Candlelight for Health, Education & Environment (CLHE)

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Case Study

Alternative Energies and Reduction of Dependence on Charcoal in Somaliland

Presented at the 6th Resource Based Conflicts (RBC) Conference in Hargeisa, Somaliland

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ACKNOWLEDGEMENT

The investigators would like to thank all those who helped in producing this document. These ladies and gentlemen are in some way or other involved in the present or potential energies for use in cooking and heating in Somaliland. They included government officials, businesspersons, professionals and housewives. Their names and occupations are listed in Annex II of the document.

Our special appreciation and thanks is due to Mr. Ahmed Ibrahim Awale, the executive director of Candlelight for Health, Education & Environment (CLHE) and our overall supervisor. He provided much relevant literature, names and organizations of information sources and numerous facilitations.

Mr. Awale while reviewing the document itself made numerous suggestions and valuable contributions to its present form.

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I.0. EXCUTIVE SUMMARY

Ever since the start of the 20th century there were indications of deleterious ecological changes in Somaliland. The latter concerned the depletion of vegetative cover and diversity. Big game hitherto abundant disappeared as they lost their habitat. The last elephant died in 1958 in Dibira-weyn in Awdal region. In addition to providing grazing for livestock, biomass became the only fuel for cooking and space heating as firewood in the countryside and charcoal in towns. The ever increasing annual use of the *galool* forests (*Acacia bussei*) which regenerates slowly in 20-30 years meant a sustained net depletion of biomass cover. Over the recent decades the depletion of biomass resulted in a reduced carrying capacity of the rangelands, subsequent reduction in herds per family and conflicts over tree ownership among the people.

The realization of the diminishing supply of woodlands as the source of charcoal and the deleterious effect on the socio-economics of the livestock people showed the clear need for the diversification of energy sources and the more efficient use of available energy. A review of the latest information on the status of *Acacia bussei* bioclimatic zone indicates severe degradation of range environment.

As a consequence, Candlelight has been proactive in fuel energy saving issues in general and biomass energy in particular whereby it carries training and interventions on the popularization of energy efficient improved stoves (*jiko*). There was also importation of liquefied petroleum gas (LPG) by private sources.

Kerosene, LPG and coal could serve as other source of energy to reduce charcoal use. There are problems related to latter regarding awareness, misconceptions, health and safety and environmental impacts.

Meanwhile, the charcoal business has been expanding at a fast pace in to cope with the demand for charcoal of the every increasing town population. The rationale for opting for alternative energy sources are:

1. Protection of the range environment from further deterioration which may further worsen the economic status of the livestock
2. Find an alternative source of energy for the towns people which they can cook and heat with. The latter before it is too late as the indications are that at the present rate of consumption the woodland reserves would be adequate for a limited period only.

<u>The objectives of the study are:</u>

- Enhance data available on alternative energy sources in the country, for use for cooking, space heating and industrial purposes;
- Gauge people's attitudes and perceptions about the known and potential alternatives such as kerosene stoves, solar cookers, LPG and coal;
- Disseminate the outcome of the study for use by development agencies for energy saving

interventions and by Somali entrepreneurs for investing in business opportunities that will contribute to the reduction of biomass resources for energy.

Present status of alternative energies:
Coal deposits exist in the country. However, it is necessary to undertake studies to determine their quantities and quality, economics of exploitation and laws before decisions regarding their utilization can be made.

LPG is imported in relatively small quantities and distributed. Lack of storage facilities for LPG in Berbera Port and high taxes raise the cost of the fuel and together with perceptions about the dangers involved in its use limited its market.

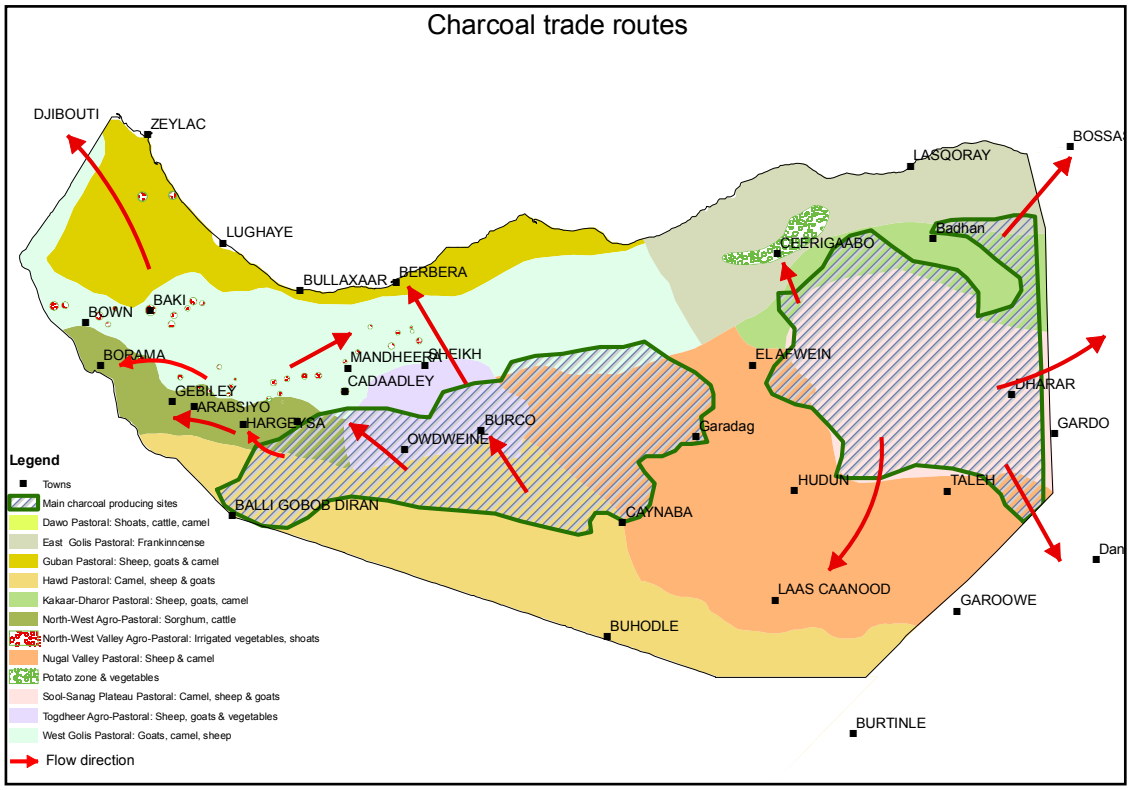
Imported kerosene is practically all used for lighting lanterns and pressure lamps. With encouragement and tax incentives to businesspeople to import the fuel in larger volumes together with the importation and later fabrication of kerosene stoves could bring the cost of using the fuel. People would also need to be educated on its safe use. Many people believe that kerosene stoves are dangerous to use or are quite ignorant about them.

