuccessful because users modified the combustion chamber (to improve burning) thereby negating the smoke suppression features. Electrification was introduced during the 1980's, but yet again this was unsuccessful at decreasing the concentrations of air pollution. Now, during the 1990's, the low-smoke (fuel) option is being re-visited." (Surridge, Grobbelaar and Thamm, 1994, p1).

As will be indicated, the low-smoke fuel project of the 1990's has not provided the desired results either. However, NOVA believes that enough has been learned in each consecutive effort to make real progress possible, as the following overview of the different projects will show:

2.1 Low Smoke Fuel 1960's

Not much is known about this effort, but one can conclude that it was not a success, because it was followed by the low smoke stove initiative.

2.2 Low Smoke Stoves

The Air Pollution Act of 1973 and 1981 and the South African Buro of Standards (SABS 1111) prescribe requirements with regard to the performance, durability and chimney emissions of stoves. Neither the SABS standards nor the laws have led to new designs that are tailor made for the needs of township residents. The standard cast iron stoves have in most cases merely been adapted by inserting a dividing brick or plate into the combustion chamber to create a secondary combustion chamber where unburnt volatiles are burned (down burning). In these cases, the basic design of the stove has remained the same for about 50 years. Only trimmings were added (statement by stove manufacturer during interview). No low smoke stove has been designed for the specific needs of township residents, such as space heating, using wood (that requires front-loading), low roof houses or to be affordable in a market where the income is often lower than R200 per person per month.

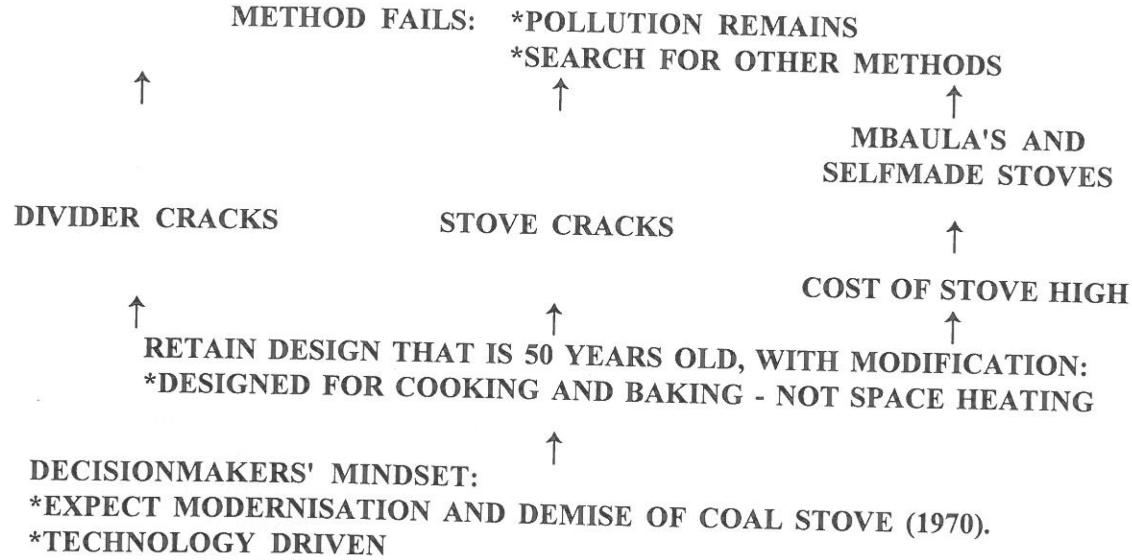
In the conferences on low smoke coal since 1994, it has often been said that people remove the dividing brick or -plate. It came as somewhat of a surprise to find stoves in eMbalenhle with the bricks still intact, and the assurance that people only take them out because they crack after a few months or years. Some people were even looking for bricks to replace damaged bricks. It appeared that the problem was with the design of the solution, not with the behaviour of the end-users.

The gap between the existing products and the needs of the people has had serious consequences:

- The price of cast iron stoves is out of reach of many or most consumers. In Samaria Park, the section of eMbalenhle selected for the 1998 experiment, 22% of households use only self-made stoves (cheap to buy, but not cost effective or energy efficient); 30% use only the very unpopular mbaula, and 33% use only cast iron stoves, which are mostly cracked and therefore not efficient. A further 10% use both a stove and a mbaula, and 5% have neither. In total, 40% use a mbaula (30% mbaula only, plus 10% mbaula and stove).
- The low smoke stove strategy has failed to reduce air pollution. For decades, pollution has remained a problem, and the search for alternatives has consumed valuable time, energy and money.
- The major manufacturer of coal stoves, Falkirk, has closed its plant in Newcastle in 1998.

