PARTNERSHIP FOR CLEAN INDOOR AIR

Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in South Africa

Prepared by
Palmer Development Consulting
Under the direction of

WINROCK INTERNATIONAL
Putting Ideas to Work

October 2004

Submitted to U.S. Environmental Protection Agency

Under the USEPA – Winrock Cooperative Agreement XA-83122601-0

Coordination and Implementation Support for the Partnership for Clean Indoor Air

The Partnership for Clean Indoor Air was launched at the World Summit on Sustainable Development in Johannesburg in September 2002 to address the increased environmental health risk faced by more than two billion people who burn traditional biomass fuels indoors for cooking and heating. The Partnership is led by the U.S. Environmental Protection Agency with support from the U.S. Agency for International Development. The mission of the Partnership is to improve health, livelihood and quality of life by reducing exposure to air pollution, primarily among women and children, from household energy use. For more information please visit www.PCIAonline.org

TABLE OF CONTENTS

List of Figures

List of Tables

ABBREVIATIONS AND ACRONYMS

ALRI	acute lower respiratory infection
ARI	acute respiratory infection
BNM	Basa Njengo Magogo
CEF	Central Energy Fund
CO	carbon monoxide
COPD	chronic obstructive pulmonary disease
CSIR	Council for Scientific and Industrial Research
DANIDA	Danish International Development Agency
DHS	District Health System
DME	Department of Minerals and Energy
EDC	Energy Development Corporation
ESMAP	Energy Sector Management Assistance Programme
ENHR	Essential National Health Research
GDP	gross domestic product
GDF	Global Development Fund
GTZ	German Technical Cooperation Organization
HIV	human immune-deficiency virus
IAP	indoor air pollution
IeCs	Integrated Energy Centres
IIEC	International Institute for Energy Conservation
IP	illuminating paraffin
ISES	International Solar Energy Society
LPG	liquefied petroleum gas
LSMS	Living Standards Measurement Survey
MDG	Millennium Development Goal
MEPC	Minerals and Energy Policy Centre
NGO	nongovernmental organization
NHS	National Health System
PASASA	Paraffin Safety Association
PCIA	Partnership for Clean Indoor Air
PM	particulate matter
PM_{10}	particles with an aerodynamic diameter less than 10 microns
$PM_{2.5}$	particles with an aerodynamic diameter less than 2.5 microns
ProBEC	Program for Biomass Energy Conservation
SABS	South African Bureau of Standards
SEA	Sustainable Energy Africa
SESSA	Sustainable Energy Society of Southern Africa
SHI	Sustainable Homes Initiative
VAT	value added tax
TB	tuberculosis
TSP	total suspended particles
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

NO_2	nitrogen dioxide
SO_2	sulphur dioxide
$\mu g/m^3$	micrograms per cubic meter
ppm	parts per million

I. REPORT HIGHLIGHTS

- Despite an increase in the national household electrification level from 36% in 1996 to 66% in 1999, almost half of all households in South Africa continue to use fuels other than electricity for household cooking. Firewood and coal are the most commonly used household fuels.
- In South Africa, approximately 24 million people (more than one-half the population) are exposed to hazardous levels of air pollution from household energy sources.
- Acute Respiratory Infection (ARI) is the sixth largest killer of children under four years in South Africa; it is estimated that around 2,000 children die annually due to ARI caused by exposure to air pollution.
- It is estimated that air pollution related illnesses cost the Government around R800 million (US$114 million) on an annual basis.

Key Actors and Stakeholders in the Field of Household Energy and Health in South Africa

- The South African Department of Health has a coordinated primary health care program that functions from the national to the district level. This structure could provide a viable vehicle for delivery of ARI reduction products and services.
- The Health Systems Trust was established in 1992 to support the transformation of the South African health system. It is primarily a developmental organization committed to improving the functioning of the health system. The organization's primary objective is to support the development of a comprehensive and more accessible health care system in the country.
- The Centre for Health Policy is an independent health policy research institution based in the School of Public Health at the University of the Witwatersrand in Johannesburg. The institution conducts research on policies in support of economic equity and social justice in health.

In addition to those listed here, many other government agencies, consulting firms, and NGOs are engaged in activities that have a household energy or indoor air pollution component.

Key Household Energy and Health Programs in South Africa

- The Integrated Management of Childhood Illness Program was initiated in 2000 by the Department of Health to increase children's access to health care services. Due to increased cases of HIV associated TB the program's resources are severely over stretched.
- The Primary Health Care System is an integrated package of essential primary health care, which aims to provide the solid foundations of a comprehensive health system. Services provided include reproductive and child health care, which aims to reduce infant and child mortality rates by 30%. Clinics have strong links with the community, civic organizations, schools and workplaces in the areas they operate.
- The Basa Njengo Magogo Program was initiated in 1997 by the Department of Minerals and Energy. The program promotes low smoke fire lighting methods to curb coal-based indoor and outdoor air pollution, disseminates lower-smoke household energy fuels and encourages energy efficient house designs.

- Between 1996 and 2003, the Department of Minerals and Energy- with funding from the Federal Republic of Germany- carried out field studies to determine the social acceptance and market potential for solar cookers as an alternative to traditional cooking appliances.
- In 1996 the International Institute for Energy Conservation (IIEC) initiated the "Healthy Home Initiative". The program provides training to community housing organizations on energy efficient housing construction.
- The Program for Biomass Energy Conservation (ProBEC) is a six-country regional program funded by the Federal Government of Germany and the European Union. The program seeks to promote energy conservation by increasing biomass energy expertise in Malawi, Mozambique, Namibia, Lesotho and South Africa.
- The Department of Minerals and Energy has piloted the establishment of Integrated Energy Centres to encourage the adoption of LPG and other modern fuels in rural communities.

Lessons Learned

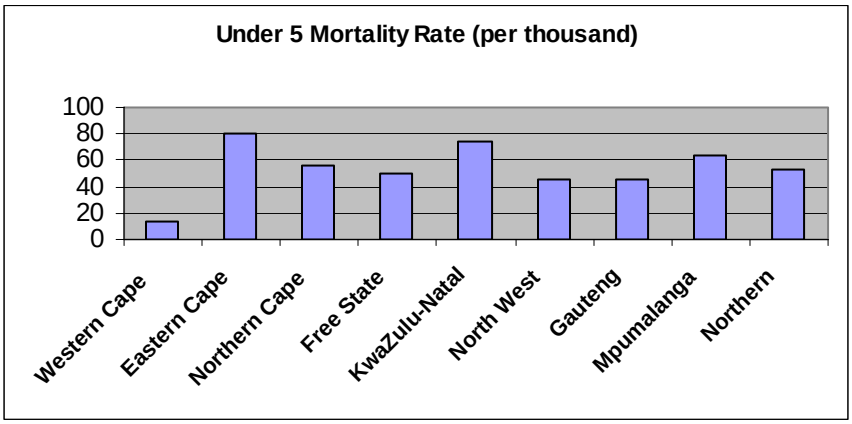
- Cost is a key impediment to wide adoption of clean and more energy efficient household energy appliances by poor households in South Africa.
- A key requirement to using cleaner fuels and more efficient appliances is affordability. In some cases subsidizing the fuel or the appliance may be the only option for reaching a mass consumer base.
- Capacity building around energy and health intersection issues is required at provincial and local government levels where most health interventions are located and planned.
- Implementation of innovative low cost interventions like Basa Njengo Magogo low smoke program can reduce air pollution, effect fuel and monetary savings and improve the health of low income households dependent on coal for household use.
- Participatory planning in community based energy programs allows the project planners to fully understand the community's needs and better integrate those needs in the implementation plans thereby making the project more acceptable to the community.
- Available technologies are rarely fully commercialised. There are several potentially viable designs and ideas, however, they lack the support which would enable them to make further progress.
- The government and development agencies have an important role to play in supporting commercialisation of innovative household energy technologies that have potential for commercialisation.
- End-user awareness remains a challenge. It is expensive to launch public awareness campaigns, and there are some obstacles to funding such interventions.

II. INTRODUCTION

Overview

South Africa has a population of about 42.7 million[1]. The figure below provides a breakdown of the mid-year population by region for 2002. Over 75% of the country's population is African, followed by Whites (14%), Coloureds (9%) and Indians (3%). The life expectancy at birth is about 45 years with little difference between men and women. The infant mortality rate is almost 62 deaths per 1000 live births [2000 est.], significantly higher than in countries like the USA (6.9 deaths per 1000 births) and China (33 per 1000). Further demographic information is provided in Table A1 in the Annex A.

Figure 1 Under 5 mortality rate by province



Source: http://www.doh.gov.za/

Approximately 3 million dwellings in South Africa are of an informal nature, accommodating approximately 18 million people, more than 35% of the population. Almost half of all households use fuels other than electricity for cooking purposes. Despite an aggressive electrification campaign, low-income households in rural and urban areas of South Africa still rely on biomass and coal as the main energy sources for cooking and space heating purposes.

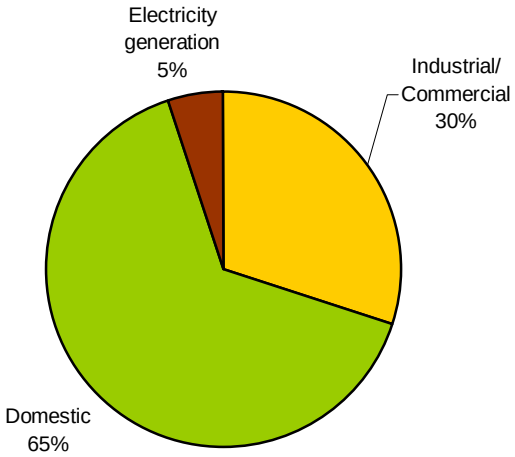
Despite high levels of air pollution being caused by the industrial sector in South Africa, at least four studies[2] conducted in the coal burning areas of Gauteng found that household coal burning was the largest contributor to air pollution in the area: *"In Ivory Park, the domestic use of coal fires is essentially the main source of air pollution in Midrand"* and *"domestic coal combustion followed by fugitive soil dust was the biggest contributor to air pollution (Mintek, 1996)"*.

Scorgie *et al* (2003) also found that around 2,000 children die annually as a result of respiratory infections caused by air pollution – the sixth largest killer of children under four in South Africa. It is further estimated that air pollution related illnesses cost the Government around R800 (US$114 million)[3] million on an annual basis[4]. Most townships experience high levels of air pollution during winter months.

---

[1] http://www.census.gov/ipc/prod/wp02/tabA-05.pdf
[2] See the Midrand state of the environment report (1999), Engelbrecht *et al* (2002), Mintek (1996) and Scorgie *et al* (2003), Vaal Triangle source apportionment study.
[3] US$1 = approximately R7.00
[4] Department of Minerals and Energy, 2003

Figure 2 Sectoral Contribution to Air Pollution



Source: Scorgie et al (2003) Vaal Triangle source apportionment study.

Some time has elapsed since the return to democracy in 1994 and an ambitious electrification program has connected 3.5 million new households between 1994 and 2001 (Espinheira, 2003). The national household electrification level has increased from 36% in 1996 to 66% in 1999. The main beneficiaries were urban settlements and populations where access levels are currently about 80%. However, rural electrification still lags behind the urban program and at the end of 1999 45.5 % of rural households were electrified. It would be useful to analyse the impact of electrification in terms of exposure to air pollution. Mathee (2004) expects that despite the provision of electricity, there will be no dramatic decline in the use of wood, coal and other polluting fuels in the short or even medium term due to cultural factors and the relative cost of cooking and heating with electricity.

Typically, compared to the higher earning groups, lower income households spend a greater proportion of their earnings on fuel and power. (Further information on household expenditure is provided in Appendix A.) Many low-income households lack access to electricity, while others lack clean fuels for cooking and heating applications. Many households are dependent on irregular, unpredictable sources of income. Such households are subjected to very short cash flow cycles, resulting in spending patterns that hamper or exclude large regular expenditures such as paying an electricity bill at the end of the month or re-filling a gas bottle. Energy that can be obtained in smaller units such as a litre of paraffin, a bucket of coal and a pre-paid electricity card for R10 (US$ 1.4) enables households to spend smaller amounts at a time and to strategise around the expenditure on fuels.

Mehlwana and Qase (1999) quoted a respondent on this issue as stating: *"In this house we buy only the paraffin we can afford today"*. However, it is not only the cost of fuels that will determine household energy supply choices, but also the availability or accessibility of the fuel that will

determine its use. In a study prepared ten years ago, Annecke (1994) concluded*: "Women were found to use the fuel which was available and most convenient according to the requirements and conditions of their households. Cost played a significant part in decision making but was not the only factor".*

Lastly, the phenomenon of multiple fuel use has been researched, discussed, illustrated and reported in various works[5]. Researchers increasingly recognise that a dominant feature of energy use patterns in low-income households is the tendency to include multiple sources to meet their energy needs. For example, a household would not use a single fuel exclusively and that electricity is perhaps used for lighting, paraffin for cooking, batteries for the radio, and a coal fire for heating the house[6]. In the second instance, it would mean that different fuels might be used for the same end-use, for example cooking with paraffin, coal and electricity[7].

The household energy consumption profile described in Section 3 discusses in detail the different use patterns between urban and non-urban areas. It will be shown that the lack of clean energy and efficient appliances deprives especially women and children of their health, their time, and also of a strong community unit.