Solar cooker has been developed in the country and is locally fabricated. It is in the market. The relatively long time it takes to cook food which is limited to boiling and steaming and its high cost inhibit its widespread sale.

Recommendations:

- Reduction of energy wastage while producing the charcoal i.e. improvement of kilning process;
- Promotion of the use of the energy efficient charcoal stoves which saves as much as 40% of charcoal used;
- Promotion of the present (locally produced) solar cooker and researching the development of more versatile ones.
- Studies related to the feasibility of using kerosene and LPG to reduce dependence on charcoal is recommended. The inefficient system of importing LPG has been explained in the discussions of LPG. A more relative picture of the potential of kerosene and LPG to replace charcoal would only come from a study at the macro-economic level involving all aspects of such a venture.
- Studies aimed at determining the magnitude, quality and economics of exploitation of local coal deposits is recommended. In addition a suitable coal (briquette) stove for domestic use is in need.
- Other alternative fuel reduction technologies and practices needs to be explored.
- Community education on alternative energy and social marketing for the introduced energy sources
- Exemption of tax on kerosene and all energy saving appliances
- Popularization of *Prosopis juliflora* firewood and charcoal.

Generalized Map of the Vegetation of Somaliland



Acacia Bussei Zone = Areas encircled with the green line

2.0. BACKGROUND

Somaliland, like other countries, has been in a state of ecological change, for many decades and perhaps for hundreds of years and practically all the changes has been towards a reduction in the vegetation cover and shrinkage of other natural resources. In the past three decades, however, the rate of deforestation, in response to rising demand for charcoal, wood for construction and thorn fencing (enclosures), has put severe pressure on the remaining acacia woodland.

Biomass is the primary and, indeed traditional source of energy for Somaliland population. Charcoal is the principal energy producing fuel for cooking, space heating, whereas firewood is commonly used in rural areas.

This energy is generated from Acacia species which predominantly grow in all over the country particularly *Acacia bussei* which mainly grow in plateau zones where annual rainfall ranges from 150-300mm. Acacia species also have other economic and environmental values. This all important tree has been selectively harvested and is reduced to remnant forest batches in the country. There is also a gap between consumption and annual increment (regeneration of forests); added to this the country is arid, and it takes considerably a long time (25-30 years) for most of Acacia tree species to mature to be good enough to produce 3-4 bags of charcoal.

Descriptions and photographs of parts of Somaliland at the end of the 19th century, such as those of Major H.G.C. Swayne, record that the country was then park like with abundant trees and grass. "Elephants could be seen roaming or resting in the shade of large trees and the wild ass was then so common and tame that shooting it was no sport…."
Today the country is so degraded.. while the last elephant died at Dibirawein in Awdal region in 1958. The rhinoceros, lion, greater and lesser Kudu and Swayne's Hartbeest are now extinct or nearly so, in the region.

The negative impact of deforestation on the environment and the socio-economy of the communities of Somaliland, particularly those living in the rural areas, are well-documented. As more trees are cut for charcoal, construction, fencing and as animal feed, the means of livelihoods of the pastoral communities are damaged and their copping mechanisms weakened. There is also a direct link between the recurring droughts and the deforestation. During the past few decades, the country has experienced reduced rainfall in terms of quantity and effectiveness.

Conflicts over biomass resources use has been on the rise. The rapid increase in the demand for charcoal due to rising population is creating considerable pressure on the shrinking forest resources. This had created competition over the remaining trees, which sometimes developed into bloody conflicts. The depletion of wood resources is one of the significant sources of conflict in the country, particularly, in district of Salahley, Sabawanag, Adadley, Sheikh as well as Sanag and Awdal regions. These districts attract various charcoal businesspersons who deliver charcoal to Hargeisa, Burao and Berbera due to their geographical proximity to the major urban centers and the fact that the areas still possess the largest remaining *Acacia bussei* forests.

Conflicts often arise among traditional resource users (pastorlists) and emerging stake- holders (Charcoal Producers, District Authorities, and the Ministry of Pastoral Development and Environment).

Attempts to reduce charcoal consumption as well as diversification of energy sources was made by few organizations most notably Candlelight which has launched in December 2004 the production of energy efficient mud stoves (Jiko) that could reduce charcoal consumption by 40%. Earlier, in 1997-98, the World Conservation UNION (IUCN), and lately the Agricultural Development Organization, a local NGO based in Hargeysa, carried out trainings on the production of ceramic stoves (jiko). ADRA was keen to introduce solar cookers and has trained local artisans in the production of solar stoves.

One or two local enterprises have also attempted the introduction of liquefied petroleum gas (LPG), but are constrained by infrastructural, logistical problems which have had an impact on the affordability of the commodity, as well as the communities' meager knowledge about LPG.
Candlelight believes that the heavy dependence on charcoal could be reduced by introducing other options such as kerosene stoves, LPG and the utilization of the coal deposits in Somaliland. The easy introduction of the above mentioned alternatives is very likely to be constrained by the absence of awareness about the options, misconceptions about their use and effectiveness as well as health and safety concerns.

1.0. INTRODUCTION

The Acacia trees charcoal specially the *A. bussei* or *galool* is the most important fuel for cooking and heating in Somaliland towns for long decade. As the town populations increased at faster and faster paces increased, larger and larger areas of woodland had to be cleared for charcoal production. The latter in turn resulted in ever worsening range environmental degradation affecting the economy of livestock rearers as well as that of the country. Furthermore, the woodland resources have dwindled to such an extent that they may be exhausted with in a decade or less.

Candlelight has undertaken study in order to review the current status of this desertification and its ramifications. Secondly to collect information on ways and means of reducing the use of the fuel from biomass, market study on alternative energy such as solar cookers, coal, kerosene and liquefied petroleum gas (LPG) was done - the latter to examine their current use and potentials as replacements for charcoal. The role that the improved charcoal stoves can play was also examined. Properly used, the later stoves have been shown to conserve as high as 40% of charcoal compared to the old traditional stove.

It is hoped that the study will yield recommendations for policy options and strategies towards the reduction of biomass energy reduction.

According to Candlelight, improved efficient charcoal stoves can conserve the fuel by 40%. Our quick summary of housewives indicted their using improved charcoal stoves were saving 20-30 % or more charcoal. We have been told by those who have been following the matter that with further instructions to the users the efficiency can be raised considerably. A third method which may work in certain locations is the reduction of the burning of live trees whenever supplies of dead trees are available. The latter envisions the attainment of knowledge of the status of woodlands and good control.

The use of kerosene and LPG are ones that can, if adopted, have a very quick effect. They should be studied at the macro-economic level since large amounts of these fuels would have to be imported and tax incentives probably needed to bring down their cost.

