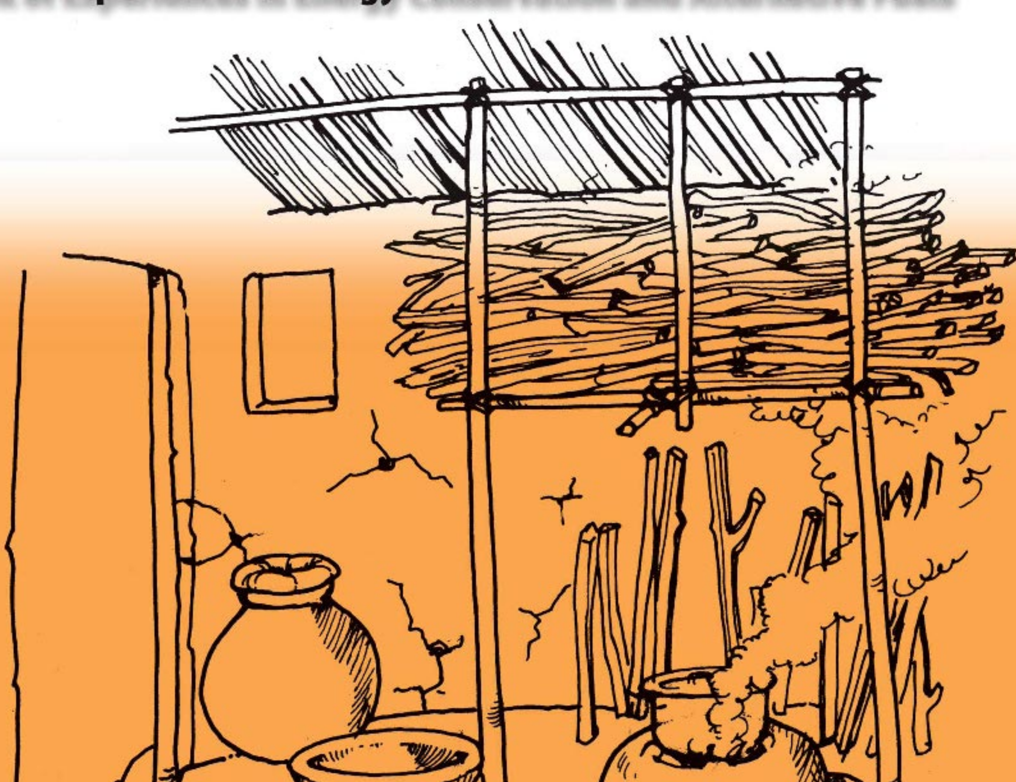
Cooking Options in Refugee Situations

A Handbook of Experiences in Energy Conservation and Alternative Fuels



UNHCR
United Nations High Commissioner for Refugees
Haut Commissariat des Nations Unies pour les Réfugiés

COOKING OPTIONS IN REFUGEE SITUATIONS

A HANDBOOK OF EXPERIENCES IN ENERGY CONSERVATION AND ALTERNATIVE FUELS

UNHCR
United Nations High Commissioner for Refugees
Haut Commissariat des Nations Unies pour les Réfugiés

Acknowledgements

Text written by Matthew Owen, with additional input from David Stone, Chris Davey and Morten Petersen.

Illustrations prepared by Dorothy Migadde, Nairobi, Kenya.

Series Producer: David Stone.

Background & Cover Images: Irene R Lengui/ L'IV Com Sàrl

Design & layout by L'IV Com Sàrl, Morges, Switzerland.

Printed by: ATAR ROTO PRESSE SA, Vernier, Switzerland.

Produced by the Environment Unit, Engineering and Environmental Services Section, UNHCR Geneva, December 2002.

Acronyms

cm	centimetre
EESS	Engineering and Environmental Services Section
g	gram
ha	hectare
kg	kilogramme
km	kilometre
m	metre
MJ	Mega joule
NGO	non-governmental organisation
UNHCR	United Nations High Commissioner for Refugees

Contents

Glossary

Biogas – A mixture of methane and carbon dioxide given off during the digestion of organic matter in the absence of oxygen, which can be collected, piped and lit for cooking or lighting. Suitable organic materials include animal manure, crop wastes or grass, mixed with water.

Bio-latrine – A biogas unit designed to use human waste as the principle organic input.

Biomass Energy – Energy derived from any organic source, including wood, charcoal, agricultural residues and animal waste. The most common energy source for refugees.

Briquettes – Manufactured fuel pellets produced from organic matter through compaction, external charring, complete carbonisation or a combination of these processes. (See also 'Carbonisation'):

> ***Densified briquettes –*** Fuel blocks produced through simple compaction of biomass, usually plants or plant residues, in combination with a binding material (such as molasses or resin). Suitable raw material includes sugar cane waste, coffee husks or sawdust.
>
> ***Charred briquettes –*** Fuel blocks produced through a process of compaction with no binder, the coherence instead created by applying high temperature to the material and creating a hardened external shell. Rice husks are suitable for producing charred briquettes.
>
> ***Charcoalled briquettes –*** Fuel pellets of higher energy content produced from material that has been carbonised either prior to its compaction or after it has been briquetted. In the former, a binder case is required as the carbonised fuel is often in powder form.

Carbonisation – The process of turning wood into charcoal. See also Pyrolysis.

Charcoal (or Lump Charcoal) – The solid residue remaining when wood is converted to carbon by slow burning at high temperatures with very low levels of oxygen. Made up of 90% carbon (by weight), 5% water and 4-6% ash.

Shared Cooking – Any type of cooking in which the food for more than one person is prepared together:

> ***Family cooking –*** The normal sharing of food and fuel for the preparation of household meals.
>
> ***Multi-family cooking –*** The pooling of food and fuel resources by nearby families or cooking groups (e.g. for the purpose of saving energy).
>
> ***Institutional cooking –*** The centralised preparation of food in bulk for mass distribution, usually by paid staff in a refugee situation.

Fireless Cooker – See 'Haybasket'

Fuelwood – Firewood. Not to be confused with woodfuel, which includes charcoal as well.

Haybasket – An insulated container into which a pot of partially cooked food can be placed to continue cooking without the use of additional fuel. Usually made with a basket or box insulated with cloth, newspaper or wood shavings and with a tightly-fitting insulated lid.

Improved Stove – General description for any cooking device designed to reduce energy consumption. Usually intended for woodfuels as an improvement on traditional open fire systems, and made with metal, clay, ceramic or a combination.

Insolation – Degree of exposure to the sun's rays. Important in assessing a site's potential for solar cooking.

Mud-stove – A simple energy-saving device for biomass fuels that can be constructed by the user using locally available materials. Can vary from simple filling-in of two sides of a three stone fire with a mud wall to prevent through-draughts, to designs incorporating a circular fire chamber, arched doorway for fuel and integral pot rests.

Peat – Organic matter that develops as a result of incomplete decomposition of wetland vegetation under conditions of excess moisture and oxygen deficiency. Can be used as cooking fuel if well dried.

Pyrolysis – The process of carbonising wood to produce charcoal.

Solar Cooker – A device that changes the light energy of the sun to heat energy to cook food.