There is a range of stakeholders from Government (national, provincial and local), NGOs, international cooperation or donor agencies as well as research institutions addressing energy/health issues in South Africa. These include agencies and organizations working in the areas of household energy, health and environment.

The policy environment, and more importantly the execution of policy can make a difference in the relationship between indoor air pollution and infant mortality and respiratory diseases in children under five. These policies are in further detail in later sections.

Population

South Africa has a population growth rate of approximately -0.2%, and an infant mortality rate of 62 per 1,000 live births. Life expectancy is approximately 44.2 years[8]. The incidence of child mortality increased from 1993 to 1998 in comparison to 1988 to 1992. It is in part indicative of the role that wood, coal and other biomass play in the deaths of youngsters in this age group, that the rate in biomass using households, 83.5 per 1,000, is much higher than the 31.7 per 1,000 figure in electricity using households.

---

[5] See for example Mehlwana and Qase (1999), Eberhard and van Horen (1995), Williams (1994), Ross (1993) and Golding and Hoets (1992).

[6] This was clearly demonstrated in the research carried out by Golding and Hoets (1992) in a survey of 2000 formal and informal households in eleven urban townships.

[7] Ross (1993) found that households changed their main cooking fuel up to four times, with changes being informed by income levels, change in tenants and labour to collect wood.

[8] http://www.infoplease.com/ipa/A0107983.html

Table 1 Mortality Rates for Children Aged One to Five

Approximate calendar period	
1983 -1987	70.1 per 1,000
1988 -1992	54.8 per 1,000
1993 -mid-1998	59.4 per 1,000
Cooking fuels used (1998) and under five mortality rates	
Electricity	31.7 per 1,000
Gas/ paraffin	52.2 per 1,000
Wood/coal/dung/other	83.5 per 1,000

Source www.doh.gov.za

III. OVERVIEW OF HEALTH IN SOUTH AFRICA

Primary Health Care System

With the overthrow of apartheid in 1994, the South African government adopted a Primary Health Care strategy to guide the transformation of the health system. The strategy emphasizes preventive health care through an integrated package of essential primary health care services availed to the entire population. This strategy is the foundation for a unified national health care delivery system aimed at promoting equity in health care service provision in the country.

The primary health care package strategy was defined following detailed consultation over four years. Clinics render comprehensive Primary Health Care services using a one-stop approach for at least 8 hours per day, five days per week. These services address, among other issues, reproductive health and child health aimed at reducing infant and child mortality rates by 30%, immunization and asthma. Clinic staff members are able to follow the disease management protocol and provide general counselling, as well as train community health care promoters to educate caretakers and facilitate community action. Clinics have strong links with the community, civic organisations, schools and workplaces in the area[9].

Integrated Management of Childhood Illness Programme

In 2000, the Department of Health issued an Integrated Management of Childhood Illness document. It describes itself as being "promotive, preventative, curative and rehabilitative". The aims are to reduce infant and under-5 mortality rates by 30% and reduce disparities in mortality between population groups. The disease and condition focus includes, amongst others, reduction in diarrhoea, measles and acute respiratory infections in children by 50%, 70% and 30% respectively. It aims to increase full immunisation coverage among children of one year against diphtheria, pertussis, Haemophilus influenzae Serotype b (Hib), tetanus, measles, poliomyelitis, hepatitis and tuberculosis to at least 80% in all districts and 90% nationally. In addition, this service aims at managing chronic asthma in infants, children and adults with treatment schedules for either mild or moderate to severe asthma. Each clinic has the National and Provincial protocols and policy documents on management of acute and chronic persistent asthma[10].

[9] http://www.doh.gov.za/docs/policy/norms/contents.html
[10] http://www.doh.gov.za/docs/policy/norms/full-norms.pdf

Health Policies

White Paper on Health

The White Paper on Health was published in 1997 and is considered to be a key guide for the health sector. The paper sets proposed health sector strategies, and states that:

- The health sector will play a key role in promoting equity by developing a single, unified health system;
- The national, provincial and district levels will play distinct and complementary roles; and
- An integrated package of essential primary health care services will be made available to the entire population at the first point of contact.

In order to realise the above mission, it is envisaged that the National Health System (NHS) will incorporate all stakeholders to obtain the active participation and involvement of all sectors of South African society in health and health-related activities.

Draft Environmental Health Policy

The 1997 White Paper for the Transformation of the Health System in South Africa states that environmental health services should be "acceptable, accessible, affordable and equitable". They must be implemented with the active participation of the communities. Some of the implementation strategy includes: promoting public health policy in all sectors of South African society; creating supportive environments (i.e. ensuring that the healthy behaviour is promoted) supporting community action by facilitating and encouraging communities to take action that will improve their health and resolve problems, developing personal skills in the formal and informal education sectors, including provision for basic health in schools.

IV. HOUSEHOLD ENERGY, INDOOR AIR POLLUTION AND HEALTH IN SOUTH AFRICA

The World Health Organization indicates that indoor air pollution is annually responsible for 1.6 million deaths worldwide. In many developing countries indoor air pollution accounts for as much as 4-6% of the burden of disease, placing it above tobacco smoking, sexually transmitted diseases, alcohol and homicides as a leading cause of ill health and death. Indoor air pollution in developing countries mostly arises from burning of solid fuels such as wood, animal dung, coal and crop residues indoors in open fires or poorly functioning stoves. The incomplete combustion of these fuels releases pollutants such as particulate matter (PM), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and other organic components into the living environment. It is estimated that at least two-thirds of all households in developing countries are still primarily dependent on biomass fuels and coal, affecting approximately 2-3.5 billion people worldwide. While air quality is important, the health effects of indoor air pollution are also determined by the amount of time a person spends breathing polluted air. Studies have shown that people in developing countries spend between 3-7 hours a day in the kitchen. Due to their domestic responsibilities, women are typically exposed to indoor air pollution far more than their male counterparts. In addition, women usually have the added responsibility of caring for children. As a result, children also experience exposure to high levels of indoor air pollution on a daily basis.

Despite indications of very high levels of indoor air pollution, relatively few studies have been undertaken to measure the extent and severity of this problem in South Africa. Kossove conducted one of the early South African studies on the effect of smoke exposure in 1982 at a high volume

outpatient clinic in Pietermaritzburg, Natal. Kossove found that of the 132 infants examined with severe lower respiratory tract disease, 70% had a history of exposure to smoke from cooking or heating fires. Only one third of the infants free of respiratory problems had a similar exposure history.

In a cross-sectional study of air-pollution by industry in the Sasolburg area, Coetzee *et al* (1986) found that whilst there was no significant difference in the respiratory symptoms of children from this highly industrialised area and surrounding rural towns, there was however a significant difference in the forced expiratory volume (FEV) of the two groups. The forced expiratory volume is the volume of air that can be forced out taking a deep breath, an important measure of pulmonary function[11]. This study implies that it may be possible to distinguish between the effects of indoor and ambient (outdoor) air pollution.

A cross-sectional examination of 1031 school children from the Eastern Transvaal Highveld, as compared to 978 children form non-polluted towns in the Transvaal, indicated that coughing, wheezing, asthma and non-specific chest complaints were more frequently reported by children from polluted areas as compared to their counterparts from unpolluted regions (Terblanche *et al*, 1992). In discussing the issue of exposure to coal in the urban areas of South Africa, Terblanche *et al* (1992) note that exposure to air pollution from domestic coal use in urban areas of South Africa exceed international health standards for almost the entire study period, and that there was little difference in exposure rates between partially electrified and unelectrified areas.

It was shown that children living in coal burning areas have significantly higher risk of developing upper respiratory tract infection than those living in completely electrified areas. The strongest predictor of respiratory tract infection, after controlling for low economic status, crowding, primary electricity use and parental smoking was found to be the use of coal as primary domestic fuel. Data collected from urban areas indicated that the prevalence of respiratory illnesses increased significantly from summer to winter. The odds ratio for lower respiratory tract infections among children in unelectrified areas, as compared to electrified areas, was 2.9 while after controlling for economic status, age and gender, the risk for coal-exposed groups developing a lower respiratory tract infection was five times higher than the risk for the group that used only electricity (Terblanche *et al* (1993)).

The Vaal Air Pollution Study (VAPS) included monitoring and measurement of Total Suspended Particulates (TSP), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) and carbon dioxide (CO_2). The 12 hour average of TSP levels measured inside coal and wood burning households was invariably well above that of the U.S. health standard of 260 micrograms per cubic meter. The WHO's no-effect exposure limit (180 micrograms per cubic meter) was also exceeded in all homes. The respiratory illness prevalence study indicated that more than 65% of the 11,000 children surveyed suffered from upper respiratory illnesses, while 29% had complaints about lower respiratory illnesses.

According to the Star Newspaper (19/09/98), Gauteng ranks as one of the world's worst polluted areas, putting it in the same league as Bangkok, Mexico City, Los Angeles, Beijing and Sao Paulo. Epidemiological data that looked at both indoor and ambient air pollution indicates that: *"The mortality rate of ARI (acute respiratory infections) in South Africa is 270 times greater than for children in western Europe"*. The results to date of the Vaal Triangle Air Pollution Health Study

[11] http://www.medterms.com/script/main/art.asp?articlekey=20404

undertaken on children aged 8 to 12 indicated that *"...the levels of TSP (total suspended particulates) exceed the 24-hour health standard (set by the World Health Organization) regularly during winter. The annual average levels during 1991 and 1992 exceeded the safe levels by more than 2.5 times".*

V. HOUSEHOLD ENERGY IN SOUTH AFRICA

Introduction

There exists an intricately connected link between energy and the environment. However, relatively few studies have been carried out on the relationship between biofuels and the environment, such as atmospheric pollution. Given that there are many negative effects associated with biofuel combustion, it is important to understand why consumers use biofuels when other alternatives exist. Three possible reasons are economics, access and culture. Budget constraints limit the availability of a certain range of possible fuels. Should cooking with electricity or LPG be more expensive than the actual food purchase, it is logical that the family will choose a cheaper or "free" alternative such as fuelwood or coal. Access to cleaner fuels can play a considerable role in the general indoor air quality. Thirdly, biofuels are sometimes the preferred choice of energy in some areas due to cultural or other influences. Studies in rural areas have shown that households without access to electricity or other modern fuel-sources such as LPG spend more time collecting fuelwood. Waldhoff (2004) mentions a study that found that, on average households spend 6-10 hours per week collecting fuelwood. This is usually a task allocated to women or girls. Fuelwood collection for the purposes of cooking, lighting and space and water heating consumes most of the collection time. Therefore, there is a strong possibility that a high degree of indoor pollution exposure is a burden coincident with the existing labour burdens that rural women and girls face.

The prevalence of ARI in Waldhoff's study was estimated by asking mothers if their children under age five had been ill or feverish with coughing accompanied by short, rapid breathing during the two weeks preceding the survey. Mothers whose children had experienced these symptoms were asked what they had done to treat the illness. Almost one in five (19%) children under five were ill with symptoms suggestive of an acute respiratory tract infection (ARI), i.e., cough, fever and rapid respiration, during the 2-week period prior to the survey. Three-quarters of these children were reported to have been taken to a health facility for advice or treatment.

There were no striking differentials in ARI prevalence rates by sex, birth order, urban versus non-urban residence or population group. The highest prevalence rates occurred in KwaZulu-Natal (26%), followed by closely clustered rates (about 21%) in Free State, Gauteng and Mpumalanga. Considerably lower rates (about 15 %) were reported for Western Cape, Eastern Cape, Northern Cape, North West and Northern Provinces.

Illuminating Paraffin (IP)

The link between air quality and fuel sources has been well documented in various studies conducted both locally and internationally. Terblanche *et al* (1994) recommended that the use of paraffin should be promoted above that of coal and wood, since IP is considered cleaner and less polluting.

John *et al* (1997) investigated the link between indoor air quality and IP use and concluded that regardless of the grade of IP, carcinogenic compounds may form in the flame of IP appliances. It was concluded that the age, type and mode of operation has a large impact on emission rates. However, measurements conducted in Kutlwanong near Kimberley indicated life-threatening levels of carbon monoxide in unventilated shacks due to the use of IP heaters. Emissions of IP cooking and heating appliances have been recorded by Graham (1997) and although IP appliances emit less CO_2, CO, NO_2 and particulates than wood and coal burning appliances, emissions are higher than LPG

appliances and could reach dangerous levels if used in unventilated conditions. Addressing the energy efficiency of low-income houses either through retrofitting or inclusion of energy efficient design principles will contribute to improving indoor air quality.

Although IP is less polluting than coal and wood, users have complained about the smell, the fact that it causes "tight chests" (PDG, 1994) and burning eyes. The quality of IP being produced has been suspect, despite the claim from oil companies that IP is produced on specification. One possible recommendation would be that government should enforce stricter quality checks to address this issue.

Another problem related to quality of IP, is accidental contamination of paraffin by petrol during the course of the distribution process, leading to fires and explosion. The Paraffin Safety Association of South Africa (PASASA) has recommended a risk assessment of the IP supply chain, training, and accreditation of both companies and independent distributors to improve safety.