3.1. Status of forest utilization in the country

Ever since the development of towns in Somaliland charcoal remained the fuel for cooking and heating. On the other hand the villages in the countryside and nomadic people used firewood instead. As the towns expanded, charcoal consumption increased accordingly. Meanwhile other fuels, Kerosene in particular played a minute and insignificant role to satisfy the ever increasing demand. Charcoal is prepared by burning trees primarily the Galool tree (*Acacia bussie*). The Galool grows in a bioclimatic zone in Somaliland of about 50,000 km^2 with average rainfall of 150–300mm and altitudes ranging farm 900m – 1125 meters above sea level according to SOGREAH[1] .

1 Ministry of Agriculture SDR Northwest Region Agricultural Development Project, Feasibility and Technical Assistance Technical Report No.6. Range and Livestock Survey, Sogreah Consulting Engineers, Grenoble, France, 1982.

A number of ecosystems were defined in the zone all characterized by the presence of the Galool. In the Northwest of Somaliland the *Acacia bussei* zone covers 718,000 hectares or 21.4% of the regions total area.

The charcoal production business increased from one where several persons using donkeys or camels supplied 4-10 sacks of charcoal of each per month to the small towns to one which supplies are as high as 93,000 sacks per month to Hargeisa town alone in 2003 according to the Ministry of Pastoral Development and Environment of Somaliland (MPD&E) case study[2] published in 2004.

The destruction of the *Galool* tree is moving at a fast accelerating pace in order to keep up with the demand from the very high growth rates of town populations.

The clearing of the *Galool* woodlands over the decades has contributed to the severe degradation of the rangelands. On the other hand the *Acacia bussei* reserves have been depleted to such an extent that the MPD&E people believe it will be exhausted in less than 10 years.

This means that the urban population of Somaliland has to find an alternative energy source to the depleting natural woodlands. The MPD&E officers also point out that most of the remaining trees at this time are young small diameter plants containing much less wood than mature trees.

3.2. Degradation of the Range Environment:

The destruction of the *Galool* charcoal production was accompanied for many decades by overgrazing and felling trees and branches for fodder during the dry season. A serious often underestimated practice that degrades the rangelands is the use of live branches and small trees or even whole trees for fencing. The fencing is of two types: One is the security fence which surrounds the compounds where livestock is kept at night and the homes of the livestock people and the other is a more destructive one which pastorals and agriculturalists parcel and enclose communal land for private use. The latter process involves the killing of hundreds of trees at one go and a continuous cutting of the same for subsequent fence maintenance.

The livestock people use wood and other plants for building and other tools and household items.

The MPD&E considers charcoal production as more serious cause of range degradation than even overgrazing. Once the vegetative cover is removed from the land, soil erosion sets in which in turn enhance the rate of desertification of the land._

2 Ministry of Pastoral Development and Environment (MPD&E), Somaliland. *Case Study, Impact of Charcoal Production on Environment and On the Socio-economy of Pastoral Communities of Somaliland*, Hargeisa 2004 (Funded by Novib,through Candlelight, Hargeisa).

3.3. Charcoal Business:
This business has sprouted into a major industry. The subject is dealt with at in depth by the MPD&E case study cited in above.

Businessmen stand at the head of the industry and make the most profit out of the business. Gangs of young local residents are advanced all the food, tools, money, *Qat (Catha edullis)* and donkeys to produce the charcoal. The produce is transported to towns like Hargeisa, Burao, Berbera, Borama others where the demand is rising continually. (see vegetation map in Pg. 4)

Twenty five years ago SOGREAH[3] advised the then government either to:
- Turn to oil based fuels, or
- Grow new plantations of selected vast adaptable fuel wood species growing trees to provide would for charcoal making.

The looming problem was visible for a very long time. We seem to have reached a critical stage.

Neither the original reserve of wood nor the exact remains at present are not exactly known. According to the MPD&E study, during the last six months of 2003, 516,990 sacks of charcoal were consumed in Hargeysa; thus involving the clearing of 6,892 hectares of land which can be translated into 323,178 trees.

A number of indications attest to the depletion of the woodland sources of charcoal for the major cities of the country – most importantly because of recurrent conflicts related to charcoal issues is on the rise. In the eastern part of Somaliland, charcoal trade routes lead to areas in Puntland, Garowe for local consumption, as well as exportation to Gulf countries.

The degradation of the rangelands has reduced the quantity as well as the quality and diversity of feed for livestock. As a result the herds kept by the stock families are getting smaller and less productive. This trend is harming not only the livestock herders but the overall economy of the country.

3.4. Reasons for Opting for Alternative Energy Sources:
- Loss of vegetation and soil erosion hazard
- The high increase in reduction of the woodland particularly *Galool (Acacia Bussei)* resulting from the appearance of high demand in urban centers due to increase of population which is resulting increase of price of charcoal.
- The falling economic condition of pastoral communities as a result of environmental degradation and denudation of their ecological lands
- In rural areas particularly the agro-pastoral the distance of traveling in search of firewood had been increasing constantly, which is an additional hardship for farmers especially for women and children.

3 (see footnote 1 above)

4.0. OBJECTIVES OF THE STUDY:

This study attempts to realize and document the following objectives

- Enhance data available on alternative energy sources in the country, for use for cooking, space heating and industrial purposes;
- Gauge people's attitudes and perceptions about the known and potential alternatives such as kerosene stoves, solar cookers, LPG and coal;
- Disseminate the outcome of the study for use by development agencies for energy saving interventions and by Somali entrepreneurs for investing in business opportunities that will contribute to the reduction of biomass resources for energy.

5.0. ALTERNATIVE ENERGY OPTIONS

5.1. Coal

5.1.1. **Origin of Coal**: Geologists believe that coal originated from trees and plants growing in swamps in past geologic periods tens or hundreds of millions of years ago. After dying, the plants formed layers of decaying vegetation. Rock layers and soil formed over the decaying layers caused intense pressure. The latter pressure together with heat from the earth's interior over geologic, time changed the plant remains into coal. Simplified stages in the formation of coal are outlined below:-

Stage	Material formed	Remarks on the chemical and physical properties of the material
Intermediate stage	Peat	Soft brown spongy fibrous material, very high moisture content
Stage 1	Lignite (brown coal	Little or no fibre content, harder than peat, relatively high moisture content. Much higher carbon content than peat – may reach 50%
Stage 2	Bituminous (soft coal)	Much lower moisture content than lignite. Higher carbon content than lignite which may reach 70-80%
Stage 3	Anthracite (hard coal)	Hard (metamorphic rock). Very low moisture content. Very high carbon content i.e. greater than 80%

Over geologic time with pressure and heat peat changes to lignite, lignite to bituminous coal and bituminous coal to anthracite coal. In the process moisture content and certain organic compounds are decreased while carbon content is increased and hence the value as fuel enhanced.

5.1.2. **Chemical Composition of Coal:** Coal is composed mainly of condensed ring (Aromatic) hydrocarbon compounds of high molecular mass. These compounds have a high preparation of carbon in relation to hydrogen. Sulfur is often found in coal as a minor component of usually less than 10%.

5.1.3. **Commercial scale Coal Distillation (Fig : 1)**: Coal may be distilled into various components i.e. coke, coal gas, ammonia and coal tar.