Curved reflector type – A solar cooker that uses reflective surfaces to collect, direct and concentrate the sun's rays as heat onto the food being cooked.

Box-type (or oven-type) – A solar cooker that uses plane reflectors (such as mirrors) to reflect radiation through a glass or plastic window into an insulated cooking container. The container normally has reflective sides and a black metal base.

Panel-type – A hybrid of reflector and box-type solar cookers, using both a curved reflector and a cooking container in which the food is placed. Combines the reflective properties of a curved surface with the heat retaining properties of a container.

Wonderbox – See 'Haybasket'.

Woodfuel – Any fuel based on wood. Normally taken to mean firewood and charcoal.

1

Introduction

Refugees tend to use sources of energy for cooking, heating and lighting that are already familiar to them and readily available in the areas where they are temporarily settled. In most situations, particularly in developing countries, this means **firewood** and **charcoal**. High demand for these two fuels can lead to environmental degradation in areas that host refugees as supplies of dead wood are progressively exhausted and live trees are cut in an uncontrolled manner. Cutting trees for fuel often tends to be the most prominent of the environmental impacts associated with refugee camps and settlements. This can be a source of conflict with host governments and local communities who see their forests and woodlands degraded. It may also mean that refugees themselves have to spend significant amounts of time, money and labour securing sufficient fuel to meet their needs. In some instances they may be exposed to physical risk in the process.

Use of energy by refugees is therefore an important issue to consider from several perspectives – not only environmental, but also social, economic and protection-related.

UNHCR has, in recent years, built up considerable experience in the field of domestic energy as it has sought to determine the most effective ways to reduce the environmental problems and social conflicts that can be associated with meeting domestic energy demands, and thereby ensure the well-being of refugee and returnee communities. This has led to the publication of a number of documents that provide guidance to managers and field staff addressing the inter-linkages between energy use and the environment.

Harvesting firewood is often a laborious exercise, especially for women, and may have negative impacts upon the environment.

The first publication that referred to domestic energy was the *UNHCR Environmental Guidelines* (1996). This is a broad overview of UNHCR's environmental policy that contains a brief section on domestic energy – as well as other environment related sectors. UNHCR went on to issue a set of more focussed technical guidelines, one of which deals specifically with energy and suggests ways to balance energy supply and demand. This is entitled *UNHCR Environmental Guidelines: Domestic Energy in Refugee Situations* (1998).

As an output of the *Towards Sustainable Environmental Management Practices in Refugee-Affected Areas* project in the late 1990s, various best practices related to domestic energy were documented in a further UNHCR booklet entitled *Refugee Operations and Environmental Management: Selected Lessons Learned* (1998, and revised/expanded in 2002). This booklet has a number of practical ideas for the energy sector based on field experiences in ten different countries.

In addition to these publications, several demonstration projects have been implemented in the energy sector, and documented by UNHCR. These initiatives have involved alternative fuels or alternative types of cooking stoves, further representing the application of "appropriate technology" to refugees' domestic energy needs.

Such projects have included:

- *the promotion of fuel briquettes made from rice husks, bamboo or sawdust (in Bangladesh and Thailand);*
- *the use of dried grass for cooking (in Tanzania and Uganda);*
- *papyrus peat (in Tanzania);*
- *biogas (in Afghanistan and Nepal);*
- *kerosene (also in Nepal); and*
- *solar energy (in Ethiopia, Kenya and Pakistan).*

Some of these projects have been documented and the relevant reports are available from UNHCR's Engineering and Environmental Services Section (EESS). Currently there are five such energy documents in the EESS publications list that focus on solar cooking and grass stoves (Annex C).

In spite of the availability of the various publications that address domestic energy concerns in general terms or under specific fuel or stove projects, UNHCR still lacks a short overall summary of cooking energy options in refugee and returnee situations. With increasing interest from donors, academics, partner agencies and commercial entities in the promotion of different domestic energy technologies and cooking fuel choices within refugee operations, it was felt important that experiences should be documented in a more concise, accessible form that would bridge the gap between the general and the case-specific. This Handbook offers a single, uncomplicated source of information on energy options for cooking in refugee situations.

2

Purpose of the Handbook

This Handbook provides a summary of practical ideas for the domestic energy sector in refugee situations – a sector that probably has a greater impact on the environment than any other. It covers both proven and experimental ways in which to balance demand for energy with available supply. Acknowledging that cooking is generally the area to which refugees commit the greatest proportion of their domestic energy resources, the Handbook focuses primarily on fuels, stoves and practices that relate directly to cooking.

The Handbook is designed for programme and technical staff of UNHCR and its implementing partners, both in the field and at headquarters. Rooted in the principles underlying the *UNHCR Environmental Guidelines: Domestic Energy in Refugee Situations* (1998), and taking into account the contents of UNHCR's existing set of energy-related publications, the Handbook addresses the following themes:

Energy Conservation:
Working With What You Have

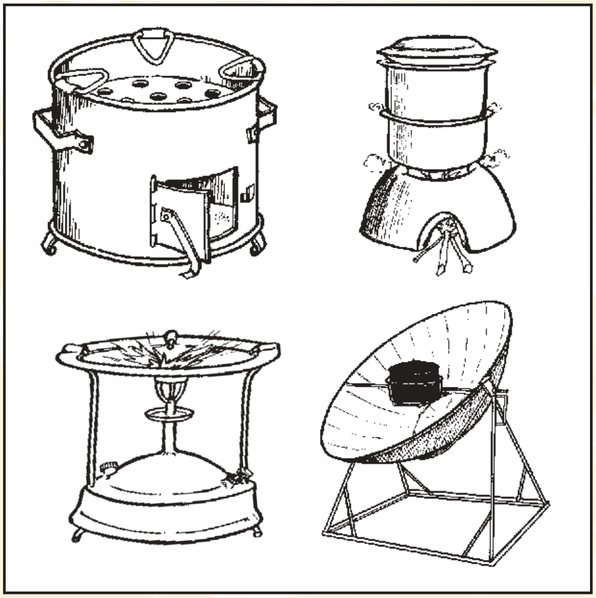
Section 3 of the Handbook looks at proven and readily implementable ways to save energy in cooking. It assumes what might be described as "a typical developing country refugee situation" where the principal fuels are likely to be firewood and charcoal, and describes various types of improved cooking stoves that have been successfully promoted in different settings. These stove ideas are usefully supplemented with 'energy-saving practices' – different cooking techniques that can be used alongside any improved stove to add to their energy-saving benefits. The promotion of the stoves and energy-saving cooking practices described in this section will represent a viable first step in almost any refugee energy programme, providing guidance from which ideas can be directly applied.

Alternative Energy:
Looking At Other Options

Section 4 looks at alternative fuels and sources of energy and is more speculative. In this context, 'Alternative' is taken to mean fuels other than firewood and charcoal. These include loose wastes and residues, manufactured briquettes, grass, peat, biogas, kerosene and solar energy, all of which have been tried in different refugee programmes and documented to varying degrees by EESS. Being more exploratory, this section documents particular experiences and offers options, but does not necessarily recommend a particular fuel switch. After evaluation of the alternatives it may prove appropriate to remain with an energy strategy based on firewood or charcoal and apply the kinds of interventions suggested in the preceding section. Or it may be worthwhile to look into these alternative options in more detail.