It is estimated that between 1996 and 2001, 80,000 children ingested paraffin every year resulting in 40,000 children developing chemical pneumonia per year (Kidsafe, 2003). Chemical pneumonia is the swelling and irritation of lung tissues caused by breathing in fumes from such chemicals as bug sprays, pool cleaners, or gasoline. This kind of pneumonia is not contagious[12]. This is mainly because IP is mostly sold to retailers in bulk and then dispensed into containers such as cold drink bottles, milk and liquor bottles. Furthermore, pre-packaged IP is sold in substandard packaging with inadequate labelling and caps can be easily opened. The distribution of safety caps through the Paraffin Safety Association of South Africa (PASASA) has been ongoing since 1996 but it is difficult to determine the impact of the safety caps in reducing IP ingestion.

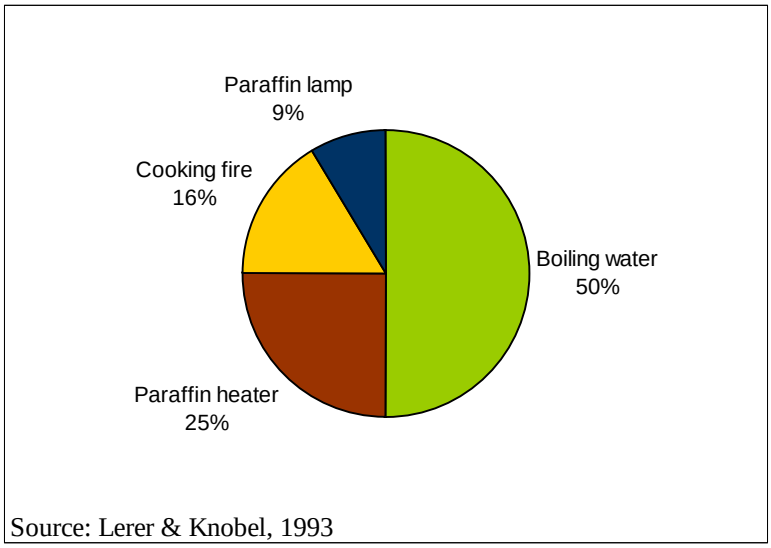
Although there are as yet no regional or national registers of paraffin fires and burns (detailing the causes of fires and burns), a national survey conducted by Markinor in 2001 reported that 46,517 paraffin related fires occurred in 2000. Markinor concluded that 50,000 individuals suffered from paraffin related burns and that 63 percent of those burns were the results of paraffin stoves exploding. It has been estimated, based on the most recent National Injury Mortality Surveillance System (NIMSS), that in 2001 unintentional burn deaths in South Africa were between 2,978 and 3,444.

In a study of burn-related fatalities amongst children in Cape Town, conducted between 1990 and 1991, it was found that domestic accidents, mainly related to cooking and heating were responsible for 21 percent of childhood burn deaths (Lerer & Knobel, 1993).

The most common types of burns are due to hot liquids or fluids such as boiling water, tea, coffee etc. More than 60 children are admitted to hospitals annually with fire/flame related burns. The majority of these children come from underprivileged communities that use fossil fuels for heating. The causes of fatal domestic burn injuries are depicted below:

[12] http://www.healthsquare.com/mc/fgmc0411.htm

Figure 3 Causes of Fatal Domestic Burn Injuries in Children - Birth To 12 Years



Source: Lerer & Knobel, 1993

Liquid Petroleum Gas (LPG)

Switching from "dirty" fuels such as coal, IP and wood to LPG could bring considerable health and environmental benefits at local, regional and global levels. Indoor air pollution could be significantly reduced. Urban air pollution and emissions of climate-destabilising greenhouse gasses from LPG, calculated on a fuel-cycle basis, are lower than from most other fossil fuels and traditional fuels used in an unsustainable way. By reducing demand for wood and charcoal, LPG can have a positive impact on deforestation. Although there are far fewer fatalities from LPG fires and explosions than from Paraffin in South Africa there is still a strong perception that LPG is a dangerous fuel. Most people feel LPG gas canisters pose an unacceptable risk of explosion because the gas is under pressure. Faulty appliances and hoses, not the LPG canisters, have caused most of the reported LPG accidents. To address this problem the LPG industry has responded by introducing appliances that fit directly onto the canister to eliminate need for the hoses and other accessories. As can be seen below, LPG appliances emitted the lowest or some of the lowest emissions per mega joule delivered.

Table 2 Comparison of LP Gas with Other Fuels for Household Cooking

LP Gas	R 7.17 per kg (average reseller retail price) incl. VAT	2.62 USD
Firewood	R 1.5 per kg (average)	0.22 USD
Paraffin	R 3.03 per litre (average)	0.45 USD

Table 3 Efficiencies and airborne emissions from household cooking stoves, India.

Fuel	Overall stove efficiency (percent)	Emissions (g/MJ delivered energy)				
		CO_2	CO	Methane	TNMOC	N_2O
LPG	53.6	126	0.61	Neg.	0.19	0.002
Biogas	57.4	144	0.19	0.10	0.06	00.02
IP	49.5	138	1.9	0.03	0.79	0.002
Woodfuel	22.8	305	11.4	1.47	3.13	0.018
Crop residues	14.6	565	36.1	4.13	8.99	0.028
Charcoal	14.1	710	64.0	2.37	5.60	0.018
Dung	10.0	876	38.9	7.30	21.80	0.022

*Total non-methane organic compounds.
Source: US Environmental Protection Agency data cited in Smith et al (1998)

The environmental benefits to switching to LPG from traditional fuels and most other fossil fuels can be considerable. LPG produces virtually no soot (particulate matter) and relative to most other non-renewable fuels, low emissions of carbon monoxide (CO), unburned hydrocarbons (HC) and oxides of nitrogen (NOx). In addition, PDC (2002) concluded that the cooking efficiencies of LPG and IP burning appliances were significantly higher than other solid fuel appliances; an LPG ring burner had the highest combustion efficiency and the lowest CO_2 emission rate; the running costs of LPG appliances are high, due to the high cost per kg of the fuel; and LPG appliances are therefore highly efficient and clean, however, expensive to operate.

Although LPG possesses many advantages as a fuel, it is not entirely without disadvantages, for example, the fuel is used from cylinders pressurised at 700 kpa, requiring it to be removed and replaced by users, and it can cause accidents and fires through human error (although on a much smaller scale than IP).

Coal

An estimated 3.3 million tons of coal are consumed annually by the household sector in South Africa. This constitutes only 3% of the total annual coal utilisation in the country. However, this small amount causes an apportionment of 36% of the average national particulate emissions and more than 20 percent of total air pollution related to coal use. For example, in the Greater Johannesburg Metropolitan Council area, where coal is widely used, air pollution levels exceed the national guideline by up to 30%. The age group most affected is under six years old, correlating to a high infant morbidity and mortality rate. Household coal users are generally restricted to areas with cold winters, and that are relatively close to coalfields. It is also mainly those households in urban and peri-urban areas that use coal. Reasons for the preference for coal include the following:

- There is a large installed infrastructure to utilise coal and there are insufficient funds or incentives to replace coal stoves with high-cost electrical appliances.
- Electricity supply is unreliable because of blackouts and vandalism.
- Coal is a less expensive source of energy than electricity.
- During winter the coal stove serves as a multi-purpose device for cooking, space heating and social centre point for the family.

As the result of users' preference for coal for cooking and space heating – especially during winter, electrification has not resulted in any significant reduction in air pollution levels during winter. A survey amongst households with access to electricity revealed that 83% of households would "definitely not" get

rid of their coal stoves. This survey (Golding and Hoets, 1992) also indicated that 90% of those coal users questioned would very likely switch to a low-smoke fuel if certain specifications were met. In particular, low-smoke fuels should be as efficient or more efficient than standard coal, should cost the same or less, and should be usable in existing coal stoves and appliances.

The Low Smoke Fuels program, an initiative under the Clean Energy Strategy addresses the use of poor quality coal for cooking and heating purposes. These initiatives are further discussed in the section titled 'Household Energy Interventions and Strategies'.

Energy Policies

Several White Papers, along with the paper on Health described earlier, provide a coherent framework for addressing air pollution, indoor air pollution and the effects on children under the age of five.

White Paper On Energy Policy 1998

Under the Energy Policy, the Government of South Africa aims to promote access to basic energy services for poor households in order to ameliorate the negative health impacts arising from the use of certain fuels. In addition it will work towards the establishment and acceptance of broad national targets for the reduction of energy-related emissions that are harmful to the environment and to human health. The Government will also aim to ensure a balance between using fossil fuels and maintaining acceptable environmental conditions.

Energy sector policy objectives include:

- increasing access to affordable energy services;
- improving energy governance;
- stimulating economic development; and
- managing energy-related environmental and health impacts

Trends indicate the complexity of multiple fuel-use in households and due to the previous government's segregation policies, household energy provision to poor and remote families has been severely lacking. The Energy White Paper states that energy security for low-income households can assist in poverty reduction, increase livelihoods and improve living standards. It is essential that basic energy needs consider costs, access and health. Technological interventions are only likely to be used if they are introduced in consultation with households. Government will also have to consider appropriate appliance/fuel combinations; households' abilities to acquire these fuels and appliances; the availability of efficient and safe appliances and fuels; and the effect of pricing and financing on affordability. Cultural factors were not considered a significant barrier to the adoption of cleaner fuels and appliances.

National Environmental Management Bill

The Department of Environmental Affairs and Tourism's National Environmental Management Bill addresses environmental management principles which include among others: "Indoor and outdoor air pollution from coal and wood use" and "Placing people's energy needs at the forefront and serving their interests equitably". The Department has no regulatory responsibility regarding the impacts of energy on the environment.

Measures to address household coal and wood use include: the promotion of clean fuels as a substitute for bituminous coal; thermal improvements to existing and new houses; continued electrification of households; the installation of chimneys in existing and new houses; improved ventilation in existing and new houses; the development and implementation of improved stoves with

regard to performance and safety; the development and implementation of improved coal and wood burning practices; and education programmes on the implementation and application of the above measures[13].

It is acknowledged in these policies that despite early expectations, electrification alone does not eliminate air pollution in coal and wood-using areas in the short to medium term. This finding is particularly common in rural areas and poorer urban areas, where wood and coal are more cost effective than electricity for cooking and heating purposes"[14].

White Paper On Environmental Management Policy 1997

The vision of this policy is of a society in harmony with its environment, seeking to unite the people of South Africa in working towards a society where all people have sufficient food, clean air and water, decent homes and green spaces. It emphasises that integrated and sustainable management of the environment, now and in the future, is the essential basis of sustainable development. The focus is on win-win solutions to promote economic and environmental gains, particularly for previously disadvantaged communities. It also seeks to integrate and address environmental concerns and environmental sustainability in decision-making processes, in the development of policies and programmes, in spatial development planning and in the development planning and management of resources and activities.

Strategic Goals include: an effective institutional framework and legislation; sustainable resource use and impact management; holistic integrated planning to ensure that environmental considerations are effectively integrated in the development of government policies and programmes; participation and partnership in environmental governance; empowerment and environmental education.

Two of the key areas of focus are health and energy. It is recognized that life expectancy and infant mortality are important indicators of the level of development in a country and the quality of life, including environmental quality that people enjoy. The white paper also acknowledges that little has been done to promote energy efficiency in industry and households[15].

VI. KEY ACTORS AND STAKEHOLDERS IN HOUSEHOLD ENERGY AND HEALTH IN SOUTH AFRICA

Key stakeholders in the energy sector in South Africa at the national government level are:

Government

Department of Minerals and Energy (DME)

DME is the national agency responsible for the coordination, development, processing, and utilization of mineral and energy resources in South Africa. The department regulates exploration, development, and management of minerals and energy resources and promotes energy efficiency measures that reduce the negative impact of energy use on human health and the environment.

[13] www.dme.gov.za
[14] White Paper on Energy Policy for South Africa, 1998
[15] www.environment.gov.za/policy/whitePapers/envimgmt.htm

Department of Housing

The Department of Housing is charged with fulfilling the clause in the 1996 Constitution giving everyone the right to adequate housing, and assigns priority to the needs of the rural and urban poor in addressing the national housing shortfall. Among other things, the Department issues national housing code regulations, and oversees the provision of housing subsidies to provincial and local housing authorities.

Department of Provincial and Local Government

At a provincial level, only three provinces (Northern Cape, Limpopo, and Mpumalanga) have established energy committees or forums through which energy issues are addressed and the focus tends to be on electrification planning and electricity only. However, some provincial departments including the Department of Land Affairs and Housing (Limpopo province) and the Department of Housing (Northern Cape province) incorporate the principles of energy efficient housing design in their housing delivery schemes. Mpumalanga and Gauteng Provincial governments expressed interest in implementing the Basa Njengo Magogo clean fire lighting technology.

Municipalities or local governments are required to formulate integrated development plans (IDPs) through which energy issues are supposed to be addressed. Again, the emphasis tends to be on electrification planning expansion although indications are that the second round of these integrated plans may be focusing on efficiency and service delivery of other fuel sources as well.

The Central Energy Fund (CEF) is the government's holding company in the petroleum industry. Each of the companies within the CEF has its own board, which is appointed by the Minister of Minerals and Energy. A major influence in the petroleum sector, the Petroleum Oil and Gas Corporation of South Africa Limited (PetroSA) was established as an independent subsidiary of CEF on November 1, 1999. Mossgas (Pty) Ltd, Soekor E&P, and elements of the Strategic Fuel Fund (SFF) were brought together to create PetroSA. The mission of the state-owned company is oil and gas exploration and production.