The causes and effects as described are summarised in Figure 2.

Figure 2: Low Smoke Stove History



2.3 Electrification

During the 1980s attention shifted from the stove to electricity. The expectation was that all people would eventually use only electricity after they had moved through the various intermediate phases to full modernity. The transitional phases were seen to be:

- Wood
- Paraffin
- Gas, coal and mixed
- Electricity

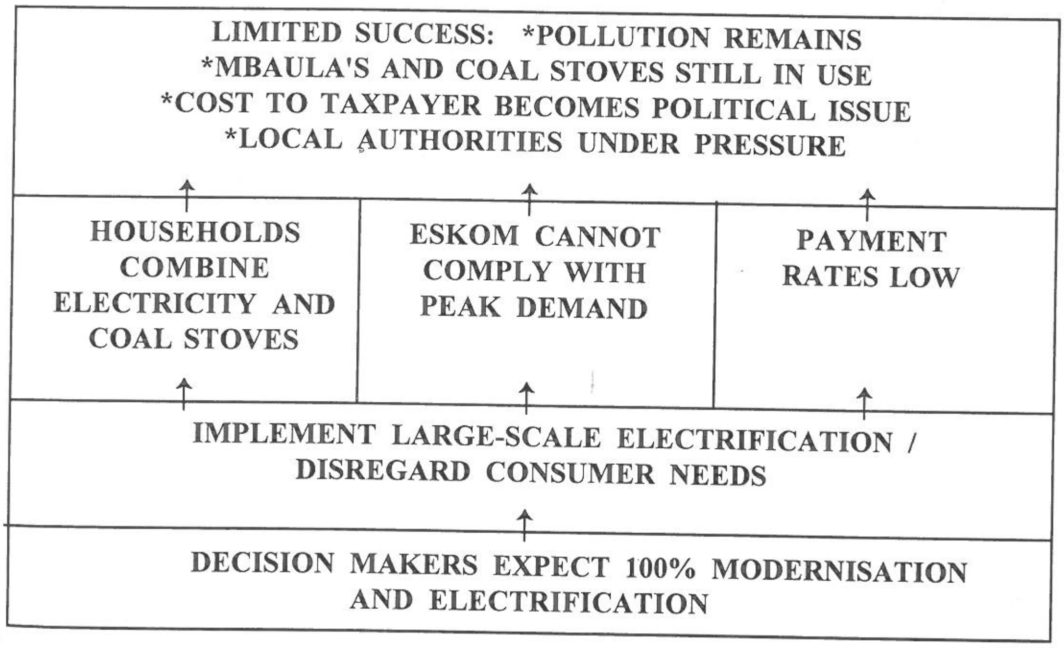
On the basis of this expected transition process, the National Electrification Drive was announced in 1991 by ESKOM, the South African Electricity Utility Company, with the aim to electrify 3 million houses in 5 years. The Drive formed part of a "kick-start" approach for development in Southern Africa, as opposed to an approach of gradual or sustained growth.

The National Electrification Drive is summarised in Figure 3.

- Objectives:
  - Modernisation (kick-start approach)
  - 3 Million households electrified in 5 years, with an expected break-even consumption of 400 kWh per household per month, over 18 years
  - The provision of tangible improvements to back up political transformation
- Complications:
  - Actual consumption 80-140 kWh per household per month
  - Payment/Masakhane:
    * Many bypass the card-system
    * Non-payment leads to cutting of services
- Results:
  - Vast improvements in living conditions of millions, but at a price
  - An average of R26,00 per household per month loss, which now equals about R1 000 million p.a. (consumption rate alone)
  - Instability, violence;
  - Local authorities in financial trouble and under political pressure;
  - Pollution and waste continue, and
  - Peak demand escalates

The causes and effects are summarised in Figure 3.