Energy Supply:
The 'When' and 'How' of External Fuel Provision

In some cases it may be deemed necessary to supply fuel to refugees or returnees in an organised manner from sources outside the immediate area. Section 5 of the Handbook considers the kinds of circumstances under which this might be justified and highlights some guiding principles for organised energy supply.



In summary, the next section of the Handbook (section 3) covers firm recommendations for stoves and cooking practices that are known to work in most situations where firewood and charcoal are the main fuels being used, and can hence be promoted with minimal risk in almost any refugee context. The following section (section 4) presents options for switching to energy sources other than firewood and charcoal; it contains more cautionary advice and encourages careful consideration of the implications before such switches are made. They may be costly and, with due fairness to their respective promoters, probably have less likelihood of being successful and sustainable. The third and final section (section 5) addresses the conditions under which an agency-managed fuel supply programme may be justified, and how such a programme might best be implemented.

The Handbook concludes with a number of technical Annexes including an energy checklist, a summary of the energy contents of various commonly used fuels and a selection of further reading.

3

Energy Conservation — *Working With What You Have*

3.1 Introduction

This section looks at energy-saving stoves and energy-saving cooking practices for refugees cooking with firewood or charcoal. These can also been described as **energy-saving technologies** and **energy-saving techniques**, or the 'hardware' and the 'software' of energy conservation.

It is relatively common to see energy-efficient stoves being promoted in refugee and returnee situations. Indeed many refugees are already experienced at building and using different types of improved stoves. It is less typical, however, to find behavioural changes being encouraged alongside these stoves in the form of more efficient cooking practices. Yet they complement each other and should be promoted jointly.

This section generally refers to technologies and techniques that have been found to work in refugee situations. This information can therefore be applied with a relatively high chance of achieving positive – and often fairly rapid – impacts. These techniques and technologies also represent cost-effective and low-risk interventions.

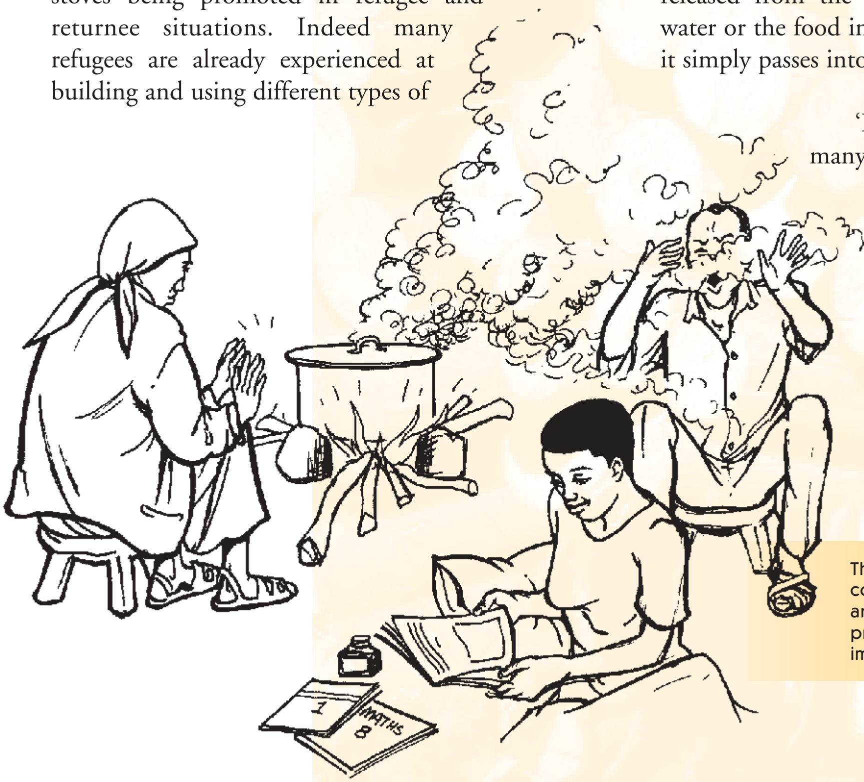
3.2 Improved Stoves

3.2.1 Overview

Many people in developing countries, including refugees, traditionally use open wood fires for cooking. These are centred on three stones, three bricks or three metal pegs on which the cooking pot is placed. Though convenient, adaptable and easy to use, open fires waste fuel because they focus flames poorly on the bottom of the cooking pot. They are typically only about 15% efficient – just 15% of the energy that is released from the cooking fuel actually enters the water or the food inside the pot. The rest is wasted as it simply passes into the atmosphere.

'Improved stoves', and there are many forms, are more efficient than open fires because:

- *the flow of air and hot gases from the fuel is better directed to concentrate heat on the pot; and*
- *because the fireplace is normally insulated to prevent heat loss by radiation.*



The traditional 3-stone fire is not only used for cooking, but also provides a source of heat and light. However it is wasteful of energy and produces smoke which can have negative impacts upon health.

Efficiencies of at least 20% can be achieved with most improved stoves, implying an energy saving of around 25% compared with open fires. Improved stoves can also reduce smoke in the kitchen and its negative impacts upon health by enabling the fuel to be burned more efficiently.

3.2.2 Specific Stove Designs

Different types of improved stoves have been developed to suit different cooking traditions. In terms of design, there are two main types:

(a) those that users can build for themselves, often called ***mud-stoves*** *because of the kind of material typically used; and*

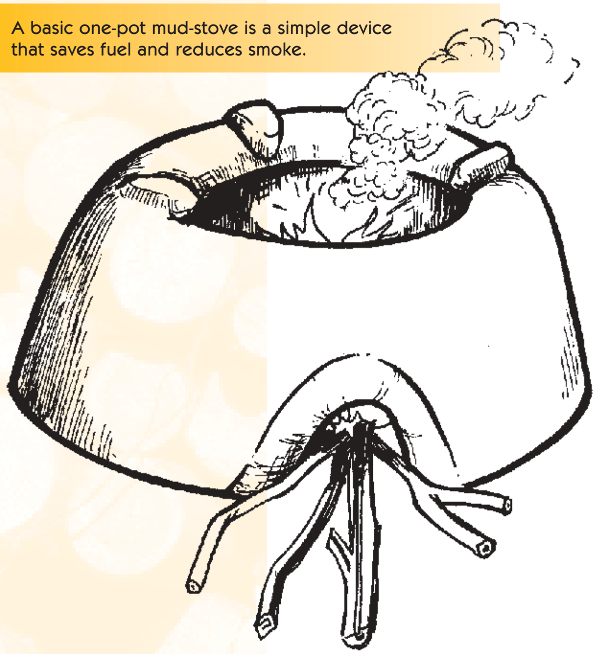
(b) ***prefabricated stoves*** *assembled by specialised producers using metal, fired clay or a combination of the two.*

(a) Mud-Stoves

The term 'mud-stove' is used to describe any number of improvements to the traditional three-stone fireplace. These are easily constructed by refugees and others using locally available materials. The most basic improvement to the open fire involves filling in two sides with a mud or clay wall to prevent through-draughts. More sophisticated mud-stoves incorporate built-up side walls, a sunken fire chamber, integrated pot rests and an arched doorway for feeding the fuel. Although two-pot and multi-pot versions exist, one-pot mud stoves are normally best suited to refugee diets. Energy savings of about 20% over three-stone fires are achievable with basic mud-stoves.