The CEF formed the Energy Development Division (EDD) to investigate investment opportunities in renewable and clean energy technologies.

Council for Scientific and Industrial Research (CSIR)

The Council for Scientific and Industrial Research (CSIR) conducts research and technology development on energy issues in the Environment Division. CSIR formed the Energy Trust recently to include various experts from other divisions who are focused on energy issues.

The following provides brief descriptions of several key actors in the field of health. Please refer to the Annex B for contact details of these agencies/organizations.

National Department of Health

The South African Department of Health and the associated ministry are responsible at the national level for:

- Formulating health policy and legislation.
- Capacity building in provincial departments and municipalities.
- Ensuring equity in the allocation of resources.
- Providing leadership in planning for and the strategic management of government and donor resources.

- Developing a coordinated information system.
- Monitoring progress and health outcomes.
- Providing appropriate regulation of public and private health sectors.
- Regulating health-related activities in other sectors.
- Supporting the provinces and municipalities in ensuring access to cost-effective and appropriate health commodities.
- Liasing with national health departments in other countries and international agencies.

Several of these roles suggest the potential for a partnership between the National Department of Health and the Partnership for Clean Indoor Air (PCIA). In particular, the Department's role in helping plan and prioritize government and donor resources and managing the national health information system would place it in a prime position to support activities that help to mainstream health concerns associated with cooking related indoor air pollution.

District Health System

While the Department of Health operates at the national level to establish regulations and oversee the distribution of resources and health outcomes, the District Health System is charged with delivering health services to South Africa's population. Its main activities[16] include:

- Assuring health promotion services.
- Collaborating with other sectors of Government and NGOs in promoting health and ensuring the rendering of health services in the district.
- Providing community participation in health promotion and health service provision.
- Ensuring the full range of PHC and other relevant health services in communities, clinics, community health care centres, and district hospitals.
- Ensuring primary environmental health services, the promotion and maintenance of environmental hygiene, prevention of water pollution.
- Enforcement of environmental health legislation.
- Integrating the public and private health sectors in a manner that makes optimal use of all available health care resources.
- Involving the community to provide individuals, communities with information on healthy behaviour.
- Working closely with social groups, especially women's groups;
- Collaborating with media to facilitate wide dissemination of health-related information.
- Working with the Ministry of Education to integrate health messages into the curriculum.

Like the National Department of Health, the District Health System (DHS) could play an important role in PCIA activities in South Africa. The DHS's front-line responsibility for delivering health services to local communities and collaboration with the media and the Ministry of Education to deliver health messages would appear to make the District Health System a key partner whose inclusion in local household energy and health activities could leverage the resources and commitments of USEPA, the Ministry of Energy, and other PCIA members in South Africa.

[16] www.doh.gov.za

Essential National Health Research

An Essential National Health Research Committee (ENHR) was appointed by the Minister of Health in 2000 to help set priorities for health research and ensure that the results of that research contribute to social equity. The ENHR program helps ensure that research agendas are developed to address the country's major health problems and initiates a process involving scientists, decision-makers, and population representatives as equal, inclusive partners. Under this program, health problems are to be addressed by means of a full range of methodologies, including epidemiology, social and behavioural, clinical and biomedical health systems and policy analysis[17].

The ENHR's contribution to the Partnership for Clean Indoor Air would likely rest on its pivotal role in setting the South African Government's health research agenda. Given the increased attention to documenting the health problems associated with indoor air pollution and monitoring the effects of interventions to improve indoor air quality, the participation of ENHR and its constituents in the health research community could be an important contribution.

Health Systems Trust

The Health Systems Trust is an independent non-governmental organisation established in 1992 to support the transformation of the South African health system. It actively supports the current and future development of a comprehensive health care system. It is primarily a developmental organisation committed to improving the functioning of the health system. The organization conducts independent research and supports research conducted by other entities. It is an advocacy organisation with the aim to promote health systems development and improve the scientific literacy of the public and media. Its main goals include: facilitating and supporting district health systems development, and disseminating information about health systems development. The main focus of activity is in Primary Health Care implementation of district health services[18]. As such the Health Systems Trust's likely contribution to the PCIA would appear to match that of the government District Health System, described above.

Centre for Health Policy

The Centre for Health Policy is a multi-disciplinary health policy research unit based in the School of Public Health at the University of the Witwatersrand, Johannesburg, and is recognised by the South African Medical Research Council (MRC). It is an independent, multi-disciplinary research organisation which works to contribute to excellence in health policy and economics, and to be a critical part in health policy processes. It aims to conduct research that promotes policies in support of equity and social justice in health. As a potential partner in the PCIA, the Centre for Health Policy's role would likely complement and help implement an indoor air pollution related research agenda developed in coordination with the Essential National Health Research Committee.

NGOs

Minerals and Energy Policy Centre (MEPC)

The Minerals and Energy Policy Centre was established by the African National Congress to serve as an energy think tank in the run-up to the 1994 national elections. The organization seeks to promote sustainable development of the minerals and energy sectors in African countries and works with

[17] http://www.doh.gov.za/docs/reports/2001/enhr/summary.pdf
[18] http://www.hst.org.za/about

national, regional and international public and private organizations on a non-profit basis to support their information sharing and networking efforts. MEPC has for the last several years operated as an independent energy and mining research institute. Although the institute has addressed energy issues in the past, current focus is on mining.

Sustainable Energy Society of Southern Africa (SESSA)

SESSA was founded in 1974 and is one of 50 National Sections of the International Solar Energy Society (ISES). As the duly appointed African office of ISES, SESSA promotes the use of renewable energy technologies and is the only representative organisation for the majority of renewable energy industry role-players in South Africa.

Sustainable Energy Africa (SEA)

SEA is a non-profit organization set up in 2000. It grew out of Energy & Development Group (EDG), an energy and policy planning consultancy firm established in 1992. SEA promotes sustainable energy approaches and practices for rural and urban development through research, capacity building, information dissemination, project implementation, lobbying and networking. SEA has been one of the main implementing agents for the EU-sponsored rural and urban Schlumberger Excellence in Educational Development (SEED) programme.

International Institute for Energy Efficiency and Conservation (IIEC)

IIEC-Africa is a South African based, registered and staffed non-profit organization that serves as the local office for Washington DC-based IIEC. The organization promotes energy efficiency, sustainable transport and climate change mitigation development programs in Africa, the organisation has been involved in a number of initiatives in South Africa including implementing an energy efficient homes program, managing a "green professionals" programme, and encouraging sustainable transport within urban centres.

Earthlife Africa

Earthlife is a South African based advocacy group formed in 1988; the group is involved in campaigns on toxics, wildlife preservation, and other environmental conservation related issues. The organization has also been active in encouraging implementation of South Africa's sustainable energy policies.

Private companies involved in community work, research, demonstration and implementation include (but are not limited to):

- AGAMA Energy
- Dikepolana Consulting
- Enerwise
- Energy and Development Group
- Eskom TSI
- Manyetla Projects
- Nova
- Palmer Development Consulting (PDC)
- Parallax
- Remote Area Power Solutions (RAPS)
- Solar Engineering Services

Key international donor institutions in the South African household energy arena include GTZ and the Danish International Development Agency (DANIDA):

GTZ has been present in South Africa since 1993, when preparations for democratic elections began. Since then bilateral technical co-operation between Germany and South Africa has continuously expanded. The number of GTZ projects in South Africa has grown from 12 in 1994 to 38 at present. GTZ's assistance to South Africa focuses on good governance and skills development supplemented by cross cutting issues such as poverty alleviation, social development, protection and conservation of natural resources, gender equality and the fight against HIV/AIDS.

The Danish and South African government development cooperation program was set up in 1994, and by the end of 2001 approximately 1 billion Rand had been transferred to various South African governmental and NGO-partners for both infrastructure and knowledge transfer based assistance. DANIDA's assistance to South Africa focuses on good governance, education and training, private sector development and environmental management. In addition, the Danish government has financed HIV/AIDS related activities implemented by the Department of Health and multilateral donors like UNDP/UNICEF.

Multilateral Institutions

United Nations Children's Fund (UNICEF)

UNICEF has played an important role in improving maternal and child health in the country. The organization's priority at present is aimed at HIV/AIDS, specifically reducing transmission rates and protection for children orphaned by the epidemic. In addition, UNICEF focuses on universal access to primary education with particular emphasis on the rights of the girl child. Given the documented impact of indoor air pollution and acute respiratory infection on maternal and child health, UNICEF would be an obvious organisation to approach for participation in the South African component of the Partnership for Clean Indoor Air.

World Health Organization (WHO)

The World Health Organization has been assisting the government of South Africa and other bodies in the delivery of health services like immunization and maternal and child health care. Earlier in 2004, the South African cabinet approved a national HIV/AIDS treatment program, which will provide free antiretroviral treatments in each district. The Department of Health is consulting with the WHO to implement this program. At the international level, the WHO has been among the leading organisations raising awareness of the dangers of cooking related indoor air pollution. As a result, it would be useful to assess the interest of their South African office in embracing this issue.

In 2003, the Department of Health, in partnership with WHO and the Medical Research Council, organized two key events to mark World Health Day. The focus of these events was on rural environmental concerns like indoor air pollution and access to water and sanitation. In addition, the Health Minister highlighted children's safety in home environments, particularly threats due to exposure to indoor air pollution, particularly among per-urban and wood and kerosene using communities. The outcome of these events was the Pledge of Commitment to Health Environments for Children in South Africa. Among other things, the Pledge notes that "Exposure to environmental threats in early childhood may lead to irreversible, life-long consequences for health and productivity" and commits the signatories to a range of actions, including the following:

- Place issues of children, environment & health higher up on political and action agendas in South Africa.

- Establish and build a strong & active Healthy Environments for Children Initiative, leading to a Healthy Environments for Children Alliance in South Africa, in association with the World Health Organization's Healthy Environments for Children Alliance.
- Undertake an in-depth assessment of the range & nature of environmental risks to the health of children in South Africa.
- Create increased awareness nationally of the links between the environment and the health of children through, for example, the establishment of Healthy Environments for Children Centres in key areas across the country.
- In consultation with communities, develop a joint Healthy Environments for Children Alliance (South Africa) Plan of Action to address environmental hazards threatening the health of children. [19]

As a result of the growing political commitment engendered by these events and the pledge signing ceremony, the Minister of Health has established a Working Group to begin putting the pledges many recommendations and targets into practice.

VII. HOUSEHOLD ENERGY INTERVENTIONS AND STRATEGIES

Clean Household Energy Strategy

The Department of Minerals and Energy (DME) has embarked on the implementation of an Integrated Clean Household Energy Strategy initiated to curb coal-based indoor and outdoor pollution and the resultant negative impact on health and the environment. The Strategy identified three phases to address residential air pollution: (1) Popularisation of the Basa Njengo Magogo (BNM) low-smoke fire lighting method (see Section 6.3 below); (2) Manufacturing and distribution of an acceptable, affordable low-smoke fuel (medium term); and (3) Promotion of housing insulation and energy efficient housing design (medium to long term). While planning for this program began in 1996, the overall budget has yet to be announced. The BNM improved fire lighting campaign's pilot phase began in 2003, while the low smoke fuels activity may be launched as early as 2005. A launch date for the housing insulation and energy efficiency component has not been announced.

Low-Smoke Fuels Programme

This nine-stage program was developed to address the health and environmental concerns of burning D-grade coal, which is commonly found in the South African domestic market. This coal has a lower calorific value and on combustion, releases the unburned volatiles as visible smoke. Natural low-smoke coals like anthracite and lean bituminous coal are also found in South Africa.

The intervention comes after two previous attempts at investigating the potential of low smoke fuels during the 1960's and 70's. In the 1970's a low-smoke stove was developed, but despite good sales, this initiative was largely unsuccessful because it was reported that users modified the combustion chamber (to improve burning) thereby negating the smoke suppression features of this appliance[20]. More information is provided in the 'Technology Standardization' section.

The multi-stage program included the following key activities:

---

[19] World Health Day 2003 Events – South Africa <http://www.who.int/world-health-day/2003/activities/afro/southafrican/en/>

[20] Grobbelaar and Surridge, 1996

- Preliminary studies, which would lead to a synthesis report.
- Formulation of standards based on the synthesis report.
- Tests of low-smoke fuels, which were available to determine technical factors of the low-smoke fuels, such as emission and ignitability.
- Determination of the social acceptability of the fuel.

Following the laboratory and field test, techno-economic evaluations were to be undertaken to determine whether the fuels tested conformed to standards and whether they could be economically viable. Macro-scale experiments were to be designed to ascertain whether the low-smoke fuel will make an appropriate contribution to the reduction of air pollution to an acceptable level. Once the viability of the low-smoke fuel was determined, formulation of policy in terms of its promotion in townships was to follow. In addition, an education and publicity campaign was undertaken to raise awareness about the coal use and coal burning procedures.