- Coke: is almost all carbon. It is a smokeless fuel which is used for heating purposes in industry or for domestic use for cooking and heating.
- Coal Gas: is composed of hydrogen, methane and carbon monoxide. These are dangerous highly flammable gasses.

- Ammonia: is converted into ammonium sulfate which is a fertilizer.
- Coal tar: is a dark heavy liquid contains a complex mixture of organic compound. Coal tar may be subjected to fractional distillation to produce benzene, toluene, naphthalene, phenol and pitch for use in the organic chemical industry.

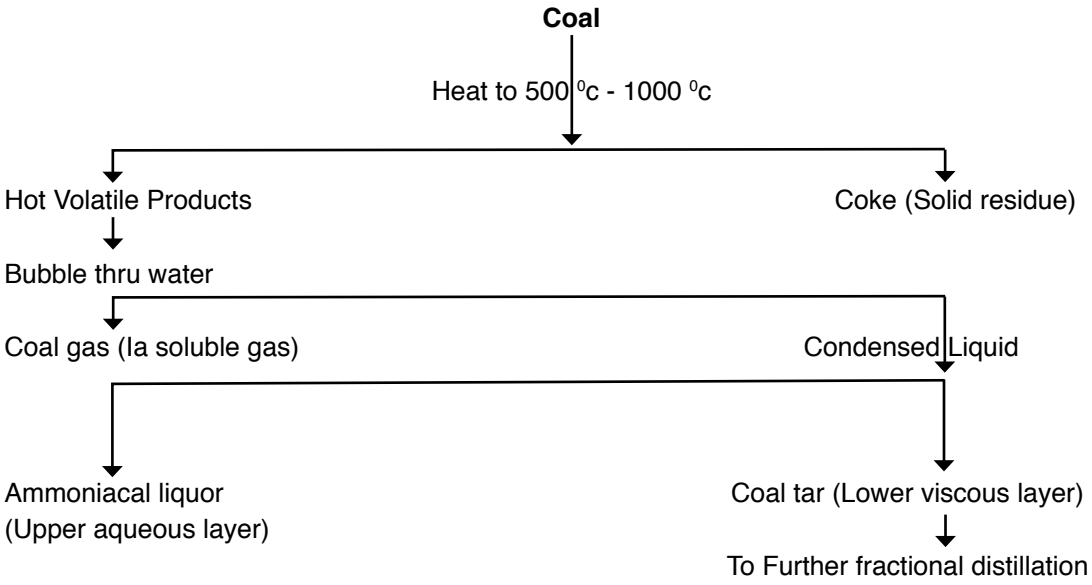


Fig 1…….. Schematic diagram of coal fractional distillation (After Bansal).

5.1.4. **Commercial Coal Mining**: There are 2 well known methods of mining coal depending on whether the coal seams (Layers) are near the land surface or deep underground.

Coal lying deep underground is mined by sinking a deep shaft perpendicular to the coal seams. Miners and digging equipment are lowered through the shaft and coal dug from the seams lifted up through it. This deep mining of coal is much more expensive than surface mining and is more hazardous because of the potential occurrence of (cave-ins) and explosions.

Coal lying near the surface is mined by removing the over burden of rock soil and vegetation first and then the coal is mined using heavy machinery for the required digging, excavation and transport of the coal to the refining plant.

Surface mining of coal eventually exposes large tracts of barren land surfaces unsuitable for plant growth, and expensive to reclaim.

5.2. Coal Deposits in Somaliland:

The existence of coal deposits in Somaliland has been known for many decades. Hunt[4] mentions the existence of lignite in the north facing slopes of the main watershed in the country starting from east of Berbera all they way to the boundary with Somalia. Others including the Director General of the Ministry of Water and Mineral Resources of Somaliland (Personal Communication) indicated the existence of coal deposits in the present Awdal region in the west also.

4 Hunt, J. (1951). A General Survey of Somaliland Protectorate, Hargiesa Somaliland.

According to Dr. Ahmed Mohamed Behi, Economic Geologist and Former Minister of the Ministry of Water & Mineral Resources (MW&MR), the coal deposits in the country are composed mainly of lignite and bituminous coal whose age is Eocene\ Eocene/Miocene i.e. 38 million years.

Dr Behi adds that the most promising coal is located in Hed-hed area where the seams are a few meters (3-4meters) below the surface. He also indicated that it is first necessary to determine the quantity of the coal reserves in the country as well as its quality. After getting that information it would be possible to decide whether it is suitable for international commercial exploitation or is sufficient for local consumption only - the latter to save our trees. Dr. Behi also pointed out the parameters used to determine the quality of coal i.e. fixed carbon %, volatile matter %, ash content %, sulfur % and caloric value per unit mass.

Mr. Ahmed Aden[5], a staff member of Action Aid, in his paper (*The social and developmental implications of Charcoal burning in Somaliland, 2004*) gives results of analysis of coal samples, probably exploration samples, from Hodmo and Erigavo. He says the analysis was sponsored by Action Aid and UNDP. Interpretation of the laboratory analysis is given i.e. "*The moisture content and volatile materials contained in the samples are high which shows that the coal is young or immature low grade type and that the sulfur content is low which promises that it could be domestically used in closed stoves with chimneys one meter above the roof*".

In the same paper Mr. Ahmed Aden mentioned that there are huge deposits of coal in the Golis mountain range including an estimated six billion tons in Hodmo area to the north of El-Afweyn. Ahmed cited (UNDP, 1998) which is understood to mean that he obtained his information from a UNDP publication dated 1998.

There is a discrepancy between the information presented in by Dr. Behi and the above information attributed to the UNDP. Dr. Behi was contacted in person in Hargeisa regarding that in fact he did a "Geologic infer" for the UNDP which they used in 2 reports according to his knowledge. He said the "infer" which he did is the source of the estimates of the coal reserves in the country attributed to the UNDP. Dr. Behi added that while geologists use the "infer" when they visit a location the resulting estimates have no real practical value. In fact several stages of investigations are done after 'infer' before accurate estimates of proven reserves of the mineral can be claimed.

Conclusions of the Workshop on Natural Resources Based Conflicts - Charcoal. Sponsored by the Academy for Peace and Development, Held in Hargeisa on 25/05/2005[6]:

The presentation regarding coal was made by Dr. Ahmed Mohamed Behi. After discussions of the presentation the workshop participants reached the following conclusions as quoted here:-

- Laws pertaining to resource ownership are required before any venture capital is mobilized.
- Cost and effect analysis is necessary to understand the dynamics of a full fledged exploration and exploitation.
- Accessible areas due to proximity to infrastructure such as roads and ports be exploited first provided coal parameters and economic viability dictate.

5 Ahmed Aden (August 24, 2004) Somaliland Charcoal, The Social and Development Implications of Charcoal Burning in Somaliland, Hargeisa.