Mud-stoves are simple, non-technical devices that can be built by anyone, following simple training, and are ready to use after a few days when they have dried and hardened. Contrary to their name, they are not made with mud alone, but normally a combination of clay, sand and straw/grass. If pure clay is not available then any type of clayey soil is an acceptable substitute. Termite hills are a good source of clayey soil. Sand is often mixed in to improve the stove's insulating properties and provide resistance to heat. The incorporation of dry straw or grass allows the stove body to expand and contract without cracking as it gets hot and cools down.

A basic one-pot mud-stove is a simple device that saves fuel and reduces smoke.



Mud-stove mixtures

There is no standard formula to use when building mud-stoves. Experimentation is the key to ensuring maximum durability and minimal cracking.

The '*jiko sanifu*' (improved stove) of Mwanza in Tanzania is often built using 1 part sand: 2 parts clay while the '*Kilakala*' stove from Morogoro uses 3 parts clayey soil: 1 part pounded grass and a small amount of cow dung and ash.

In neighbouring Uganda the 2-pot '*Lorena*' stove is commonly built using 3 parts sand: 1 part clay while the single pot *Hoima* stove is made with 3 parts sand: 3 parts clay: 1 part cow dung: 1 part ash.

The mud-stove promoted by '*Approvecho*' in Central America uses 2 parts ordinary clay (as used in earthenware); 1 part clay that melts at a higher temperature (to add strength): 1 part cement: 4 parts fine sifted organic matter, like sawdust.

Stove builders add anything from cement to crushed bricks to the stove mixture to enhance strength and performance. There are also plants such as '*mlenda*' (in Tanzania), aloes and sweet potato vines that, when soaked in water, yield gummy substances that are used as binders in mud-stove construction.

The mixing ratios will vary from place to place, so experimentation is needed. If the stove-building mixture is not sufficiently malleable or is not holding together properly then it is likely that more clay is required. If stoves are cracking excessively during drying prior to use then it is likely that more sand is needed. If they are cracking during cooking itself then cow dung or grass might help make them more resistant to heat-related expansion and contraction. Refugees should always be involved in the process of experimentation with different materials and mixtures.

Mud-stoves come in many shapes and sizes but are all hand-moulded by the intended user in the kitchen or cooking area. Innovation in their design should be actively encouraged as the users will then feel more comfortable and familiar with the stove and are more likely to maintain it themselves. There are no limits to the ingenuity of mud-stove designs and it is a mistake to try and impose standardisation – though this is a common failing of extension workers trying to meet numerical targets for stove construction who find it efficient to apply the same design for all households and even to build the stoves themselves, instead of allowing the beneficiary to do so.

This is not to say that a mud-stove should not follow some basic design principles. The most important physical parameter to check is the distance from the ground to the base of the cooking pot. This should be about 20cm, equal to the length of the hand from the wrist to the fingertips, to give enough space for firewood to burn properly. The walls of the stove should be about as wide as a hand laid flat on the ground to get the best compromise between insulating properties and the ability to heat up quickly. The stove's internal diameter should be customised to fit the family's normal cooking pot so that it fits snugly, and heat loss around the sides is minimised.

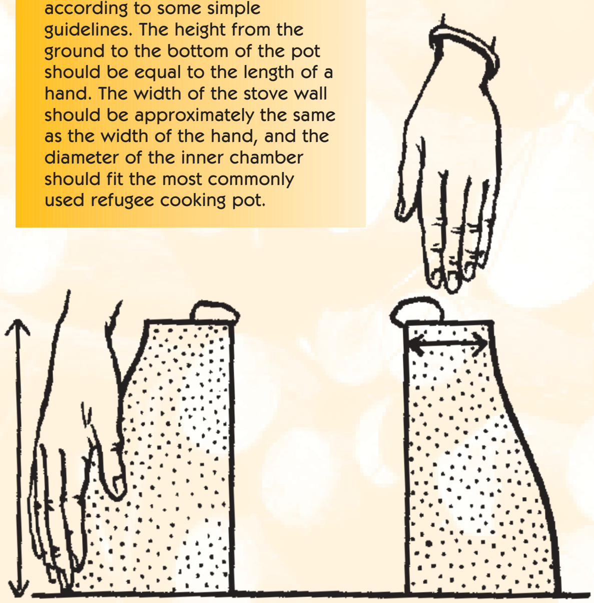
Other than ensuring that these basic guidelines on height, wall thickness and diameter are adhered to, refugee stove makers should be given flexibility to innovate and adapt. They may come up with alternative raw materials, new designs not seen before, or unexpected add-on technologies.

The only customisation that the promoting agency should normally discourage is the inclusion of chimneys or smoke vents. These features tend to be redundant additions that retard stove adoption and serve only to allow heat to escape. In camps in Rwanda for Congolese refugees, women routinely blocked up smoke vents once the stove promoters from a non-governmental organisation had left, finding that they were allowing cold draughts to enter the kitchen and were not performing any useful function. Dry wood and good ventilation of the cooking area are the preferred ways to reduce any indoor smoke problem.

Mud-stoves are designed primarily for firewood but can be adapted to use charcoal by simply inserting a metal grate inside the fire chamber. A grate may be as basic as a piece of metal with holes punched in it – which can be removed or inserted as required – or as sophisticated as parallel steel bars embedded in the stove body during construction.

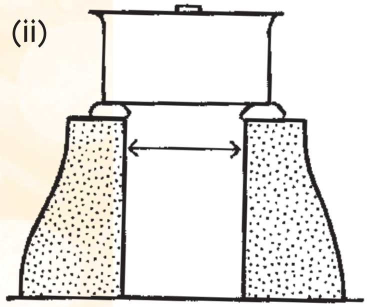
As they use local materials, cost nothing to build and allow great design flexibility on the part of the user – an important element to ensure that they will continue to be used – mud-stoves present an attractive opportunity for energy-saving and home improvement in a refugee setting. This is particularly so where markets for fuel are limited, giving no clear incentives for refugees to pay money for more

A mud-stove is not a complicated device but it should be built according to some simple guidelines. The height from the ground to the bottom of the pot should be equal to the length of a hand. The width of the stove wall should be approximately the same as the width of the hand, and the diameter of the inner chamber should fit the most commonly used refugee cooking pot.