The experiments undertaken in Qalabotjha and eMbalenhle informed the main results of the Program since 1994[21] as follows:

- Cost: a subsidy of R416 million (US$ 60.4 million[22]) p.a. would be required; however, this figure could be reduced if all other potential market interventions are considered. It is assumed that the state would benefit through increased revenue because of VAT (value added tax). If consumers can be persuaded to pay more, the subsidy could gradually phased out.
- Desirability: Low-smoke fuels are not as desirable as ordinary coal, because of higher costs, poor ignition or poor heat retention, and a tendency to crumble when transported. There is an added complication, namely that of soliciting support from coal merchants.
- Effectiveness in reducing domestic air pollution: mixed results, but success is deemed possible if the product is further improved.
- Phase of development: no low-smoke fuel is available for full-scale implementation.

Basa Njengo Magogo Method

As described above, the Basa Njengo Magogo (BNM) fire lighting method is being promoted on a pilot basis with 10,000 households in eMbalenhle and 18,000 households in Orange Farm. The method was named after an elderly lady who was able to demonstrate the 'top-down' or 'Scottish method' of burning coal in eMbalenhle. This method was first introduced by the Nova Institute, a South African NGO, to the eMbalenhle community to overcome the debilitating impacts of unhealthy indoor air. The Institute is involved in social development work and focuses on integrated life skill trainings. The organization tries to address energy in cases where it is identified as a development issue. Nova was contracted by Sasol, the major industrial employer in Secunda in 1997, out of concern for the high levels of harmful air pollution emitted by coal stoves and braziers used by eMbalenhle residents. Sasol wanted to explore options to introduce low-smoke coal to reduce pollution.

[21] van Niekerk and Swanepoel (2002)
[22] US$ 1 = 6.8 R

The Basa Njengo Magogo method has a direct impact on the combustion process of the coal, which results in a significant reduction in visible smoke and particulates. The process involves adding a small quantity of coal on top of the coal, newspaper, and wood (in that order) once the paper and wood is burning well. The idea is that the fire burns from the top down, affecting the combustion process of the coal in such a way that the particulates in coal smoke are combusted, thereby reducing smoke emissions and increasing the efficiency by which coal is burnt.

Comparison of the BNM Method (left) and Conventional Method (right)

Source: Integrated Household Clean Energy Strategy Prospectus, Department of Minerals and Energy.

The 'Basa Magogo' method was demonstrated to emit less smoke since only 15 minutes of initial burn time is required to achieve effective heating. This is compared to an 'mbawula' (brazier) which takes up to an hour for the coal to burn down sufficiently before smoke emissions stop. The method produces 50% less smoke than before implementing the project. The average savings is estimated at 25% of their annual coal expenses, which amounts to about 2 bags of coal per months in eMbalenhle (Spurr, 2000). Consumer response has been positive, with a 98% take-up rate in Orange Farm and a 60% take-up rate after two seasons in eMbalenhle. The pilot period is expected to end in 2004, with full scale up and replication to reach five million households running from 2005-2015, at an estimated budget of R1 million per year. One of the key advantages of adopting this method is that it does not result in any additional cost to the households. No new fuel or technology is required; simply a change in the fire lighting method reduces smoke emissions. The demonstrations serve to train households on use of this method. This costs about R40-50 (US$ 5.71-7.14)[23] to reach each household.

Vesto Stove

This stove is being produced by *New Dawn Engineering*. It can cook as well as be upgraded to a heater, at a cost of approximately R380 (US$ 55)[24], and can be used inside or outside, as it is small and does not emit smoke. The stove makes use of biomass fuel types such as wood, twigs, charcoal, dung and biomass briquettes; can cook for 1–10 people, and saves 40-66% of fuel, depending how it is used[25]. Further description of the functioning of the stove is provided under the 'Technology Standardization' section. New Dawn received financial support from the Central Energy Fund to market this product and has sold about 500 improved stoves to date.

Solar Cookers

The Solar Cooker Field Test, a pilot program was performed under a bilateral Technical Cooperative Agreement between the Governments of Germany and South Africa from 1996 to 2003. It consisted of Phase 1- Global market situation of solar stoves and social acceptance test (1996-1998) and Phase 2, which estimated the market potential in South Africa, the manufacture of stoves, and test

[23] US$ 1 = 7 R

[24] Ibid.

[25] http://solarcooking.org/Ecocookers.htm

marketing (1999-2003). The executing agencies were the Department of Minerals and Energy (DME), and GTZ. The reasons for implementing the pilot program in South Africa lie in the will and commitment of both Governments to significantly contribute to solving the problem of household energy, and more specifically, the fuelwood problem, by coming up with a market oriented solution in South Africa; as it has been shown that solar stoves are not only a niche solution.

In a pilot program, a comparative field test of solar stoves was conducted in South Africa, comprising two stages: user acceptance of these stoves and market study to assess the feasibility of commercialisation. The potential contribution these stoves can make towards fuel scarcity and indoor air pollution issues was also assessed. Initially seven solar stove models of all types were selected for an 18-month acceptance test. Intensive monitoring showed that families used the solar stoves as frequently as wood, and more frequently than other cooking options. The usage levels of solar stoves in schools and similar institutions were erratic and greatly dependent on non-technical parameters. The market study included local production and assembly, organizing information campaigns, assessing prospective prices and test marketing. Further analysis showed that for consumers, price is the number one constraint on wider adoption of these stoves, followed by pot content, thermal performance and aesthetics. Average payback time for the retail price is 2 years, based on the fuel savings achieved in the first phase and the cost of the stove based on an estimated 10,000 unit production run. The value of the fuel savings from solar cookers is often not very high because the cooker is replacing woodfuel which has no commercial value- its "cost" is the time of the (usually unemployed) person collecting the wood.

After Phase One, a reassessment was conducted and found that 90% of the stoves were still in use. In two areas use rates decreased, while in a third area usage increased. After the 2000 assessment, no further investigation was conducted on the stoves from Phase One. Stoves sold commercially in the second phase (approximately 500) were investigated about a year after purchase and revealed a usage rate of 70% (approximately 350 solar stoves still in use).

Solar Electricity in Remote Areas

The South African government's White Paper on Energy Policy of 1998 identifies universal access to electricity as a primary goal of the country's energy policy. In spite of a decade-long aggressive electrification drive, approximately 30% of the country's households remain without electricity. The communities that were electrified benefited greatly from a cross-subsidised programme allowing each household a 20-amp grid connection using a prepayment system. Between 1 and 2 million households are located far from the grid, and are often too scattered to electrify effectively. During 1999, Shell Renewables and Eskom embarked on a joint venture in the Eastern Cape to supply more than 50,000 households with photovoltaic systems capable of powering household appliances. The Minister of Minerals and Energy launched a second project in June 1999 with BP as the main technology provider and Eskom as a core participant to serve the northern KwaZulu-Natal area with PV systems. This initiative also includes the enhanced supply of LPG to communities, aiming to meet basic electricity and thermal needs of households. In total five consortia were elected to supply these services, and substantial financial support had been earmarked for this programme, to be used in the form of a subsidy system. The subsidy is to cover at least 50% of the investment costs and has to ensure that the service fees do not exceed a level that is inaccessible to the poor[26].

[26] http://www.jxj.com/magsandj/rew/2000_01/pv_power_and_profit.html

Smokeless Imbawula

The Smokeless Imbawula is an improved brazier (it emits less smoke than a normal brazier). It is being produced informally and promoted mainly by NGOs at a subsidised price. The Department of Environmental Health of Johannesburg for example sells the Imbawula subsidized to street vendors. The stove costs R180 (US$ 26) of which R100 (US$ 16) is subsidized and the street vendors sell the stove for R80 (US$ 12)[27]. Total dissemination figures and the overall budget for this activity since its start in 2002 have not been published.

The Program for Biomass Energy Conservation in Southern Africa (ProBEC)

This programme has the vision to satisfy lower income population groups' energy requirement in a socially and environmentally sustainable manner. The programme targets artisans and crafters to produce fuel-efficient stoves and lobby at a national government level to address biomass conservation issues in regional and national policies. It is estimated that biomass will remain the primary source of basic energy for up to 80% of total energy consumption for families and small businesses in most southern African countries. Thus it is important that the available energy is being used in an environmentally sound and socially responsible way. Smoke reduction through biomass energy conservation (BEC) measures has been proven to reduce emissions faced by women and children by 50%, thus implying a reduction in respiratory disease and child mortality. The implementing agency for this project is GTZ. The orientation phase (1997-1998) included inception missions to six Southern African Development Community (SADC) countries, national workshops, and development of proposal for implementation. The first implementation phase (1998-2001) was co-financed by the EU and has set up national steering committees, regional workshops and information exchange. In addition it included full implementation in Malawi, Mozambique and Namibia, with demo-projects in preparation in Lesotho and South Africa. The second implementation phase is expected to last from 2002–2005. Goals[28] include: further development of Biomass Energy Conservation (BEC) Strategies and promotion at a national level; promotion of Biomass Energy Conservation measures; strengthening of biomass energy conservation expertise in the region; and agreement on the long-term promotion of the program in the SADC region.

Energy Efficient Housing Design

Energy efficient housing design is based on the principle that it is easier to build conservation measures into a house during initial construction than it is to retrofit an existing house. These measures can have a dramatic impact on household fuel usage rates and energy expenditures. Energy efficient measures include designing windows and roof overhangs to shade the house in summer and allow warming sunlight in winter, insulating walls and ceilings, and introducing other interventions that reduce the need for artificial heating, cooling and lighting. The arguments for promoting energy efficient housing design are numerous and very valid, as it improves indoor comfort levels, saves energy, improves health and safety due to a reduction in indoor air pollution, as well as other spin-off benefits. The International Institute for Energy Conservation (IIEC) embarked on "The Healthy Homes Initiative" in 1996. As part of this initiative, IIEC-Africa, PEER Africa and the Minerals and Energy Training institute developed the Eco Home Advisors programme, with the aim to train representatives of community housing organisations of the basic benefits of this concept. The impact of the Eco Homes programme could best be analysed in Kutlwanong (Kimberley), as this is the area where a significant number of energy efficient homes have been built and where the programme has

[27] US$ 1 = 6.8 R
[28] http://www.probec.org/goto.php/probec/index.htm

been running for a longer time. All respondents agreed that the houses were warmer in summer and cooler in winter, and they also noticed that their children were not as often sick in winter as previously.

Sustainable Homes Initiative (SHI)

The Sustainable Homes Initiative was a three-year programme incorporating a range of support, training, outreach, networking functions, and hands-on technical assistance to bring about a change in the building, finance, and materials sectors servicing the historically disadvantaged communities of South Africa. The objectives of the SHI can be summarized as: networking all energy efficient housing projects by creating a forum to share knowledge on Sustainable Homes between key housing, energy and environmental stakeholders; influencing new housing projects by offering technical assistance to low-income communities wishing to build energy-efficient homes; developing a "green" training curriculum for emerging contractors and site managers that teaches them the principles of energy efficiency; assisting large commercial builders and decision-makers to adopt the Eco-Home model by providing information and support; and Impacting policy and support government initiatives by working with the Department of Housing, Parliament and other key stakeholders to support policy initiatives that encourage environmentally sound homes.

The SHI broadly consists of 3 project areas:

- Technical Assistance or the Green Professionals Programme
- Information dissemination, capacity building and training
- Sustainable Homes Network

The Network is the SHI's forum for information exchange. South Africa's low-cost housing sector is fraught with lack of awareness of energy efficiency and best practices in energy efficiency construction, but their success stories are not often told. For those communities that have found a way to build energy efficient homes for themselves, the next barrier is their capacity to spread the word to other like-minded communities. The Sustainable Homes Network consisted of five partner projects (Nova, Thdego, Kutlwanong, Waterloo and Midrand-Eco City). The partner projects as well as other relevant organisations, suppliers and implementing organisations met 3-4 times per year to share information, strengthen linkages and networks, and focus on specific themes encountered in implementing their projects.

The latest development in the energy efficient housing sector is that the South African and Danish governments are set to sign an agreement that would lead to the wide-scale implementation of energy efficient housing design in new houses being built by government. The project is being funded by Danish International Development Agency (DANIDA), in co-operation with the Department of Health and the World Bank. The project is also supported by Eskom and is looking at innovative ways of insulating houses to save energy and reduce carbon dioxide emissions, which are driven mainly by household fires in low-income areas not connected to the national grid.

LP Gas Rural Energy Challenge

South Africa is one of the six countries recently selected for implementation of pilot projects for the LP Gas Rural Energy Challenge, a public-private partnership initiative between the United Nations Development Program and the World LP Gas Association. This is one of several UNDP initiatives that emerged from the World Summit on Sustainable Development held in Johannesburg in 2002. The initiative is designed to create viable and sustainable markets for LP Gas delivery and consumption as a means to generate a wide range of productive services contributing to sustainable energy solutions to improve people's lives in selected countries. A pre-pilot workshop will be held in

every country selected for the pilot. In South Africa a three-day workshop was held in Pretoria on 20th April, 2004 where some 75 executives from the private and public sector, NGOs and development agencies spent three days discussing the LP gas market in South Africa, barriers to rural market development and identifying pilot project opportunities for LP gas business development. The workshop focused on defining elaborate projects to deliver LP gas to rural and peri-urban communities in the country, and identifying market bottlenecks and problems that need to be overcome to promote dissemination as well as to harmonize the initiative with the South African energy policies. With support from the South African Department of Minerals and Energy, the LP Gas association is developing a national strategy for LP Gas delivery to the poor. The LP Gas Rural Energy Challenge aims to achieve wider access to LP Gas, safe use and handling, fair and affordable pricing relative to other fuels and ensuring the market is properly regulated.