6 The Academy for Peace and Development, Dialogue for Peace Program – Workshop Report, Natural Resources Based Conflicts – Charcoal, May 25 2005, Hargiesa – Somaliland.

- It is absolutely vital to commerce activities in launching measures in coal exploitation in order to stop the savagery against our plant cover.

5.3. Investor Interest in the Exploitation of Somaliland Coal:

The study team visited the Ministry of Water & Mineral Resources (MW&MR) of Somaliland to discuss with them on the above-mentioned topic. The director general (DG) mentioned that there are two groups of businessmen including foreigners and Somalis who came to the Ministry on the subject matter. He added that at present the Ministry had only memorandum of understanding only with them regarding the exploitation of the country's coal.

The D.G. joined by two of his geologists pointed out the locations of coal deposits which agreed with what was mentioned here earlier. He said that the reserves are quite large but did not give any figures. The D.G. also told the study team that the businessmen who contacted them about the coal were actually interested in exporting it.

Coal may sometime in future become an important source of energy for Somaliland the later due to the fact that the mineral is known to exist in many parts of the country. In any case due to the acute need for alternative energies to rely on, charcoal discussions will continue in the country.

5.4. Potential of Small Scale Utilization of Coal for Cooking and Heating in Towns:

Coke is an excellent fuel for home or restaurant use in cooking and space heating. That however, is possible when coal is distilled on a large scale and the volatile materials removed leaving the smokeless coke as residue.

Rather then wait for some commercial entity to engage in distilling our coal and making available smokeless coke. Somaliland is under pressure to explore the use of raw coal. The pressure comes from the fact that the trees from which the traditional fuel i.e. charcoal is obtained from have been depleted to such an extent that the present reserves may not last for more then a limited number of years. The effect on the severe degradation of rangelands due to burning of trees for charcoal is also is a serious consideration.

A promising system involving the briquetting of coal and coal stoves is described here in the following sections[7]. Briquetting process usually consists of crushing, screening, mixing (with bonder or adhesive) and pressing. Briquetting were being used by Japan which they switched to fuel and electricity when they became rich. For developing countries it could be an alternative source of energy to replace the diminishing wood resource and the high costing oil and gas energy source.
For optimum utilization of briquettes, a purposely designed briquette stoves is required.

7 Karekezi, Stephen and Timothy Ranja (1997). Renewable Energy Technologies in Africa. Zed Books, London and New Jersey in Association With African Energy Policy Research Network (AFREPREN), P.O.Box 30979, Nairobi, Kenya and the Stockholm Environment Institute (SEI).

They vary in design and capacity and so do their efficiencies. A good briquette stove should ensure smokeless combustion, flexible fire control and high heat efficiency over a wide range of combustion rates. Being light and easy to move is sometimes important for household use. A high combustion temperature is required for restaurant use. Convenient ash removal is also a consideration in design.

The method of feeding new briquettes into the stove often contradicts the requirement of smokeless combustion. If a briquette is added on the top of one already burning, smoke from the volatile matter in the coal is likely. If the new briquette is fed under the burning one, smoke will be burned away as it is emitted, but this creates dilemmas in designing the feeding mechanism and ash outlet. A new way to solve the problem is by the so-called reverse combustion, where the new briquette is fed on the top but the combustion proceeds downwards by a forced draught.

Stoves for household use can be classified as being for space heating or for cooking. The former require stable low temperature combustion; the latter a quick start and high temperature combustion that may increase heat efficiency 20-30% compared to direct heating of coal.

5.4.1. Some Facts of Coal and its Briquetting:

- It can be consumed both privately and institutionally for cooking, space heating etc.
- It is a cheap fuel because of its abundance
- It emits harmful gases and particulates, leaves ashes when it burns, and contaminates the environment during transportation.
- It is hard to ignite compared to gas and petrol fuels
- Gasification is one of the approaches for utilization but this requires lot of investment and may cause secondary pollution.
- Coal briquetting is an intermediate technology
- If chemistry is provided to extract the smoke, briquettes are safe, even if the stove is installed in bedroom. In door pollution from coal briquette however could be a problem if there is no chemistry in the stove and the ventilations of the space is poor.
- When briquette is only used for cooking and ventilation is good no chemistry is required.

The critical point here is to find a stove which will not release the lethal gases discussed earlier into the home or air and is suitable for domestic use. It means that almost all of the coal is burnt and the gases released are carbon dioxide rather than carbon monoxide. The sulfur released depends on the original sulfur content of the coal. The coal briquette stove discussed in Diphaha et al (1994)[8] looks like it needs extensive testing and modifications before it is adopted for our conditions. The subject needs to be followed up.

5.4.2. Impact of coal burning on Environment:

Global warming due to the high concentration of CO_2 in the atmosphere is a world wide concern and burning coal produces CO_2 but if the coal is used to replace fuel wood, as in the case of African countries, the consumption of coal can save trees which will absorb CO_2 in the atmosphere. Therefore, the net result is not as clear as if first appears.

8 Diphaha, J.B.S. et al (1994). Biomass Energy and Coal in Africa, Edited by Dig Hall and Y.S. Mao. Zed Books Ltd, London and New Jersey in Association with African Energy Policy Research Network – AFREPREN, Gabarone.

A study shows that the net balance of carbon in determined by a number of factors including, the growth rate and the remaining life of the trees, the carbon content in coal, and the time span under consideration.

- It had been demonstrated that the greater the remaining life of a tree and its growth rate, the more preferable it is to replace the wood from this tree with coal. Dead trees should be collected to be used as fuel as its remaining life is zero.
- Chinese experience showed that barren hills turned green within TWO YEARS after coal briquettes were brought in. At the same time, the yield of farm products per hectare gradually increased because farm residue remained in the field instead of burning, thus increasing the organic matter.
- Coal briquettes can be dangerous fuel source if it produces carbon monoxide while burning it in a closed room, but in normal combustion these conditions do not occur. The AVERAGE ANNUAL TOTAL OF FATALITIES DUE TO BURNING OF Briquette in Beijing is about FIFTY people (One tenth of those killed in traffic accidents).

5.4.3. Suggestions

1. The size of the coal deposits and their types need to be investigated thoroughly.
2. The economics of exploitation which are controlled not only by the reserves but also many other factors need to be determined.
3. The impact of mining of coal on the environment of the mined area should be included in economic feasibility. This includes the effect of surface mining, if it comes to that, on the mining, on the effect on grazing, water resources, frankincense and other useful trees etc. The people living on the coal bearing areas must be fully informed and be included in relevant decisions
4. Decisions on international commercialization or saving for its use to save the trees can be made after the realization of the above 3 points.
5. As a prerequisite to the mobilization of venture capital the laws suggested by the Academy for Peace and Development (APD) workshop[9] pertaining to the ownership of the resources should be enacted. Such laws should be based on a study of relevant issues and not on arbitrary decisions which may lead to the failure of the laws of implementation.
6. A suitable stove for coal burning (briquette) for domestic use should researched.