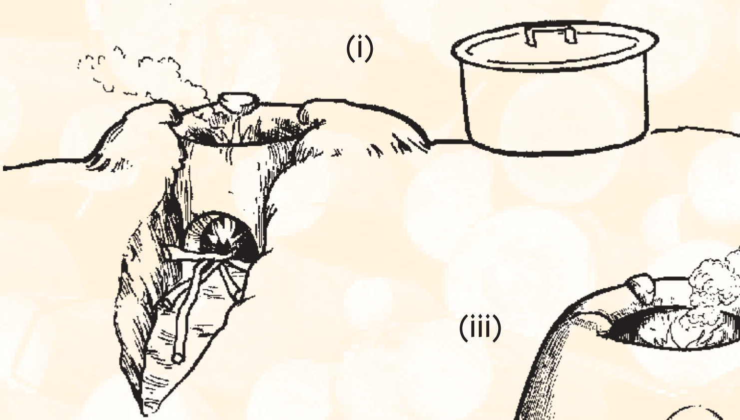


Different types of mud-stoves:
(i) Sunken mud-stove for firewood
(ii) Raised mud-stove for firewood
(iii) Mud-stove for charcoal with metal bars
(iv) Mud-stove for charcoal with ceramic firegrate

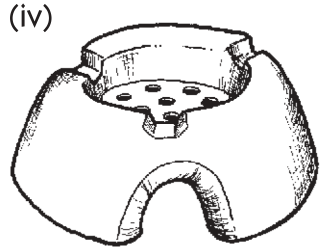
(ii)



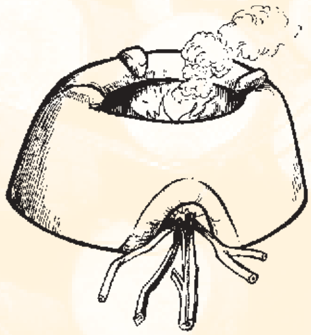
(i)



(iv)



(iii)



elaborate energy-saving devices such as purchased stoves. Mud-stoves are therefore especially attractive in situations where refugees lack the financial resources to buy prefabricated stoves, but still seek energy savings or other improvements in cooking technology.

At the same time, however, mud-stoves require constant repair by the user as they become cracked and damaged by constant exposure to heat and the abrasion of pots and utensils. Where conditions are right, the promotion of more durable pre-fabricated stoves may be appropriate.

(b) Pre-fabricated Stoves

In some situations it will be possible, and advantageous, to move from mud-stoves to more sophisticated cooking devices that are fabricated by local or refugee specialists. In terms of energy-saving, these stoves may not be any more efficient than a well built and operated mud-stove, perhaps saving 20-25% of fuel compared with an open fire, but they can have add-on benefits that make them useful in a refugee programme.

ⓘ Innovation in mud-stove design

Mud-stoves come in many shapes and sizes. Refugee innovation is to be encouraged.

In Uganda, Sudanese refugees built mud-stoves as one part of an overall home improvement package in which they re-floored their kitchens, re-smeared the internal walls of their huts and constructed small seats, pot stands, windows and wall niches for lanterns around the focal mud-stove – all using the same clay/sand/straw combination. Competition between households for the most imaginative mud-stove and the smartest add-on home improvements became common.

Refugees in Bangladesh built semi-submerged mud-stoves with a fuel entrance underground and the pot resting at floor level.

In other places, refugees make pot rests within their mud-stoves from clay, stones, metal or broken bricks, sometimes within the stove's fire chamber and sometimes on top. They construct different types of doorways, sometimes open and sometimes arched. The stoves can even be portable if they are made of strong clay.

Among the benefits that can be expected are:

- ***Skills development or income-generating potential:*** Individuals or groups of artisans may be able to fabricate stoves for a refugee population as a profit-making enterprise, developing new expertise and generating income in the process. For this to succeed, it is important that a training programme is established locally to help make the operation sustainable.

- ***Higher adoption rates due to perceived status:*** Refugees may find prefabricated stoves more attractive than mud-stoves, for reasons of status, and may adopt them more readily.

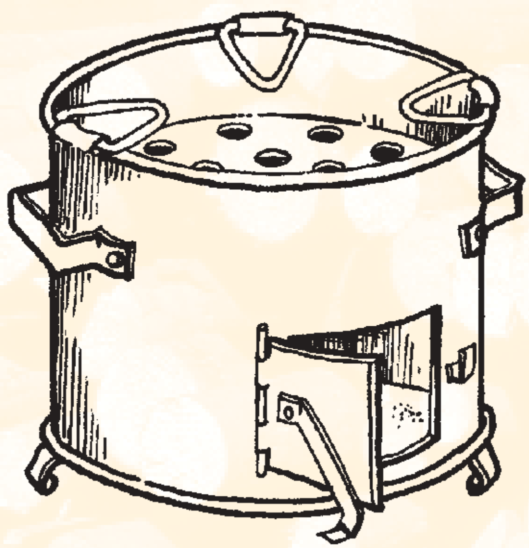
- ***Value added to energy conservation:*** The procurement of a prefabricated stove will require an outlay of cash or labour. This means that energy conservation begins to take on a tangible value. Such stoves can help promote a culture of energy conservation in the refugee community.

Three types of prefabricated stove have been successfully introduced in refugee programmes:

(a) all-metal stoves;
(b) fired-clay stoves; and
(c) combination stoves with a fired clay lining and a metal exterior.

(a) All-metal Stoves: All-metal stoves can be made fairly simply using scrap metal, perhaps taken from old oil drums or cooking oil containers. A stencil is normally used to guide the cutting out of the stove components, which are then riveted or clamped together by semi-skilled artisans. The simplest versions of these stoves burn firewood, but with the addition of a perforated grate they can be modified to also use charcoal. Although this type of stove is easy to make, the metal body tends to radiate a lot of heat, so levels of efficiency are relatively low (25% at most). The lifetime of the stove may be less than a year because the unprotected metal body corrodes rapidly. Vegetable oil cans are also rather flimsy so the use of this metal makes for a particularly short-lived product.

While these are easy-to-make stoves that use waste materials and have a low production cost, they offer a fairly low energy saving potential and do not last long. They can still, however, be a useful introduction to stove making for a group not previously familiar with metalwork.



All-metal stoves are inefficient and do not last long, but they offer the advantage of portability and can often be made with locally available materials.

(b) Fired Clay Stoves: Various types of stove can be made from fired clay. Suitable clay is gathered, cured, shaped into a stove (often using a special mould), left to dry and then fired in a kiln. This type of stove is considerably harder to produce than the all-metal stove, even by experienced potters used to working with clay. This is mainly because the firing of a thick-sided stove requires fairly sophisticated kiln technology that ensures controlled temperature changes to minimise cracking. For this reason, traditional open firing methods used by local potters for making thin-sided water jugs or cooking pots are not suitable for firing most types of clay stove. There can also be cracking problems prior to firing if the newly made stoves are dried too rapidly, especially in hot areas, but this can usually be overcome by covering the moulded stoves with damp sacking.

Depending on their previous levels of experience in pottery, a group of refugee (or local) artisans might need as much as a year's training and experimentation in clay stove making before they can reduce drying and firing losses through cracking to acceptable levels of 10% or less. At this point they may be ready for progressive commercialisation of production and dissemination to the refugee population. External assistance, perhaps through a subsidy programme, may be needed.

There are many types of fired clay stoves. Some are free-standing and portable while others are sunken within a fixed fireplace in the kitchen. If used properly they may be 20% more efficient than all-metal stoves and considerably more durable. Well known ceramic stoves include the East African *Maendeleo or Upesi.*

(c) Combination Clay/Metal Stoves: The most sophisticated type of fabricated stove is made from a clay liner with an external metal cladding. This stove brings the portability of the all-metal stove together with the efficiency and durability of the clay liner. Well-known clay-metal stoves include the *Thai Bucket* and the *Kenya Ceramic Jiko.* These stoves require a combination of skills in metal working and ceramics, as well as small enterprise development and marketing at the dissemination stage, so are best viewed as an eventual extension of all-metal or all-clay stoves if sufficient levels of success are achieved in production and marketing.