VIII. INDOOR AIR POLLUTION AND/OR HOUSEHOLD ENERGY PROGRAMS AND PROJECTS IN SOUTH AFRICA

The Partnership for Clean Indoor Air has four key areas of focus. These are: Market Development, Technology Standardization, Health Impact Monitoring, and Addressing Social and Cultural Barriers. The following discussion will focus on selected projects under each area.

Market Development

Solar Cooker Field Test Project

The project's main approach for disseminating solar stoves was through the establishment of a commercially viable and sustainable household energy market and industry. The research shows that solar cookers are viable for commercialisation as household cooking appliance in South Africa. The obstacles are largely in the supply (industry) side. The key issue is to ensure that there is investment on the supply-side. This requires that there be a convincing potential for a reasonable return to investment risk. The Solar Company project believes that a target of 250,000 total unit sales at an accelerating rate over a period of five years is a realistic objective. This equates to an industry generating about R15 million in sales revenue for five years.

The solar cooker programme drafted a convincing business case with respect to the potential market and social acceptability of the products and the programme was transferred to the Energy Development Corporation (EDC), part of the Central Energy Fund (Pty.) ltd., tasked with identifying and investing in renewable energy business opportunities. EDC will support private sector businesses in the renewable energy cooking industry by investing in sensible businesses with appropriate investment returns. Currently, three businesses are benefiting from EDC investment.

Integrated Energy Centres

In 2002 the Department of Minerals and Energy began working with the major petroleum products companies to establish community owned fuelling stations in rural centres. The Integrated Energy Centres (IeCs) are intended to address the lack of high quality fuels in rural areas by serving as a centralised source of paraffin (kerosene), LPG, candles, and vehicle fuel. The first two stations, located in Kuruman, Northern Cape Province and Eshone, LwaZulu/Natal, were constructed with cofinancing by Sasol and Total, and the government is reviewing their performance with an eye to developing a broader IeC promotion program. A third station, sponsored by Sasol, has recently opened in Caba Mdeni in the Eastern Cape.

Sustainable Homes Initiative (SHI)

In general, the SHI endeavoured to act as a catalyst of market change in the various low-cost housing sectors such as government, material suppliers, professionals, planners, and the community. During 2001, an evaluation of the SHI was carried out to learn the extent to which the first indicators of market change can be detected in the different low-cost housing sectors. It was concluded that respondents are of the opinion that the SHI contributed to the beginning of market change in the low cost housing sector, but that more actual implementation of concepts would be required to create a demand for energy efficient homes.

Not surprisingly, subsidization of household energy programs appears to be a common theme in South Africa. The Ministry of Minerals and Energy's solar electricity program had large subsidies to cover at least half of the investment cost and keep the service fees affordable for the poor. In the non-grid electrification programme both capital and operating subsidies are applicable. Similarly, in the Smokeless Imbawla project, about 55% of the cost is subsidized to enable vendors to sell these stoves at a lower price. Although, there are no 'successful' subsidy mechanisms, further information is required on the impact of this financial support on product dissemination and adoption.

Technology Standardization

A number of promising improved cooking devices exist in South Africa. The challenge appears to be ensuring that the devices are made to a consistent standard of quality, and encouraging their adoption by households.

South African Bureau of Standards (SABS)

The South African Bureau of Standards (SABS) is the organisation responsible for drafting product standards and verifying products through SABS marks of approval. Standards can be compulsory or voluntary. Both the solar cooker and solar water heating industries have initiated the process of drafting standards for their products. Although the drafting of acceptable standards is the first step in the process of product standardisation and consumer protection, both industries suffer from the lack of adequate testing facilities where products can be verified and tested against the standards. Winrock International has been working with the UNDP GEF office in Pretoria to expand local testing facilities for solar water heaters, but testing for other products remains a challenge. However, some stakeholders feel that the SABS lacks adequate support mechanisms to check products, allow consumers to complain or report inferior products and to administer the system of product testing and standardisation.

Low-smoke Fuels Program

As mentioned earlier, the low smoke fuels program initiated in the 1970s faced certain obstacles including concerns that users modified the combustion chamber by removing the dividing brick or

plate, thereby negating the smoke suppression features. However, research by the Nova Institute in eMbalenhle, near Secunda, found a number of stoves with bricks still intact, and they were given assurance that the people only took out the bricks because they were cracked after a few months or years. It was further reported that the bricks were not durable and sometimes even cracked after less than a month of use. Some people were even looking for bricks to replace damaged ones. This led Nova to conclude that the problems faced by the project may have resulted from the design of the stoves, not the behaviour of end-users.

Lack of technology standardization can result in device malfunction or breakdown. Nova's experience highlights the fact that quality assurance is an important aspect of the process and that standardization is not simply limited to issues associated with the efficiency of the stove's reference design.

Vesto Stove

The coal burning Vesto is a unit, which bolts onto the wood Vesto, or any other 25 litre can. The Coal Vesto uses pea-sized coal pellets and draws air through the bed.

The chimney is 2.4 metres. The grate is 190 mm in diameter and it can accommodate smaller ones as well if that was what a person wants. It can hold a large amount of coal, but can also cook a full meal using only 0.8 kg of coal. It is a total bolt-on unit - no special can is required. Any paint tin can be used as long as it is 15 litres or more and the standard 286mm diameter top. The bottom (required) is filled 1/3 with sand to make it steady. One makes holes near the top lip to let air in and then place the unit on top of the lip. The ring clamp is placed around it to hold it onto the can.

The key to "smokelessness" is coal size and top lighting, not the device. The Coal Vesto uses pea-sized coal and by its very design it has to be lit from the top. The estimated cooking time for 1 kg of coal is about 80-90 minutes.

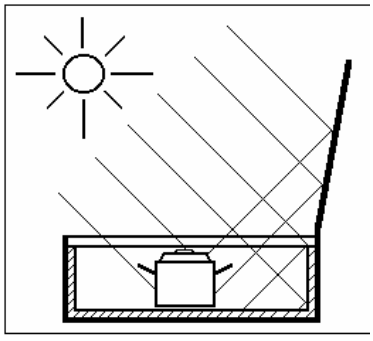
The Vesto Stove

The Vesto stove appears to require minimal maintenance and can be constructed with locally available material. This may help address the quality assurance issues encountered in the Low Smoke Stoves program. To date, about 500 of these stoves have been sold commercially by a private company, with marketing support via the Central Energy Fund. While the company, New Dawn Engineering, can deliver the stoves to customers anywhere in South Africa, they have focused their sales efforts on townships in Gauteng Province.

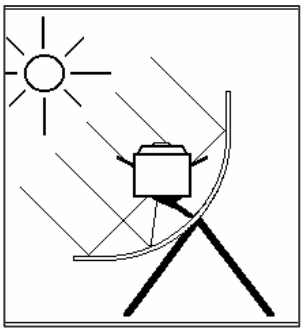
Solar Cookers

Initially GTZ conducted some field tests under a program titled GTZ/DME Solar Cooker Field Test. The program researched the social acceptability of solar cookers and aimed to commercialize these cookers and develop a market in South Africa. This activity is currently ongoing and is supported by GTZ, UNDP (GEF), and the Central Energy Fund (CEF) of South Africa.

There are several models of solar stoves. These include the Box Stove, the Concentrator Stove, and the Collector Stove. The following provides brief descriptions and diagrams of these models.



Box Stove

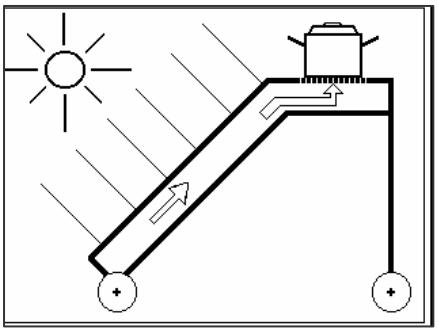


Concentrator Stove

Box Stoves are insulated boxes with a glass top, often with a directionally adjustable reflective lid, designed to surround a cooking pot. Box cookers exploit both direct and diffuse solar radiation. They require little intervention by the user and are characterized by widely divergent thermal performance.

Concentrator Stoves concentrate direct solar radiation on a cooking pot. They are quite efficient but require the user's attention to keep them aligned with the sun, maintaining good performance.

Collector Stoves are made up of two parts that often share a single casing: a collector for gathering heat and a cooking range for exploiting the yield. These powerful devices make use of diffuse and direct solar radiation. They are, however, rather complicated to build[29].



Collector Stove

After the first phase of the solar cooker programme that established social acceptance, the programme attempted local production. Only one solar cooker model, the Sunstove, is produced locally by Sunstove Organization the local manufacturer of these cookers. Sunstove has sold an estimated 50,000 units in South and Southern Africa. Other sellers in the market import their stoves and these are usually more expensive. The models used in the test are not necessarily available commercially, as they are too expensive or difficult to produce. The Sunstove costs R250, while an imported version of the parabolic cooker is available in different sizes. The stoves can be ordered via a solar cooker website or through direct agents and cost between R550 and R1500.

Health Impact Monitoring

As mentioned earlier, most of the household energy interventions in South Africa have not included any rigorous air quality-monitoring component. Further research is required to fully understand the role of exposure and air quality monitoring in these interventions.

Health impact monitoring has been carried out to a certain degree by the Department of Environment and Tourism. They are responsible for erecting air quality monitoring stations and collecting and analysing data. Larger municipalities such as Johannesburg and Cape Town also maintain ambient air quality monitoring stations to provide air pollution information. Lastly, large companies such as Eskom and Sasol own and operate their own ambient air quality monitoring stations in their areas. While this type of monitoring does not provide data on indoor air quality conditions, it can potentially be useful to researchers who want to distinguish between the health effects of indoor and ambient (outdoor) air pollution.

The Basa Njengo Magogo (BNM) project carried out various health impact monitoring activities and the eMbalenhle project included ambient air quality monitoring utilising Sasol monitoring stations. The Orange Farm project relied on reported observations by clinic staff on frequency and treatments associated with air quality related illnesses. In particular, Nova, the project manager, indicated that

[29] Solar cooker field test (2001).

before the introduction of the BNM method, for the period May to August 2001, the air quality monitoring of PM2.5 particulate concentration was 306.25 micrograms per cubic metre. Measurements of above 600 and indoor measurements of above 1000 micrograms were recorded per cubic metre. PM2.5 particulates are known to contain most of the potentially toxic deposit in the lungs (Annegarn et al). However, after introducing the BNM method, a decrease of 211.8 micrograms per cubic metre was recorded.

A longitudinal study monitoring health treatments at clinics and hospitals related to air quality illnesses could provide supplementary data to correlate efforts to reduce indoor air pollution exposure to health outcomes.

Social and Cultural Barriers

At the level of prevention, behaviour change has been identified as a possible intervention strategy to reduce the impact of indoor air pollution on child health. Behaviours such as moving children out of the room while a fire is burning, using pot lids while cooking and improving the quality of ventilation practices have all been identified for their potential to reduce the impact of indoor air pollution on human health. Yet published studies have yet to systematically focus on these and other behavioural change strategies in reducing the impact of indoor air pollution.

Mathee (2002) conducted a study testing behaviours to reduce children's exposure to indoor air pollution in rural South Africa. This study utilized a *Trials of Improved Practices Methodology*, which is a formative research method that involves families actually trying out and possibly modifying selected behaviours of a selective period of time. Thirty families participated over a 4-week trial period.

Phase one identified and recommended four behavioural clusters that may serve to reduce children's exposure to indoor air pollution. These included:

1. stove maintenance;
2. ventilation practices;
3. cooking practices; and
4. childcare practices (amount of time the child spends near the stove).

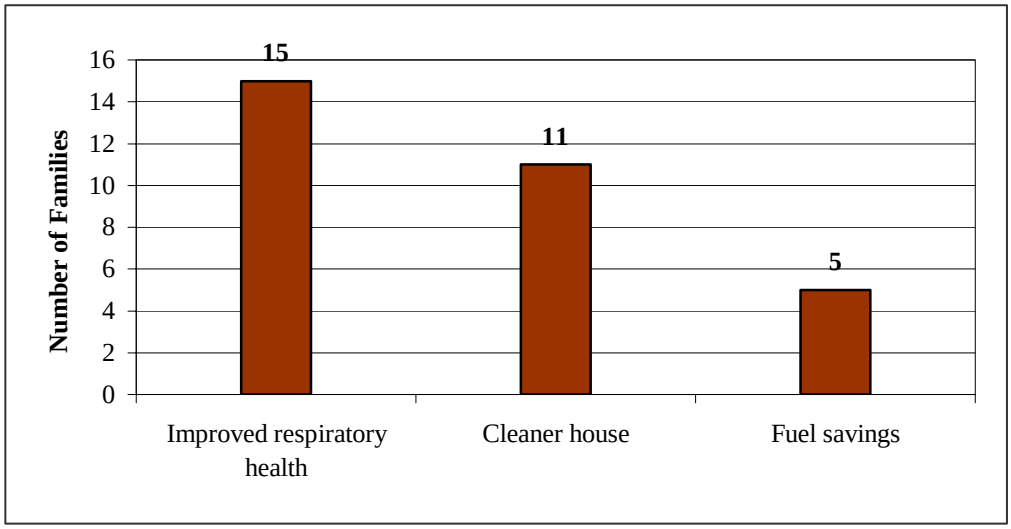
The selection of the behavioural clusters was based on their association with the risk of respiratory ill health, suggestions from mothers, likely cost, required effort and probable reductions in exposure to indoor air pollution.