6.0. NATURAL GAS

6.1. Source: Natural Gas is a fossil fuel originating from the death and decay of living organisms in the distant geological past. Pressure, heat and bacterial action transformed the decaying organic material into the crude oil (Petroleum) and natural gas. Natural gas occurs lying over crude oil deposits or in separate pockets in rocks and is extracted from these sources.

6.2. Chemical Composition: Both crude oil and natural gas are composed mainly of aliphatic or open chain hydrocarbons. Natural gas is the important source of alkanes (Hydrocarbons having only single covalent bonds) of low molecular mass like methane 80%, ethane 10%, propane 4% and butane 2%.

9 (See footnote No. 6 above)

Methane the major constituent of natural gas is used for heating and cooking purposes. Methane provides a hot clean flame. Propane and butane are also good heating fuels. They are sold in liquid form in pressurized containers as liquid petroleum gas (LPG). Propane and butane can also be distilled from crude oil.

All hydrocarbons require adequate oxygen to oxidize completely and thus provide the maximum heat, under conditions of oxygen deficiency inadequate combustion occurs and the production of carbon monoxide (a poisonous gas) results.

6.3. Present Use of Liquid Petroleum Gas (LPG) in Somaliland

A very modest quantity of LPG is presently used in Somaliland, all of it imported like all other products of fossil fuels.

The businessman who imports the LPG and sells it was located; he is Mr. Yousuf Ismail who provided the following information:

1. "We import very modest quantities of LPG. As there are no storage facilities for LPG in Berbera port we have to use small cylinders (25-50 liter capacity). These are brought in containers up to Hargeysa. Import taxes are very high. We distribute the gas to our clients in Hargeysa in the same pressurized 25 and 50 liter cylinders in which they were imported. The empty cylinders are sent out overseas to be refilled.
2. The refill price for a 25 liter capacity LPG cylinder is USD 20 and $ 40 for the 50 liters. Our pickup delivers the full cylinders and collects the empty ones from the users. Clients have to buy the empty cylinders for $ 20 each and accessory/fittings for another $ 80.
3. Our clients are people with relatively high income. Most people cannot afford to use LPG at present.
4. The rate of consumption varies from 16-17 days (according to the users) for 25 liters of LPG for average family size or an average of 37.5 liters per family per month.
5. Mr. Yousuf made the following suggestions in order to insure that LPG play a role in covering the energy needs of the townspeople in Somaliland for cooking and heating in more affordable prices. The latter to reduce dependence on charcoal.

    5.1 Develop the current importation system of LPG; most importantly this requires the construction of LPG storage tank(s) and related facilities. The latter so that the LPG could be brought to Berbera by tanker ships to fill the storage tanks. The storage tanks would have facilities for the filling of the distribution cylinders under pressure.
    5.2 Government to reduce the tax levied on the LPG imported.
    5.3 If the conditions created are conducive to business, the businessmen could guarantee the timely importation of the quantities needed. A group of businessmen in Somaliland (2 or more) alone or jointly with foreign investors could undertake the venture.
    5.4 As a start Mr. Ismail suggested that the government should lead the way with a study on the feasibility of LPG playing a role in covering the energy needs of Somaliland towns in place of charcoal.

The number of Ismail's clients who are supplied with LPG at present (October – November 2005) are 1500.

6.4. Results of the Survey of Housewives in Hargeysa on the Use and Perceptions about Liquid Petroleum Gas (LPG)

Five percent of the housewives surveyed use LPG. 85% said they were aware of LPG. The reasons given by those aware of LPG were not using it included:-

S.N.	Percentage of Respondents	Reasons Given
1.	55 %	Too dangerous to use
2.	29 %	Know little about it. Just used to charcoal
3.	16 %	Too expensive
	100 %	

6.5. Responses Directed to Users of LPG on Costs, Conveniences, Availability in Comparison to Charcoal

Cost $ 20 per 25 Liters and monthly consumption of 37.5 liters is much more expensive then charcoal.
Convenience: Much more convenient, more efficient and cleaner then charcoal.
Availability: Good

What the above shows is that the overwhelming portion of those surveyed respondents are aware of LPG. A majority believe that LPG use involves much danger. The next largest number has little knowledge of the commodity and is contented with charcoal. The rest believe it is too expensive.

Despite the above facts, in the long run, it will be the affordability of the gas that will determine how widespread it is used. The danger posed by the LPG is real but only if it is used with ignorance and negligence.

We use many technologies which pass danger if abused electricity being one of them. Education of the people on the use of the fuel and legal regulations against criminal and careless actions and detailing safety procedures would be needed.

The cost of using LPG fuel for an average family using 37.5 liters of the gas per month is:
37.5 liters x $.80 per liter = $ 30

N.B. Let us disregard the cost of the stove that will be needed.

The cost of using charcoal for an average family of 11 people would be:
4 sacks charcoal/month x 18,000SL.Sh./Sack/6300 Sh./US. Dollars = 11.4 US Dollars.
Or 0.96 Sacks/Person or 1.04 Dollars\Person.

7.0. KEROSENE

Kerosene is distilled from crude petroleum oil. About 10 % of the refined products are Kerosene. It is also possible to obtain Kerosene from fractions of the refined products that have much greater molecular masses through the process of "Cracking".

Kerosene has been imported to Somaliland for many decades mainly for lighting purposes to bush lanterns and pressure lamps. It is still used for the latter purpose. Kerosene was also used, to a minor extent, to fuel pressure Kerosene stoves for cooking purposes. In the 1970s and 1980s, a small number of Kerosene stoves with wicks were introduced. However the use of Kerosene stoves has not expanded since that time.

It is worth noting that kerosene stoves is very popular in neighboring Ethiopia and Djibouti in particular where over 90% of the residents of Djibouti use it for cooking. The Djibouti example is worth studying as the communities in Somaliland and Djibouti share, among other things, social, cultural and commercial ties which could serve as an entry point for attitudinal change in the usage of Kerosene stoves.

7.1. Present Kerosene Stove and Kerosene Fuel Trade and Use for Cooking and Heating in Hargeisa

Information on the subject in the heading was collected in 3 ways:

- Through a survey of the housewives (Annex I),
- Survey of the importers and sellers of Kerosene stoves and
- Survey of the fuel stations selling Kerosene.

Literature on the subject was also searched for, for review. The latter search was disappointing. We found one IUCN publication[10] which treated Kerosene in a few paragraph but they were devoted to Mogadishu and Bosaso and Somalia in general.

7.2. Kerosene Fuel

An unknown but small quantity is imported to Somaliland. It is sold by the fuel stations in Hargeysa at uniform costs. These are the figures the stations gave us.

Year	Cost of 5 Liters of Kerosene	Remarks
2003	10,500 S.L.Sh.	Average for the years
2004	12,500 S.L.Sh.	Average for the years
2005	12,500 S.L.Sh.	As of 30th October, 005

N.B. $ 1 = 6,300 Sl. Shs

Kerosene comes through the port of Berbrea, but when it is in a short supply it is imported from Ethiopia.