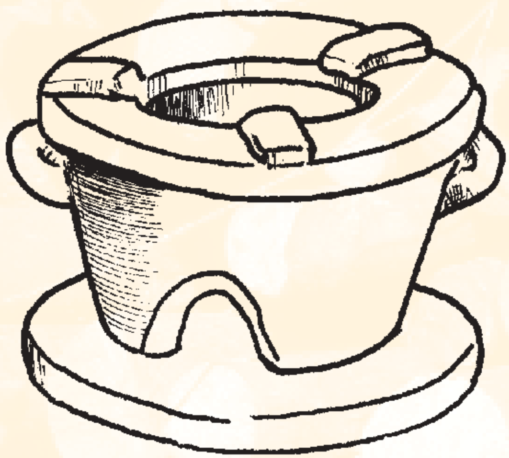
Table 1 summarises the principal benefits and drawbacks of the various mud, metal, clay and combination stoves that have been discussed.

3.2.3 Conditions for Improved Stove Promotion

In spite of their advantages in terms of potential energy-savings, there are some drawbacks with improved stoves that can mean they are not a guaranteed success. Cost is one such drawback, as is the lack of flexibility for non-cooking purposes. People may also not always be interested in using improved stoves, or may use them inefficiently.

A clay-metal stove is portable, durable and efficient.

Fired clay stoves come in both portable and fixed versions.



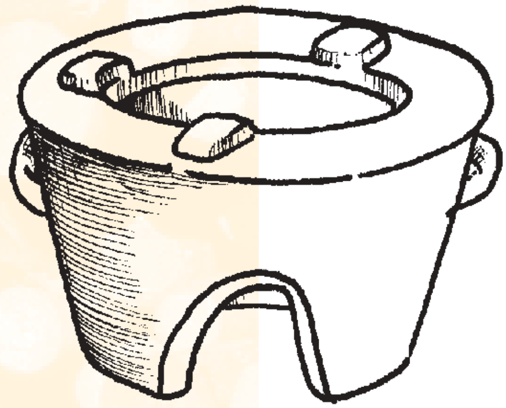


Table 1. Advantages and Disadvantages of commonly – used Stoves

Type of Stove	Advantages	Disadvantages
Mud-Stove	Easy to build Require only locally available materials Costs nothing Can be sized to fit the family's own pots Can be maintained by the owner Can promote self-led innovation and home improvement Up to 25% fuel efficient	Low durability Requires regular repair (re-smearing)
All-Metal Stove	Portable Suitable for charcoal or firewood Production provides source of income for artisans	Often of low durability due to use of flimsy cooking oil tins Hot exterior can be dangerous Maximum 20-25% efficient
Fired Clay Stove	Durable Fuel-efficient (up to 30%) May be portable, depending on style Potential for producers to generate income from sale	High degree of ceramics expertise required Need high quality clay, moulds and access to kiln Firing requires firewood Refugees may not buy stoves, prompting need for subsidy
Combination Clay/Metal Stove	Durable Prestigious Portable Most fuel efficient (30%+) Safe Can be made to burn either firewood or charcoal Potential for producers to generate income from sale	High degree of expertise needed in ceramics and metalwork Raw materials needed, some of which may be hard to source (e.g. vermiculite for attaching liner to cladding) Refugees may not buy stoves, prompting need for subsidy

There are certain preconditions for the promotion of improved stoves, without which it may not be cost-effective to attempt to disseminate them. Such preconditions include the fact that:

➤ *Users should be in a situation of energy shortage.*
If an improved stove is going to be accepted and carefully used it is important that the user of firewood or charcoal feels the need to conserve energy. This might seem obvious, but the number of programmes promoting stoves among communities living in forests – where firewood is abundant – is testament to the fact that it has not been widely appreciated.

If refugees or returnees have access to plentiful energy resources around their camps, settlements or homes, they will probably not be interested in adopting an improved stove – unless it has other benefits that they desire, such as reducing indoor smoke or speeding up cooking. Improved stove programmes will therefore work best in places that have an energy shortage.

➤ *Fuel should be a market commodity.*
Many stoves cost money so there should be an economic incentive to buy one. This generally means that the refugees should already be buying some or all of their fuel and not gathering it freely. If they are buying fuel then the purchase of an improved stove will represent a direct investment in something that will ultimately save them money after a certain payback period. In contrast, if energy is free then any money spent on a stove only replaces human labour – which tends to be under-valued, especially if it is women's labour. For a stove programme to work well and be sustainable, a market for fuel should ideally already exist. If no such market exists then user-built mud-stoves will be a more viable option than fabricated stoves.

➤ *The stoves should have multiple benefits.*
Although an improved stove may be more efficient than an open fire, it may demand changes in behaviour that people are not willing to make and can preclude certain traditional uses of the fireplace. Firewood may now have to be properly

dried and cut into small pieces, for example, so that it can fit into a smaller and more efficient stove, whereas the open fire can take any size of wood and even green branches. The need for fuel preparation can add a labour burden. Improved stoves may not be able to roast food in the same way as an open fire because the hearth is small and does not accumulate as many embers. Improved stoves are also no substitute for open fires as focal points for social gatherings. When weighing up the benefits and drawbacks, some refugees may decide that the open fire suits their overall needs better than an improved stove. For maximum success, any new stove design should therefore be locally adapted to suit cultural preferences and multiple needs. Ideally it will be a stove that local people in the refugee-hosting area are already buying or using, as this demonstrates that it can work in the context of the area where the refugees have been settled.

If one of the above conditions is not met then careful consideration needs to be given to the viability of a stove programme. It may not be worthwhile or further adaptations may be necessary. The following questions probe these conditions further:

➤ ***What if an energy shortage does not seem to exist?***
Consider ways of deliberately inducing an energy shortage. In other words, create a feeling of energy scarcity to try and make refugees aware of the need to introduce efficiency measures. This might be possible by:

- *making wood harder to obtain, perhaps by supporting government restrictions on wood harvesting (through forest guards or similar);*
- *developing environmental byelaws with a refugee/local working group;*
- *introducing awareness campaigns of the host government's or local communities' environmental regulations; and/or*
- *taxing firewood or charcoal traders, or issuing trading licences to regulate their activities and introduce more realistic pricing.*

If fuel becomes harder to obtain, or more costly, there will be greater incentives to adopt improved stoves and use energy more efficiently.

Try also to look for other benefits of an improved stove, in addition to simple energy saving, which might make it attractive to the intended users. Consider for example faster cooking, a protected fireplace that is safer for children, greater prestige associated with a more modern cooking system, or the opportunity to reduce smoke in the kitchen. The promotion of energy-saving hardware should ideally be part of a co-ordinated environmental education strategy which acknowledges that fuel-saving is not necessarily the main priority for refugees or returnees.

➤ ***What if there is no apparent market for fuel?***
Consider promoting stoves that can be made by the end user at no financial cost, e.g. mud-stoves as opposed to prefabricated stoves.