Figure 3: Electrification Drive History



2.4 Low Smoke Fuels (1990's)

While the Electrification Drive was based on a kick-start or change-of-strategy towards modernity, the DME took a more gradualist approach, with low-smoke fuels as a transitional fuel "until electricity becomes the preferred energy source" (of Asamoah, Surridge, Grobbelaar, 1995). This approach doesn't try to push the consumer towards modernity, but leaves the consumer the choice to prefer other fuels for as long as the need is there. This is a step forward.

A second step forward of the Low Smoke Program of the 1990's is that social acceptability has become an important factor, and that proper testing, evaluation and consultation with end-users preceded implementation.

DME has thirdly initiated an imaginative project to design an integrated Energy Decision Support Model, a computer program that could weigh up the expected health effects, costs and social response, with respect to various possible energy strategies in a given community. The model integrates the meteorological, technological, health, social and financial factors. This project has drawn international interest, because the inclusion of all these factors in one model is seen as a world first.

It seemed, however, that devolatalised coal would require large capital and running expenses, that its effectiveness was greatly reduced if the stoves were cracked, as they mostly are, that it was the least desirable solution for the end-user, and that it failed to reduce the total emission of greenhouse gasses.

3. WHAT IS THE PROBLEM?

NOVA's premise is that no solution would succeed unless the problem is correctly identified. We therefore submit the following problem definition:

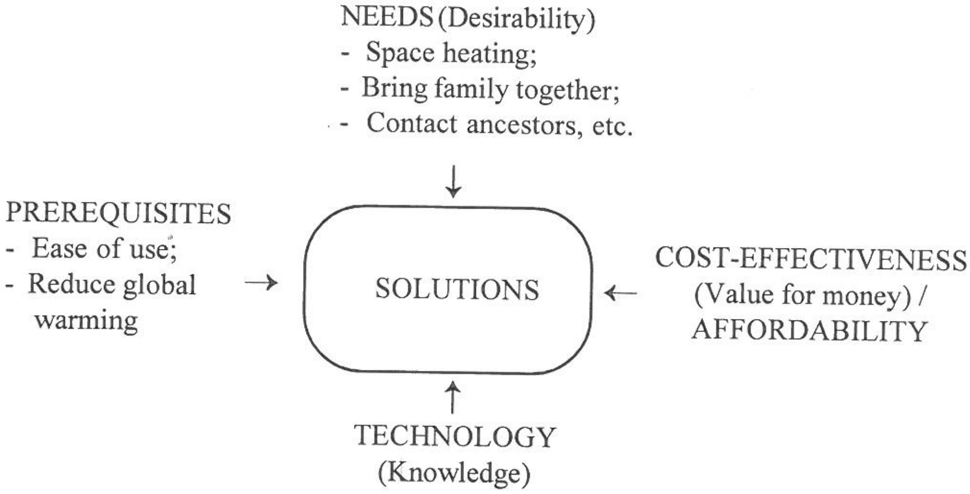
> **Air pollution in South African townships is the result of the multi factorial (political, economical, social, religious, etc.) interaction between complex systems such as the ecology and the cultural traditions of Africa and the West, resulting in a gap or clash between the social and cultural patterns and needs of the people on the one hand, and the products that are provided on the other hand.**

The definition of the problem determines the search for a solution. This problem definition requires an approach that takes the total context into account in order to understand the interaction of all factors involved. Attention will now be given to two aspects of the problem definition.

3.1 The gap between people and technology

Sensibly designed solutions must be evaluated from different points of view, as illustrated in Figure 4.

Figure 4: Methodology



The challenge is to design solutions that satisfy the needs of the consumers by applying available knowledge, without ignoring the two conditions that must be met: prerequisites and cost-effectiveness / affordability.

Prerequisites refers to the essential conditions that must be met to make a solution acceptable: the fuel must not be difficult to ignite and the stove must be durable, for example. These are not the desires that drive the process, but if they aren't met, the solution fails. Outsiders can also impose certain prerequisites, e.g. reduction of greenhouse gasses.

Value for money compares cost and results. Attention must be given to acquisition costs and life cycle costs. Investment in research and development can produce significant benefits in this respect. There may be solutions that give good value for money, but that are so expensive that they are not affordable. In that case one must compromise on value for money, or preferably find ways to design more affordable products.

Affordability means that the government, service providers, and/or households must be able to pay for the solution in the short term.

3.2 The gap between cultures

The concepts "people" and technology must be seen against the background of two major cultural traditions that interact in the wider society and in the household: Western culture with it's drive towards modernisation, vs the drive towards an African Renaissance in contemporary Africa. The African Renaissance can also be described as modernisation in an African way.