Of the various measures recommended, 'keeping children away from fires' was practiced by the highest number of families (nearly 60%). Despite the mothers saying it was difficult to do so, they cited their motivation to lessen their children's exposure to indoor air pollution. However, many noted that it was difficult to look after children at night while they were away from the fire. Other practices like fixing stoves, improving ventilation and burning solid fuels for a shorter duration were undertaken, to a lesser extent, by about 27 – 47% of the households. Most families were motivated by health benefits and cleaner cooking environments. Reduction in fuel costs was also a key motivator.

The perceived benefits of various behaviour change practices are depicted in the accompanying figure. It can be seen that improved health benefits was recognized by the largest number of households, followed closely by cleaner environments. A number of barriers were noted, most notably the need for space heating in winter, as well as the fact that women now have less time in which to do chores such as cooking and making tea. Of the 30 families that participated, 25 reported that they intended to continue with the practice, mainly due to the improvement in their children's

health. The five that would not continue with this behaviour said that it would be too difficult to continue the practices.

Figure 4 Perceived Benefits of Behaviour Change



Source: Mathee, 2002

Social Acceptance of Manufacturing and Marketing of Solar Stoves in South Africa

The solar cooker field test conducted a year-long social acceptability study to determine the level of acceptance and impact of solar cookers in South Africa. The stoves were tested by 66 families and 14 institutions in the three selected test areas during a one-year placement period. Thirty families without solar stoves acted as control households and monitoring personnel were selected and trained. Six solar stove models were placed with families, three models each for large and small ones. Every family had one solar stove model for a period of two months before changing and using another one. Three large solar stove models were placed at institutions. At the end of the placement period, a workshop was conducted in each test area to carry out a preference voting exercise.

The solar stoves during the social acceptance test exclusively used local cooking profiles taking into consideration such data as typical housing, monthly family income, number of people in the household, type of dishes, cooking techniques, cooking times, meal times etc. Intensive monitoring showed that families used the solar stoves at least on 38% of all days, prepared 35% of all cooked meals on the solar stove, and were satisfied with the results of 93% of their solar cooking attempts. Solar stoves, along with wood, were the most used cooking appliances, followed by stoves fuelled with gas, paraffin and electricity. These results may indicate acceptance of solar stoves by family test users; "acceptance" of solar stoves being defined as "solar stoves are used as much as or more than other cooking options in the household".

The preference of family users for different solar stove models was also assessed. During the solar stove placement period, the participating families enjoyed 38% of overall fuel savings (with 33% of paraffin, 57% of gas and 36% of wood). In absolute terms, the 60 or so test user families have saved almost 60 tons of wood, more than 2 tons of gas, and over 2,000 litres of paraffin. The solar stoves have been tested in complex social environments characterised by poverty; high levels of migration; low levels of production; and lack of institutional support. Impact on women at the household level include monetary savings which have enabled them to allocate finances to their spheres of influence,

as well as time savings, which provide the opportunity for them to spend more time strengthening their social networks. Of the 66 solar stoves sold to families at the end of the social acceptance test, 44 units were found to be operational more than 3 years later[30]. Several factors may explain why many families stopped using their solar cookers. The most likely of these is convenience. While solar cookers reduce the need to collect firewood, they limit the conditions under which women can cook. They can only be used during the day, when many rural women are working in the fields or otherwise away from their homes. As a result, the cookers and food must be carried along, or must be left unattended outside their houses for long periods. Rather than face this inconvenience, it is likely that many women revert to traditional cooking practices.

Basa Njengo Magogo Project

Marketing campaigns and community demonstrations are an integral part of the project.

The pilot project conducted by Palmer Development Consulting, in the Orange Farm area in late 2003 held over 300 demonstrations for nearly 19.5 thousand households. Over 98% of those present adopted the method and 99% of that total was still using the method after one month. Over 75% of the residents of Orange Farm noticed substantially less smoke after one month of use. Interestingly, over 65% of household also noticed less smoke in the streets which may indicate that the traditional method of lighting coal fires was leading to neighbourhood pollution as well. These figures indicate that hands-on demonstrations are a very effective tool for bringing about behaviour change and thereby reducing exposure to indoor air pollution.

Preparing for Demonstration

Source: Integrated Household Clean Energy Strategy Prospectus, Department of Minerals and Energy.

Various stakeholders have expressed strong interest in the project, and the Department of Minerals and Energy is currently in the process of developing a program at the national level. This program will approve specific projects and provide trainings, workshops, standards and logos for marketing effort.

IX. LESSONS LEARNED FROM HOUSEHOLD ENERGY INTERVENTIONS IN SOUTH AFRICA

General lessons learned from the described interventions can be summarised as follows:

- It often takes a very long time to move from research and policy to implementation – the clean household energy strategy and low-smoke fuels programme was launched in 1994 and results are only now becoming visible in the form of the BNM programme.
- It is extremely difficult to implement interventions requiring the input of a number of governmental stakeholders –the Department of Minerals and Energy attempted since 1996 to launch a co-ordinated effort with the Department of Housing in terms of energy efficient housing delivery. Integration and co-ordination has been very difficult to achieve.

[30] Solco Compendium. GTZ, 2004

- Any intervention requiring a capital outlay from households will be met with difficulty. Households are poor and cash strapped and although they acknowledge air pollution as a problem, it is not high enough on their priority list to warrant spending scarce household income. The solar cooker programme found that any device above R250.00 (about USD $35 in April 2004) met with resistance, especially if no end-user credit is available. This is also experienced by the promoters of the smokeless imbawula (stove).
- Due to limited end-user willingness to pay and resultant uncertainty regarding the actual market potential, investors are reluctant to invest in commercial ventures manufacturing energy efficient technologies (such as solar cookers, solar water heaters, etc.). Technological interventions therefore remain largely in the "project domain".
- Available technologies rarely make it to the stage of being widely available – a lot of good designs and ideas are floating around but not progressing to the stage of a commercial product.
- End-user awareness remains a challenge – it is expensive to launch public awareness programmes, and industry is often reluctant or unable to fund such programmes.

The lessons learned from the Low-smoke Fuel Program are that for solutions to be successful the following criteria has to be satisfied:

- Affordability: The ability and willingness of the end-user to pay for the solution, and if not, for another party to do so.
- Benefit: The extent to which the solution does not merely transfer the problem elsewhere, or bring about a new problem in other areas or spheres of the household or community.
- Cost-effectiveness: The effectiveness of the solution compared with the cost involved.
- Desirability: Evidence that end-users willingly implement the specific solution, and continue to do so.
- Phase of development: The amount of work required to bring a potential solution to bear.
- Sustainability: The possibility that a solution will be sustained by the end-users and will also be affordable in the future, and has no detrimental net impact on the ecology.

The lessons learned from the Eco-Homes Advisors project are:

- Reconciling project aims and community needs: Although there is a need in most South African communities for a cleaner indoor environment, community needs are often different from project priorities. This must be addressed in a positive light as it draws attention to possible ways of making projects even better accepted by communities by learning valuable lessons from this experience.
- Improvement in air quality: In Kimberley, 9 out of the 10 respondents reported noticeable cleaner air in their homes after implementing the EHA's advice. It was thus concluded that the programme impacted positively on the improvement of indoor air quality as part of environmental health issues.

Lessons learned from the Basa Njengo Magogo (BNM) project are:

- The implementation of the BNM method can reduce air pollution, effect coal and monetary savings and improve the health of communities dependent on coal as an energy source for space heating and cooking.

- An awareness raising and information dissemination campaign is strongly dependent on demonstrations. Demonstrations have a double impact – they teach people how to make a BNM fire and show the difference in emissions between a conventional and a BNM fire. As the difference in smoke output is quite dramatic, demonstrations prove a very effective way to bring about behaviour change.
- Although implementing a demonstration and awareness-raising programme is logistically challenging and resource intensive, the project demonstrated that it is achievable. Furthermore, the cost of R38 (about US$5.40) to reach a household as demonstrated in the project may be lowered to as little as R17 US$2.40) per household with greater efficiencies and a smaller research component.

X. KEY RECOMMENDATIONS

The potential market for energy-efficient cooking appliances is as vast as it is difficult to access. Changes in appliances and fuels have major impacts on the lives and the environment of those who use low-efficiency, high emission devices for cooking. –As a result, uncertainties about markets and approach should be used not to justify inaction, but to spur further research and trials.

Key recommendations for future activities in the sector can be summarised as follows:

- When setting priorities, be certain to distinguish between "negative" or zero cost, low-cost, and high-cost interventions, especially when those costs must be borne by the end users. While this recommendation may appear generic and common-sensical, cost has proven to be the single greatest determinant of household adoption of improved fuels and appliances in South Africa.
- Support existing efforts and projects and avoid duplication. There are many promising designs for stoves, water heaters and the like, but not enough designs that are available at affordable prices to a wide audience. It may be preferable to look for opportunities to support existing technologies and lower their cost than re-invent the design. Again, this recommendation focuses on the importance of cost in driving product adoption in the South African context.
- A key requirement to using cleaner fuels and more efficient appliances is affordability. Although the practice has fallen out of favour in many circles, in some cases subsidising the fuel or the appliance may be the only option, for reaching a mass consumer base.
- End-user awareness, information dissemination and training remain areas where assistance will always be required. These interventions could be well targeted, to avoid waste and duplication. There are several bodies in the health and energy sectors in South Africa that could be involved in this process.
- Capacity building around energy and health issues is required at provincial and local government level where interventions are located and planned. For example, when implementing energy efficient housing design programs, provincial governments and municipalities are attractive partners as actual housing implementation decisions are made at this level, not at the level of the national government.
- Impact monitoring must be done more consistently, both to evaluate the effectiveness of the intervention and provide lessons learned for future efforts.

XI. REFERENCES:

Annecke, W. 1994. An in-depth investigation of fuel use by urban women. Report number EO9117. Department of Minerals and Energy Affairs:Pretoria.

Ballard-Tremeer, G. 1997. Emissions of rural wood-burning cooking devices. University of the Witwatersrand. Thesis submitted to the faculty of engineering in fulfilment of the requirements for the degree Doctor of Philosophy.

Bruce, N; Padilla, RP; Albalak, R. 2002. *The Health Effects of Indoor Pollution Exposure in Developing Countries*.

Department of Minerals and Energy. 2003. Integrated household clean energy strategy prospectus. Internal document. Department of Minerals and Energy:Pretoria.

Eberhard, AA and van Horen, C. 1995. Poverty and Power: Energy and the South African State. East Haven, Conn.: Pluto Press.

Eia.goe.gov. *South Africa: Environmental Issues*. January 2002.

http://www.eia.doe.gov/emeu/cabs/EMIS

Engelbrecht, J.P., Swanepoel, L., Chow, J.C., Watson, J.G., and Egami, R.T., 2002.

The comparison of source contributions from residential coal and low-smoke fuels, using CMB modeling, in South Africa. Environ. Science and Policy, v.5, p. 157-167

Gender and Energy: How is Gender Relevant To Sustainable Energy Policies?

http://www.undp.org/seed/eap/html/publications/2000/SEStrategy/chapter2.doc

Espinheira, T. 2003. Electricity tariffs in Southern Africa. In ESI Africa, Issue 3, 2003.

Golding, A.P. and Hoets. P.A. 1992 . Energy usage in urban black households in selected formal and informal townships of South Africa. DME Final Report. DME:Pretoria.

Graham, J.A.N. 1997. The determination of emissions, efficiencies and the cost-effectiveness of various domestic appliances used for cooking and heating in South Africa. Journal of Energy in Southern Africa. November 1997.

John, J; Oosthuizen, R; Schwab, M; Brent, A; Immink, H and Rogers, D. 1997. Indoor Air Quality and Paraffin use in Port Elizabeth: A scoping study. Project Number ME086/980. Council for Scientific Industrial Research:Pretoria.

Kidsafe. 2003. *Kidsafe Background*. http://www.kidsafe.co.za/pages/mid.html

Klunne, W.E. Energy efficient housing to benefit South African households

http://www.itdg.org/html/energy/docs48/bp48_pp27-29.pdf

Mathee , A. 2004. Indoor Air Pollution in Developing Countries. Recommendations for Research Commentary on the Paper by Professor Kirk R Smith

South African Medical Research Council

McDade, S. 2002. The Rural Energy Challenge. Prep Com III Side Event, UNDP. March 27.

Mcintire, D. et.al. 2000**.** *Geographic Patterns of deprivation and health inequities in South Africa: Informing Public Resource Allocation Strategies.* Health Economics Unit, University of Cape Town, Centre for Health Policy, University of Witwatersrand, Centre for Health Policy, University of

Witwatersrand and Health Economics and Financing programme, London School of Hygiene and Tropical Medicine, Health Financing and Economic Directorate – National Department of Health.