Also consider subsidising stoves or giving them away for nothing, for a short period only as an introduction or pilot activity. Be aware, however, of the potential impacts on sustainability of this approach in the longer-term and the fact that it may undermine potential producers of stoves in the private sector. A workable compromise between stove giveaways and outright sale may be the exchange of stoves for some non-cash contribution from the beneficiary community. In Kenyan refugee camps this took the form of tree planting or labour for digging micro-catchments to irrigate seedlings in arid areas. The more sophisticated or prestigious the stove being offered, the greater the contribution asked of the beneficiary.

➤ ***What if the stove cannot perform certain desired functions?***
There are clearly some limits to the resources, skills and information available. Look for a new stove design that is more adaptable, even if it sacrifices a certain amount of efficiency. Allow refugee innovation and design modifications, even if they sacrifice a small amount of efficiency. Myanmar refugees in northwest Thailand, for example, adapted the traditional 'Thai Bucket' charcoal stove to suit their tradition of burning firewood by cutting a hole in one side and adding a protruding shelf for feeding firewood. This modification meant that it could be widely used as a multi-fuel stove instead of being rejected as a technology suitable only for those who could afford charcoal.

3.3 Energy-Saving Practices

More efficient cooking stoves such as those previously described should not be promoted in isolation, but always alongside **improved cooking practices**. These are cost-free adaptations to cooking techniques, some of which may already be in use among the refugee or returnee population but also others that can be usefully encouraged. Using better stoves without employing improved practices at the same time is to lose the full benefits of energy-saving that might be achievable. In fact there is often an unjustified focus on stove hardware in refugee situations – as stoves are visible devices and serve as ready indicators of success – but the impact of using fuel-saving practices can often be far greater than the stoves themselves, even though their adoption is less easily observed.

Priority should be given to fuel-saving options that have the most positive impact on health and nutrition and which reduce, rather than increase, the burden of labour on women. Different adaptations to cooking will be appropriate for different foods, environments and cultural settings, of which the following are some examples:

3.3.1 Firewood Preparation: Some Essential Facts

- ***Cut and split firewood***
  Thick logs burn slowly and often incompletely. Smaller pieces of wood, with a greater surface area, ignite faster and burn more completely and efficiently with no sacrifice in heat output. Sticks with a diameter of 3-5cm are best for most cooking jobs and are easy to handle.

- ***Use dry firewood***
  Wood with a lot of moisture does not burn efficiently because of the amount of energy needed to remove water from the wood (2.4 mega-joules per litre of water). A high moisture content slows down the combustion process, cools the fire and causes incomplete burning of the wood, producing a lot of smoke in the process.

Wood which is air dried for two months has about twice the heat value of freshly cut wood. This means that fuel savings of 20-25% can be achieved using air-dried firewood instead of freshly cut pieces.

Wood will dry more quickly if it is split to increase its surface area. In refugee and returnee situations pieces of split firewood can be dried on the ground, on roofs, inside huts or on purpose-built racks which may form part of cooking shelters. It may be necessary to supply cutting tools such as axes or machetes, but this is not always acceptable for security reasons and may promote further cutting of standing trees if not well controlled.

For maximum efficiency, firewood should be cut, split and properly dried before it is burned.

3.3.2 Fire Management

- ***Shield the fire***

  Fuel savings of 15-20% can be achieved by proper shielding of fireplaces from wind. This can be done using locally available materials such as rocks, mud or pieces of firewood in the process of drying. Shielding a fire is really the first step towards any form of energy conservation and savings. The next stage in fuel economy would be a form of basic mud-stove, progressing to a fully enclosed fireplace and a true improved stove.

- ***Control the air supply***

  Fires require different amounts of air at different stages. During lighting they need a lot of oxygen and should be well ventilated, but by the time full combustion is reached they require much less. Therefore, after the fire is lit, rapid, incomplete combustion can be avoided by controlling the air supply. A regulated fire uses less wood, burns completely and gives off heat at a constant rate.

- ***Simmer food gently***

  Simmering cooks food just as quickly as rapid boiling, and also ensures that more of the nutritional value is retained. Once food in a covered pot has been brought to the boil it is often not necessary to add more fuel to the fire because the retained heat of the fireplace, stove and pot is transferred to the food. Fuel can even be removed once boiling point has been reached, resulting in substantial energy savings. Refugees may need convincing, but the fact is that any effort to heat water beyond its boiling point will result only in wastage of fuel and generation of steam.

- ***Put out the fire promptly***

  Once cooking is complete the fire can be deliberately put out rather than being allowed to burn out naturally. This can amount to fuel savings of 15-20%. Refugees will, however, need matches or some other means to re-light the fire later.

- ***Distribute sufficient clothes and blankets***

  Related to the preceding point, families may be obliged to keep fires burning for long periods simply to keep warm. For the sake of both energy conservation and as a humanitarian obligation, it is important to ensure that refugees have access to sufficient clothing and blankets to keep themselves warm at night, without having to light fires in their homes.

3.3.3 Diet and Food Preparation

- ***Promote fresh food***

  Fresh food grown in the local area, perhaps by refugees themselves, will cook more rapidly than dried rations brought in from outside. Fresh beans, for example, can usually be cooked in a matter of 30-40 minutes, whereas dried imported beans, often several seasons old, may require up to ten hours of boiling and proportionately more fuel. Increasing the amount of fresh food in the refugee diet will normally be a combined effort led by food supply agencies such as the World Food Programme. This not only has environmental benefits, but is also likely to improve nutrition, promote refugee self-reliance, offer small enterprise opportunities from the sale of produce, and can often save money as food transport costs are significantly reduced.

- ***Pre-soak hard foods***

  The cooking time of hard grains and beans can be greatly reduced by soaking them in water for 5 to 8 hours prior to cooking, resulting in fuel savings of as much as 40%. This may not be a simple practice to introduce as refugees are likely to complain of a difference in the flavour of the food. These beliefs persist despite the lack of confirmation in blind taste tests.

  Pre-soaked food normally loses colour and texture – other reasons for resistance to change. Pre-soaking also leaches certain nutrients so, ideally, the food should be washed and rinsed first and then pre-soaked in a fresh batch of water – which is also that used for cooking. Water in camps is often chlorinated and this may have further detrimental effects on the nutrient value of pre-soaked foods. But, of course, the boiling time is reduced, which helps to preserve nutrients in the food, so this may off-set any nutrient losses brought about by pre-soaking.

➤ *Mill or pound hard grains and beans*

The cooking time of hard grains and beans can be reduced substantially by milling or pounding prior to cooking. Milling will normally take place at centralised locations and a loss of nutrients should therefore be expected. Pounding is more likely to be under the control of the individual refugee family and therefore nutrient loss can be prevented by careful collection and use of all crushed food stuff. Milling can, however, result in the loss of micro nutrients. The higher the extraction rates the better the nutritional value.

Cooking times can be reduced by pre-processing food. Here, maize is pounded using a traditional method.

➤ *Cut hard food into small pieces*

Food cut into small pieces cooks faster. Meats, potatoes and vegetables should therefore be cut up before cooking. This alone can enable fuel savings of 20-30% to be realised.

Traditional Tenderisers

Many refugee communities have traditionally used tenderisers in cooking and they often transfer these traditions to their new situation in exile.