"Any genuine African modernity must grow out of the African tradition. A modern African culture ... must be continuation of old African culture".

(Chinweizu, 1975, quoted by Makhene, 1996)

"... for the African, modernisation does not have to be Westernisation. In fact, African can modernise their way of life and environment without giving up the essence of the positive aspects of their culture and their way of life ..... In this way, modernisation would not be a process of alienation as has been the case in many African societies...".

(Omotoso, 1996)

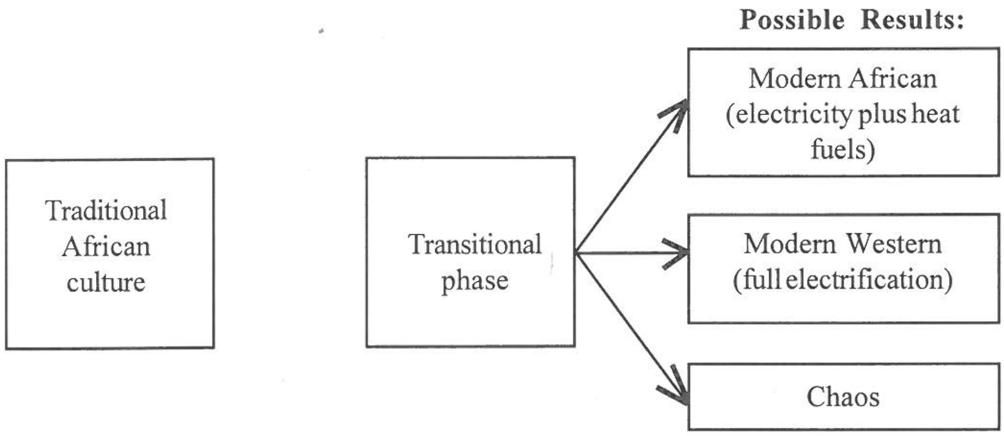
Omotoso says that modernisation in an African way would not bring about alienation, as Westernisation does. This is very important. The sociologist Peter L Berger has described alienation as a worldwide characteristic of modernisation, so that "modern man has suffered from a deepening condition of homelessness". This can lead to loneliness, depression, a loss of values (anomie), social disintegration, and violence. Even more, claims Berger (1973: 122), modernisation can promote social dissatisfaction and revolutionary consciousness, by raising expectations way above the ability to meet them - or by calling forth cultural resistance, as has happened in Iran and often in Africa. The unrest that accompanies electrification could also be seen in this light: electrification has raised expectations it couldn't meet, resulting in dissatisfaction and conflict.

The implications of these ideas for an energy strategy is profound. An energy carrier is also a culture carrier. The proponents of the Electrification Drive quite correctly saw electricity as an agent of modernity. Fire, on the other hand, is deeply embedded in traditional African culture (and many other traditional cultures). A modern African culture would integrate both into the total lifestyle.

In the new South Africa, a household energy policy should aim at bridging the gap between two worlds, Africa and the West, as well as between technology and people. In a constructive and beneficial way.

Modernisation can lead to different results, as depicted in figure 5.

Figure 5: Phases in the modernisation process



4. EXECUTION OF THE EAQ PROJECT

A key to the success of this project is the systems approach, in which the functioning of each factor is considered within the context of the systems hierarchy, e.g.: coal → stove → household → community.

The first step was to form the eMbalenhle Air Quality Project Steering Committee, that represented the entire eMbalenhle community, to guide and oversee all aspects of the work in the community. This Committee met on a weekly basis, and members helped with visiting families involved.

Samaria Park (extension 19) was selected, after careful consideration, to be involved in the experiment, because of its location and because it is representative of the target community. All 239 houses in this section were visited with a basic questionnaire, in order to enable the research team to select 40 houses on a statistically justifiable basis. The following strategies were installed and evaluated for effectiveness in reducing air pollution and social desirability.

- A control group representative of the present situation;
- A group utilizing new coal stoves with ordinary coal;
- A group utilizing repaired coal stoves with ordinary coal;
- A group utilizing repaired coal stoves with low smoke coal;
- A group utilizing Liquid Petroleum Gas (LPG) together with stoves;
- A group whose dwellings have been provided with insulation;
- A group utilizing repaired coal stoves with ordinary coal, LPG and whose dwellings have been provided with insulation, and
- A group utilizing repaired chimneys.