Mehlwana, M and Qase, N. 1999. The contours of domesticity, energy consumption and poverty: The social determinants of energy use in low-income urban households. Report number EO9612. Department of Minerals and Energy:Pretoria.

Midrand State of the environment report. 1999. Midrand Green City Project

Mintek. 1996. Engelbrecht, J; Reddy, V; Swanepoel, L and Mostert, J. Airborne particulate matter monitoring and source apportionment in Olifantsfontein. Mintek:Johannesburg.

Palmer Development Group. 1994. Cost and distribution of transitional fuels in the rural Transvaal. Department of Minerals and Energy:Pretoria. Report number EO9121.

ProBEC - Programme for Biomass Energy Conservation in Southern Africa. http://www.probec.org/goto.php/probec/index.htm

Ross, F. 1993. Assessment of the impact of fuel-use on residents of an informal settlement. DME Final Report No: EO 9116. DME:Pretoria.

Scorgie, Y, Burger, L and Annergan, H. 2003. Vaal Triangle source apportionment study. Paper delivered the National Association for Clean Air Conference, October 2003.

Solco Compendium. GTZ, 2004 **(**Draft)

South Africa: Environmental Issues. January 2002. http://www.eia.doe.gov/emeu/cabs/safrenv.html#EMIS

Terblanche, P; Nel, C,M and Opperman, L. 1992. Health and safety aspects of domestic fuels. Department of Minerals and Energy: Pretoria. Final Report NE14/6/30.

Terblanche, P; Danford, I and Nel, R. 1993. Health and safety aspects of household fuels – Phase II. Department of Minerals and Energy: Pretoria. Final Report EO 9120.

Terblanche, P and Pols, A. 1994. Characterisation of risk factors associated with household fuel usage in South Africa. Department of Minerals and Energy: Pretoria. Final Report EO 9303.

Terblanche, P; Nel, R and Golding, T. 1994. Household energy sources in South Africa – an overview of the impact of air pollution on human helath. CSIR Environmental Services, Department of Minerals and Energy and EMSA (Pty)Ltd.

The Department of Health. 2000. *The Primary Health Care Package for South Africa – a set of norms and standards.* http://www.doh.gov.za/docs/policy/norms/full-norms.pdf

The Department of Health. *The South African White Paper on Health 1997.*

www.doh.gov.za/docs/policy-f.html

Waldhoff, S. 2004. *BIOFUEL USE AND FUELWOOD COLLECTION TIME IN SOUTH AFRICA.*

Williams, A. 1994. Energy supply options for low-income urban households. Energy and Development Research Centre:University of Cape Town.

Websites:

www.nationmaster.com/country/health

http://www.statssa.gov.za/Archives/Publications/Bulletin/Bulletin.pdf

http://en.wikipedia.org/wiki/Demographics_of_South_Africa

Demographics of South Africa, 2004

www.library.uu.nl/wesp/populstat/Africa/safricac.htm

http://www.infoplease.com/ipa/A0107983.html

http://solarcooking.org/Ecocookers.htm

http://new.hst.org.za/indic/indic.php/31/?mode=data

(http://www.doh.gov.za/docs/policy/norms/contents.html

ANNEX A

Table A1: South Africa Demographics

Ethnic groups: black 75.2%, white 13.6%, Colored 8.6%, Indian 2.6%
Age structure: *0-14 years:* 31.6% (male 6,943,761; female 6,849,745)
15-64 years: 63.4% (male 13,377,011; female 14,300,850)
65 years and over: 65 years and over: 5% (male 816,222; female 1,360,069) (2002 est.)
Population growth rate: 0.02% (2002 est.)
Birth rate: 20.63 births/1,000 population (2002 est.)
Death rate: 18.68 deaths/1,000 population (2002 est.)
Net migration rate: -1.56 migrant(s)/1,000 population (2002 est.)
Sex ratio:
at birth: 1.02 male(s)/female
under 15 years: 1.01 male(s)/female
15-64 years: 0.94 male(s)/female
65 years and over: 0.6 male(s)/female
total population: 0.94 male(s)/female (2000 est.)
Infant mortality rate: 61.78 deaths/1,000 live births (2000 est.)
Life expectancy at birth:
total population: 45.43 years
male: 45.19 years
female: 45.68 years (2000 est.)
Total fertility rate: 2.38 children born/woman (2002 est.)

Source: http://en.wikipedia.org/wiki/Demographics_of_South_Africa

Table A2: Under 5 Mortality Rate

	EC	FS	GT	KZN	LP	MP	NC	NW	WC	ZA
Under 5 mortality rate										
1998	80.5	50.1	45.3	74.5	52.3	63.7	55.5	45.3	13.2	[1] 59.4
1998 Rural	-	-	-	-	-	-	-	-	-	[2] 71.2
1998 Urban	-	-	-	-	-	-	-	-	-	[3] 43.2
1998 revised	80.5	72.0	45.3	74.5	52.3	63.7	55.5	56.0	39.0	[4] 61.0
1999	-	-	-	-	-	-	-	-	-	[5] 69.0
2000	-	-	-	-	-	-	-	-	-	[6] 70.0
2002	112.0	106.0	82.0	124.0	87.0	106.0	72.0	95.0	46.0	[7] 100.0
EC=Eastern Cape, FS=Free State, GT=Gauteng, LP-Limpopo, MP=Mpumulanga, NC=Northern Cape, WC=Western Cape, ZA=Total										

Source: http://new.hst.org.za/indic/indic.php/31/?mode=dat

ANNEX B

B1 Contact list for Key Agencies, Organizations and Individuals

NATIONAL GOVERNMENT	NGOs
Department of Health Dr Tony Surridge (Low-smoke fuels/BNM) Private Bag X59, Pretoria, 0001 Tel: (012) 317-9204 Fax: (012) 317-9388 surridge@mepta.pwv.gov.za www.dme.gov.za	**Eartlife Africa** Mr. John Duncan (Air pollution control) PO Box 2036, Parklands 2121 Tel. (012) 543 0151 naca@mweb.co.za
Department of Housing Mr. Joe Asamoha (Low-smoke fuels/BNM) Private Bag X59, Pretoria, 0001 Tel: (012) 317-9232 Fax: (012) 412-1613 joe@mepta.pwv.gov.za www.dme.gov.za	**International Institute for Energy Efficiency & Conservation** Ms. Christelle Beyers (Energy efficient housing) 62 A Fifth Avenue, Melville, Johannesburg, 2092 Tel: (011) 482-5990 Fax: (011) 482-4723 cbeyers@iiec.org.za www.iiec.org/
Department of Minerals and Energy Ms. Pamela Sekhonyana (Energy efficient housing design) Private Bag X644, Pretoria, 0001 Tel. (012) 421-1304 Fax: (012) 421 1613 pamela@housepta.pwv.gov.za www.housing.gov.za/	**National Association of Clean Air** Ms. Sarah Ward (Urban and rural seed programme, community based energy work info@sustainable.org.za
Department of Minerals and Energy Mr. Ramutle Sikwe 391 Andries Street Pretoria Tel: (012) 317 9000 Fax: (012) 320 4327 www.dme.gov.za	**Paraffin Safety Association of Southern Africa** Mr. Trevor Van der Vyfer (Promote use of RE, represent RE industry) PO Box 152, La Montagne Tel: (012) 804-3435 Fax: (012)804-5691 info@sessa.org www.sessa.org/
PROVINCIAL AND LOCAL GOVERNMENTS	
DACEL Gauteng Dr. Justin Dell P O Box 8769, Johannesburg, 2000 Tel. (011) 355 1577 Fax: (011) 337 2293 justind@gpg.gov.za www.dacel.gpg.gov.za/	**Sustainable Energy Africa** Ms. Nazeema Ahmed (Paraffin safety issues and research) PO Box 16225, Vlaeberg, 8018 Tel: (021) 424-3473 Fax: (012) 3496 nahmed@pasas.org www.pasasa.org/

Ekurhuleni Metro Mr. Simon Mokgala (Energy efficient housing) Private Bag X9485, Polokwane, 0700 Tel. (015) 295-6851 Fax: (015) 295-2836 mokgalams@locptb.norprov.gov.co.za www.norprov.gov.co.za	**Sustanable Energy Society of Southern Africa (SESSA)** Mr. Richard Worthington (Renewable Energy Advocacy and research)
RESEARCH INSTITUTIONS	**PRIVATE COMPANIES**
Council for Scientific and Industrial Research Ms. Angela Mathee (Energy/health/air quality research) amathee@mrc.ac.za	**AGAMA Energy** Mr. Pieter Swanepoel (Implemented BNM in eMbalenhle) P O Box 75468, Lynwoodrif, 0040 Tel: (012) 665-9710 Fax: (012) 665 4846 konditek@acc.co.za
Medical Research Council Ms. Pat Manders (Acting energy trust manager) P O Box 395, Pretoria, 0001 Tel: (012) 841-3680 Fax: (012) 841 2597 pmanders@csir.co.za www.csir.co.za/	**Energy and Development Group** Ms. Marlett Wentzel (Implemented BNM, energy efficient housing design, m&e) PO Box 11906, Queenswood, 0121 Tel: (012) 349-1901 Fax: (012) 349-1913 marlett@pdc1.co.za www.pdc1.co.za/
OTHER ORGANISATIONS	
Central Energy Fund (pty) Ltd Mr. Sibusiso Ngubane (Clean energy investment, solar cooking) Southern Life Gardens, 6 Proetea Place Sandton, 2199 Tel: (011)535-7000 Fax: (011)883-3233 sibusison@cef.org.za www.cef.org.za/	**Menyetla Projects** Ms. Mmathabo Mrubata (Community training, solar cooker project, BNM, energy efficient housing) PO Box 3078,Pinegowrie, 2123 Tel: (011) 886-4661 Fax: (011) 886-7753 mmathabo@pdc1.co.za www.pdc1.co.za/
Eskom Corporate Ms. Wendy Poulton (Corporate Sustainability and Environmental Dept.) Private Bag 40175, Cleveland, 2022 Tel: (011) 629 5790 Fax: (011)629 5264 www.eskom.co.za/	**Nova** Ms. Carmen Collison (Non-grid electricity service provider) Carmen@raps.co.za

Nov Africa Mr. Aubrey Julies (Implements Zamdela community BNM project) aubrey.julies@sasol.com	**PDC** Mr. Chris Venter (Energy investment fund administrators) chris@raps.co.za
Sasol Mr. Gerrit Kornelius (Sponsored BNM clean fire lighting project) 4 Baker Street, Rosebank Tel: (011) 344 0141 Fax: (011)522 7588 gerrit.kornelius@sasol.com	**Raps** Mr.Mark Borcherds (Energy research, Urban and rural SEED)
BI-LATERAL DONOR ORGANISATIONS/TECHNICAL CO-OPERATION ORGANISATIONS	
Basa Njengo Magogo Programme Ms. Linda Ntombela (Fund household energy and environmental studies P O Box 747, Saxnworld, 132 Tel: (011) 441 7389 Fax: (011)441 7433 linda.l.ntombela@shell.co.za www.shell.co.za/	**Shell Foundation** Mr. David Hancock (Project Leader solar cooker programme) 6 Protea Place, Southern Life Gardens, Sundown david.hancock@gtz.de www.gtz.co.za/
CLEAN ENERGY/HEALTH INITIATIVES	
Clean Energy/Health Initiatives Mr. Martin Matlebyane (Interested in BNM programme) P O Box 9536, Pretoria, 0001 Tel: (012) 431-4268 Fax: (012)342-7050 matlebyanemm@state.gov	**Solar Cooker Project** Ms. Maragarett Bennet (Manufactures and sells the Sunstove solar cooker) P O Box 21960, Crystal Park, 515 Tel: (011)969-2818 Fax: (011)969 2818 sunstove@iafrica.co.za
GEF Solar Water Heater Project Dr Tony Surridge (Low-smoke fuels/BNM) Private Bag X59, Pretoria, 0001 Tel: (012) 317-9204 Fax: (012) 317-9388 surridge@mepta.pwv.gov.za www.dme.gov.co.za/	**Sunstove Organisation** Dr Marlis Kees (GTZ project leader ProBEC programme) Tel: (012) 342-3132 Fax: (012) 342 3839 Marlis.Kees@gtz.de www.probec.org.co.za
Low-smoke Fuels Programme Dr Tony Surridge (Low-smoke fuels/BNM) Private Bag X59, Pretoria, 0001 Tel: (012) 317-9204 Fax: (012) 317-9388 surridge@mepta.pwv.gov.za www.dme.gov.co.za/	**US Embassy** Mr. Andre Otto (DME contact for UNDP project Private Bag X59, Pretoria, 0001 Tel: (012) 317 9000 Fax: (011) 482-4723 andre_o@mepta.pwv.gov.za www.dme.gov.za/

ProBEC Ms. Rina King (Manufactures and promotes Vesto coal and wood stove) 11 Mazoe Road, Emarentia, 2195 Tel: (011) 486-1611 Fax: (011) 486 1612 rking@infodoor.co.za	**Vesto Stove** Ms. Christelle Beyers (Imlements SHI, Green Professionals scheme, EEHD etc.) 26 A Fifth Avenue, Melville, Johannesburg, 2092 Tel: (011) 482-5990 Fax: (011) 482-4723 cbeyers@iiec.org.za www.iiec.org/