10 Kairu, Prof. E.N. et all (1997), *Wood Based Energy Dynamics in Somalia*. ETC-East Africa for IUCN – The World Regional Office, Somali Natural Resources Management Program Project No. 6/SO-82/95 + 6/SO-83/04.

7.3. Kerosene Stove Trade in Hargeisa

Two enterprises trading in Kerosene stores were visited. Their identities and the information collected from them are given here.

1. Shiraacle Market: Traders in a sub-block sell the stoves in addition to numerous other items. These are mainly imported from the Gulf countries and sometimes traders get consignments from Ethiopia. Each stove was being sold for 85,000 SL.Sh. ($ 13). They told us that they sold 40 stoves during the last 2 years.

2. Big Sale Shop: Managed by Ahmed Dirir Ali, Tel. 391111. The enterprise is linked to Body Line International Group of India, through the Somaliland–India Friendship Society. In 2002, Big Sale imported 600 Kerosene stoves of the pressure type. They costed 6 dollar each at the port of Berbera and were supposed to be sold at 11 dollars each. There was difficulty in selling them so they auctioned them at 3 Dollars each.

The pressure stoves (ordinary type) were imported from India. Big Sale also imported samples of self-pressurized stoves which would have costed $ 40 each.

80% of the stoves sold (the 600 mentioned above) were sold to Ethiopia and 20% locally. The working life of ordinary pressure stoves were estimated by Mr. Ahmed as one year and that of self pressurized ones as 2 years.

7.4. Kerosene Stove Use and Perception of them Among the Housewives Surveyed:

All those surveyed were aware of the existence of Kerosene stoves. None of them was using them. Reasons given by them for not using them included:-

Percentage of Respondents	Reasons Given
50	Considered dangerous
28	Don't know how to use them
17	Have used them but can not find them in the market
5	Unhealthy, smoke from stove causes nasal allergy.

Costs of Using Kerosene Stoves:

a) Pressure Type: Daily Kerosene consumption = 2 ½ liters
Cost of one liter = 2,500 S\L.
Daily cost of using the stove: 2500x2.5 lit = 6250 Sh. or 0.99USD
Monthly cost = 0.99 x 30 = 29.7 US Dollar.

Some street tea cookers (micro commerce people) are noted from time to time using Kerosene. They brew the tea in the street. Not all of them use them. They have not been surveyed.
It appears that there is no market of any significance for Kerosene Stoves. The manager of BIG SALE believes that the cost of Kerosene is the main obstacle to the use of Kerosene stoves. This is also clear from the results of our short survey of Kerosene use. It is not only the cost but also

the consumption per day of the pressure stoves.

Kerosene consumption/Day = 2 ½ liters
Cost per day = 0.992 US$
Cost per month = 29.7 US$
(The degradation of the stove is not included); compared with charcoal cost/month of $11.4

b) Wick-type kerosene cooker

Kerosene consumption/Day = 1 ½ liters
Cost per day = $0.595
Cost per month = $ 17.85
(The degradation of the stove is not included). Compared with charcoal cost/month of $11.40

8.0. THE SOLAR COOKER

The Solar Cooker developed in Somaliland is shown in fig. 2. It has actually reached the stage where it has been put into the market. The cookers are available in a shop in the commercial center of Hargeysa city. The agency ADRA (Adventist Development and Relief Agency) has assisted in the endeavour.

The following information on the cooker was provided by Mrs. Amran Ali Hiis of Hargeysa University who has also a stake in the business.

- The present solar cooker can cook tea, cake, rice, sorghum, grain, soup, vegetables etc. The cooker cannot do frying, it can do steam or boiled cooking.
- The cooker can accommodate large or small pots. The cooking pots used have to have black exteriors. It takes about 4 hours for the solar cooker to complete the cooking - for example 8:00 a.m. to 12:00 noon, and it has to be put out into sun.
- A team has been trained very well to fabricate the cooker in Hargeysa and they have proven their skills.
- The cookers are on sale in a shop in the center of the town.
- Because the cooker is made of aluminum and glass both of which we have to import. Their costs together with labour expenses etc makes the solar cooker priced at 80 US Dollars

The price of the cooker and the time taken to complete the cooking inhibit the would be client. Mrs. Amran recommends the promotion of the cooker through advertisement and demonstrations. She says this cooker can be used for a portion of the cooking and heating of water. Its advantage is that the fuel (sun shine) is free. The next is a more versatile cooker. In the world solar cookers can do roasting and even baking.

Photo1:A solar cooker fabricated in Hargeysa

9.0. PERCEPTIONS OF THE HOUSEWIVES SURVEYED REGARDING ALTERNATIVE ENERGIES

Percent aware of kerosene stoves – 100%	Percent using them = 0%
Percent aware of LPG - 85%	Percent using them =2%

Reasons given by those aware of the above two energies for not using them (in percentages)

Answer	Kerosene	LPG
Too dangerous	50	55
Do not know much about it (Accustomed to charcoal)	28	29
Used them but can't find them in market	17	-
Too expensive		16
Smoke (health hazards)	5	-
	100	100

The figures shown above are not strange. For those who don't know how to operate any new technology and get their hands into are likely to get into danger. The point is if a new technology is introduced into a country the people should be educated on its safe usage. In addition, government regulations may be needed to protect people against people selling defective equipment, shoddy installations and so on. We already use electricity, refrigerators, TV sets of which all pose danger if abused. Charcoal poses danger to ignorant people and many deaths occurred in Somaliland as result. The death occurred when people started a fire, closed all windows and ventilations during cool weather. All hydrocarbon fuels including kerosene require adequate oxygen for full combustion. Partial combustion results in the formation of carbon monoxide – a respiratory poison gas. Explosions and fires can occur with careless use of pressure kerosene stoves and LPG leaking.

Education and regulations to protect the customer are of vital importance. In the long run, however, the cost, convenience and availability of the energy will become more important to the customer, as experience from other countries whose people learned the use of these equipment and materials indicates.

10.0. POTENTIAL UTILIZATION OF ALTERNATIVE ENERGIES

Solar energy is the cheapest and cleanest of all energies i.e. sunshine which plentiful in Somaliland every day of the year. However the solar cooker which is fabricated in Somaliland has two (2) drawbacks. It costs US$ 80 and takes 4 hours to finish the cooking. It does boiling and steam cooking but not frying. With vigorous promotions and demonstration adoptions may become possible. Its worth trying if a loan system where the equipment could be paid by installments would probably favour its adoption for these who give it suitable. More advanced, more versatile solar heater and cooker are available in the world. The advantage of the present cooker is that it is easy to fabricate and use locally. Further research into the technology is appropriate. The following table summarizes the results of a quick survey of Hargeysa housewives, Kerosene and LPG seller.