A number of fieldworkers were selected with the aid of the local Unemployment Committee, and trained extensively for either the qualitative or quantitative research.

The levels of indoor pollution were measured, the intervention implemented, and after due time the levels were measured again. A survey was also made of household members' perceptions of the impact of the interventions on their actual coal use.

The household members' responses, feelings, energy use patters and needs were discussed intensively in interviews at home and in focus group sessions.

Results were reported regularly to the household members, the EAQ Project Steering Committee and other community representatives, who discussed them thoroughly, approved them and helped to make proposals for further implementation.

5. RESULTS

5.1 It became clear that previous attempts to reduce air pollution (low smoke coal, low smoke stoves, electrification) have failed, often at great cost, because they are technology-driven. In this project a needs-driven approach has produced results with a high potential of success.

5.2 One of the most important results of this phase is that the project has become community driven to a very high degree. The EAQ Project Steering Committee has proposed an approach in which;

- Rather than giving subsidies or gifts to residents, their own responsibility is made a key to the whole project: and
- Residents are assisted to save money on energy expenses by making available improved designs of the mbaula, stoves, insulation and LPG products.

5.3 The project has made it possible to draw up a logical step-by-step procedure to replace air pollution in a given community.

6. PROPOSALS: NEXT PHASE OF THE PROJECT

The results indicate that there are two types of implementation to be followed:

- implementing known solutions for immediate results, and
- improving the designs of these and other solutions for greater long-term effectiveness.

6.1 SASOL Synthetic Fuels has approved the continuation of the EAQ Project with an energy centre as central instrument of implementation. The following available solutions are presently being marketed in Samaria Park, with about 1 000 households:

- promote top-down ignition o mbaula;
- make capacity available
- repair of stoves and chimneys;
- promote insulation of houses;
- promote use of LPG in niche market, and
- determine summer effects of insulation.

The energy centre is the instrument for the exchange of information, both:

- to the community / to promote implementation of available solutions, and
- from the community (to understand needs and usage patters, and to start conceptualising improved designs).

6.2 Important strategies of national interest will be implemented when sufficient funding is found. These strategies consist of the improvement of the design of existing solutions, especially:

- small stove to replace mbaula;
- small stove to replace home-made stove;
- bigger stove;
- insulation of houses, and
- LPG

7. BIBLIOGRAPHY

Asamoah J K, Surridge A D, Grobbelaar C J. 1995. Strategy to provide clean energy through low smoke coal. The SA Institute of Energy Conference.

Asamoah J K, Surridge A D, Grobbelaar C J. 1997. Low smoke fuel programme: preliminary results of the macro-scale experiment. DME.

Berger peter L, et al. 1973. The homeless mind. Penguin.

DME, 1996. Energy in South Africa. Revision 1, November, parts 1, 2 and 8.

Hardin Blaine. 1990. Africa. Dispatches from a fragile continent. New York: Harper Collins.

Holm D. et al. 1994. Towards a policy for passive thermal design in low cost housing by D Holm, K Trieloff, DF van Aswegen and S van Wyk. Report to the DME, report No. OE9307/8.

Kotze DA and Kotze PMJ. 1996. What is wrong in development? In Focus Forum. HSRC, 4.1.

Makhene Motsumi M. The morning after Uhuru. In: Steyn ME and Motshabi KB (eds.). Cultural Synergy in South Africa. Randburg: Knowledge Resources.

Mataboge E. 1977. What is mission today in our land? Theologia Viatorum.

Mofolo Thomas. 1926. Afrikaans transiation by Chris Swanepoel. 1974: Tjhaka. Cape Town: Tafelberg.

NOVA. February 1998. Final report: a strategy to improve air quality in eMbalenhle. SSF. Secunda.

Omotoso Kole. 1996. Traditional African capital Accumulation: A corrective to Western thinking. In: Steyn ME and Motshabi KB (eds.). Cultural Synergy in South Africa. Randburg: Knowledge Resources.

SABS 1111 - 1976. South Africa Bureau of Standards. Standard Specification for coal-burning domestic cooking appliances (reduced smoke emission type). Pretoria

Surridge AD, Grobbelaar CJ and Thamm AG. 1994. Low smoke fuels produced from the bonification of coal discard. DME.