Consumption and costs of various fuels per family of those in the housewives survey in Hargeysa (1 US$ = 6300 s/sh)

Fuel	Unit	Unit cost in US$	Consumption per months	Cost per Months in US$
Charcoal	Sack*	2.86	4	11.4
Kerosene (wick type)	Liter	0.4	45	18
Kerosene (pressure type)	Liter	.4	75	29.7
LPG	Liter	0.8	37.5	30

* One sack of charcoal weighs 17-18 kg.

The kerosene consumption per day of 1.5 liters was obtained from women in the survey who used to use pressure stoves in the past for a long time in Mogadishu and Ethiopia. Kerosene is purchased mainly for lanterns and pressure lamps.

Coal: Before the potential for coal as replacement for charcoal or other fuels can be evaluated the relevant information gaps need to be fueled i.e.

- Determination of the quantity and quality of the coal deposits in Somaliland
- The relevant laws defining the ownership of the resources.
- Economies of its exploitation
- Environmental impacts of its mining and how to deal with it

In the light of the above table, it is apparent that charcoal is the cheapest source of energy so far and given the existing negative community perceptions about the other alternatives and due to the limited awareness and knowledge about their utilization, it is envisaged that the continuing onslaught on trees for charcoal production will continue for the foreseeable future, unless a drastic measures are taken towards community awareness raising, coupled with exemption of taxes on all energy saving related products such as kerosene, solar cookers and LPG.

11.0. RECOMMENDATIONS:

- Reduction of energy wastage while producing the charcoal i.e. improvement of kilning process
- Promotion of the use of the energy efficient charcoal stoves which saves as much as 40% of charcoal used
- Promotion of the present solar cooker and researching the development of more versatile ones.
- A study lead by the government covering all aspects related to the feasibility of using kerosene and LPG to reduce the use of charcoal is recommended. The inefficient system of importing LPG has been explained in the discussions of LPG. A more relative picture of the potential of kerosene and LPG to replace charcoal would only come from a study at the macro-economic level involving all aspects of such a venture.
- Studies aimed at determining the magnitude, quality and economics of exploitation of

local coal deposits is recommended. In addition a suitable coal (briquette) stove for domestic use is in great need.

- Other alternative fuel reduction technologies and practices needs to be explored.
- Community education on alternative energy and social marketing for the introduced energy sources
- Exemption of tax on kerosene and all energy saving appliances
- Popularization of the fast growing mesquite which produces prolific amount of seeds and have the capacity to establish itself in different ecological zones for firewood and charcoal.

ANNEX 1

Results of the interview with housewives on Energy Consumption for Domestic purposes - Undertaken in Hargeysa city in October-November.

The short survey done thought interviews of housewives involved questions (see single questionnaires attached) regarding the type of fuel they used to cook with, their awareness of attractive to the charcoal they were using. Reasons for not using alternatives to the charcoal they were using, reasons for not using alternative fuels, if they were aware of them.
Charcoal users were asked the quantity they used per month and unit costs, family size and whether they were using the efficient charcoal stoves or not. The kerosene stove and liquid petroleum gas (LPG) users were asked about the quantity and costs of the fuel used per month, and if they used charcoals in the past, to compare the kerosene stores or LPG with the charcoal in terms of cost, convenience and availability.
The sample size was 21 house wives.

Finding

1. Fuel used (percentages of the m interviewed).

Charcoal %	LPG %	Kerosene%	other
98	2	0	0

2. Awareness of Alternative Fuels by the charcoal users (percentage of housewives interviewed)

Not aware = LPG - 85% kerosene stove = 100% others = 0%

3. Reasons given why those who are aware of alternative fuels don't use them.
(Percents of respondents) Liquid petroleum gas LPG.
Answers to respondents as percent of the total

Too dangerous 56.9%
Too expensive 17.6%
Other 29.5% know little about them; just accustomed to charcoal.

Comment: Of these who responded with too dangerous some made additional comment i.e. about one third (1/3) said they wouldn't know how to use it too.
About 1/5 said it explodes
About 1/10 said it will burn children,
Another 1/10 said charcoal is safer.

4. Kerosene Stoves
Responses of those who said they are of kerosene stoves to the question "why don't they use it (given as percentages of respondents):

Not available in the market	17%
It is dangerous	50 %
Don't know how to use them	28%
Unhealthy – causes allergy	5%

5. Charcoal users answers on its usage
a) Average No. of sacks
Cost of a sack of charcoal

Year	cost in Sl. Shs.
2002	7,000
2003	13,000
2004	15,000
2005	17,000

b) Average family size claimed
By those interviewed = 11 persons
Medium = 10 persons

c) Percentage of charcoal users using efficient charcoal stoves = 5%

d) Charcoal consumption saved by using efficient charcoal stoves (shown below) was 40%

6. LPG users on quantities used
Cost: $ 20 25 liter capacity cylinder
37.5 liters used per month
Much more expensive than charcoal
Comment: Much more convenient and cleaner than charcoal
Availability: Good

Photo. 2: Energy efficient stoves fabricated in Hargeysa with Candlelight support

ANNEX II: Areas visited and people met:

- Hargeysa City Housewife Survey on the Fuel and Stoves they Use, Oct. – Nov. 2005, Hargeysa – Somaliland.
- Meeting with Restaurant Managers of Hargeisa on the Type and Quantity of Fuel they Use in Oct. – Nov. 2005.

Other Sources Met to Collect Relevant Information:

Traders:

- Ahmed Dirir Ali, Manager of Big Sale Shop, Hargeysa – Importer and Distributor of Kerosene Stoves, Tel. 381111, Hargeisa.
- Shiraacle Market Traders in wick type Kerosene stoves, Hargeysa (2005).
- Yusuf Ismail, Importer/Distributor of Liquid Petroleum Gas (LPG) in Hargeysa.
- Hargeysa Fuel Stations, Sellers of Somaliland (Oct, 005). Kerosene, Hargeysa, (Nov. 2005).

Solar Cooker Development Promotion:

- Ms Amran Ali Hiis, University of Hargeysa – Somaliland (Oct. 2005).

Geology (For Information on Somaliland Coal Deposits):

- Dr. Ahmed Mohamed Behi, Economic Geologist and Former Minister of Ministry of Water & Minerals, Hargeysa – Somaliland (Nov. 2005).

Ministry Officials Visited (October 2005)

- Engineer Ali Abdi Odowaa, Director General, Ministry of Water & Minerals of Somaliland, Hargeysa – Somaliland.
- Ministry of Pastoral Development and Environment Officers: Abdi Karim Aden Omer and Ahmed Jama Sugulle, Hargeysa Somaliland.

Visits to Some District Where Charcoal is Produced and People Met (Nov. 05):

Salaxley:
Ahmed Ismail Jama: Deputy District Mayor
Ahmed Ibrahim Abdi: Member District Council

Balli-gubadle:
Omer Abdi Mohamed: District Mayor

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