Sudanese refugee families in Uganda keep a small tea strainer full of ash to hand, and through which they filter all water in which beans are to be cooked. This not only adds flavour but also speeds up cooking.

In the street markets in refugee camps in Kenya, it is common to find small lumps of soda ash for sale. These have been brought hundreds of kilometres from Magadi in the Rift Valley. The material is actually known as '*magadi*' and is used in crushed form by the refugees to soften green vegetables.

In Tanzanian camps, Burundian refugees are well aware of the tenderising qualities of the pawpaw fruit, and use its juice as a marinade for meat. This softens the meat and makes it easier to cook.

➤ *Use tenderisers*

The cooking time for some foods can be reduced through the addition of traditional tenderisers, e.g. rock salt or bicarbonate of soda for green vegetables, papaya juice for meat or water filtered through ash for beans. The use of tenderisers is found in many cultures and their promotion may be a simple matter of identifying what is already known and then encouraging its uptake among the community as a whole.

3.3.4 Cooking Management

➤ *Build a cooking shelter*

A shelter for cooking can be built out of poles and either plastic sheeting or some sort of thatch, as available. As well as protecting the fireplace from the elements, larger shelters can form a central component of communal living areas. Cooking innovations can be shared, as can cooking itself (see below).

➤ *Use the right pot*

Metal pots heat up quickly but retain little heat, whereas fired clay pots are better insulators over long periods. Therefore, if there is a choice of pots, refugees and returnees will benefit from using metal pots for boiling water and preparing fast-cooking

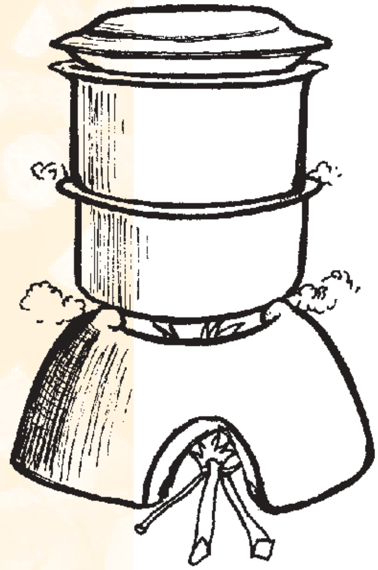
Lids on pots save energy. The scope for improvisation is unlimited.

Two or three pots can be placed on top of each other in a 'double-cooking' system, maximising the use of the heat from the fire.

foods such as rice and potatoes, but clay pots for dishes requiring extensive simmering such as maize and beans.

- ***Use a tight-fitting lid, with a weight on top***
  Food should always be covered while cooking to reduce loss of energy through convection and radiation. A tight-fitting lid can save 20% of fuel. In refugee situations, lids are not always distributed with pots and they are not always of the right size. In such cases, refugees can improvise with plates, pieces of metal nailed together, woven pads of banana leaves, or similar. A weight on the lid serves to improve the seal on the pot, and may even create a slight pressure cooker effect.

- ***Try 'double cooking'***
  While one pot is on the fire a second can be placed on top to start warming water. This second pot will also act as a lid. This is, of course, subject to the availability of pots of the right size. But, as refugees often buy their own pots to supplement those that have been issued to them, double cooking will be feasible even where the standard cooking sets include too few pots or pots that cannot be stacked up on each other.



➤ ***Add water during cooking***
Instead of filling a pot with water at the start of cooking and later finding out that it is not all needed, it is more efficient to just use sufficient water to cover the food and add further small amounts, as required.

➤ ***Do not over-clean the outside of a pot***
Soot accumulating on the bottom of pots and pans will reduce their ability to transfer heat. At the same time, however, fire-blackened pots are good at absorbing radiated heat. They should therefore not be polished outside, although surface layers of loose soot and soft tar should be removed.

➤ ***Transfer food to a 'haybasket'***
The energy-saving technology of the 'haybasket' or 'fireless cooker' is simple but effective. The principle is that a pot of partly cooked food can be transferred to an insulated container where it continues to cook without the need for further external heat. In a refugee situation, this might mean that a pot of rice can be brought to the boil and then put inside an insulated haybasket while the fire is extinguished. Instead of feeding the fire for a further 20 minutes to maintain a simmer, the rice can be cooked in 30-35 minutes inside the cooker using its own stored energy. Not only is fuel saved, but the risk of burning the food is also eliminated. A haybasket is also much safer than a fire if children are around.

Haybaskets can be made using materials as basic as a cardboard box stuffed with crumpled newspaper and lined with black cloth. Other suitable insulating materials include cloth scraps, wood shavings or even leaves. A tight-fitting pillow or cushion is placed on top of the pot of food. The most sophisticated haybaskets used by the military are strong metal boxes with plastic linings.

It is important that a high standard of haybasket workmanship is maintained to ensure that the device is durable and fits tightly around the cooking pot to conserve heat. Refugee or local groups should be trained in haybasket manufacture to instil an appreciation of its working principles and the importance of maintaining high production standards. The use of haybaskets will demand some changes to traditional cooking practice, but if cooking fuel is in short supply then the benefits to the user have been shown to outweigh any inconveniences.

3.3.5 Shared Cooking

There are considerable energy savings to be achieved by moving towards more collective cooking arrangements. The economies of scale to be achieved by catering for more people with fewer stoves are clear. Even at the family level, a refugee household of four or more members typically requires 45% less fuel per capita than a family of two or fewer. Especially inefficient are cooking groups of just one or two people. Cumulative energy-savings begin to decline rapidly above group sizes of seven to eight.

One shared cooking option is termed multi-family cooking, referring to the pooling of food resources by adjacent families for cooking together. This option can be encouraged through camp designs and incentives which explicitly promote pooled cooking for households in close proximity. An option necessitating more significant infrastructural and social change is institutional cooking, whereby food is cooked in bulk by agencies and distributed at centralised locations.

➤ ***Multi-family cooking***
In the face of an energy shortage, time constraints or other incentives, it is possible that adjacent refugee families will begin to cook certain foods together using fewer pots. This energy-saving practice cannot necessarily be influenced significantly by outside agencies as its adoption will depend to a great degree on the social traditions of the refugees themselves, but it is certainly to be encouraged from an environmental point of view.

Camp arrangement of rows of shelters, each with their own stove or fire is the least efficient in terms of creating conditions that can facilitate multi-family cooking. It is possible to introduce more collective arrangements in which shelters are clustered or grouped around central spaces in which cooking and social interaction can take place. The feasibility of such arrangements may depend in no small part on the social traditions of the refugees themselves, certain groups being more likely to support closer integration than others. Another measure that can facilitate the adoption of shared cooking is the distribution of larger pots. A capacity of 8-10 litres enables two or more households to cook together. The standard sizes of distributed pots are five and seven litres, which tend to be too small to facilitate shared cooking.

It is not appropriate to attempt to deliberately impose multi-family cooking, as individual households may still prefer to determine for themselves how they control their food and fuel. Under pressure of fuel shortage, however, and with certain food rations taking excessively long to cook, neighbouring families within the same cluster may decide to share the cooking of certain slow-cooking dishes such as beans. As well as achieving such direct fuel savings, living and cooking in close proximity is also more likely to result in the spread of innovative cooking practices than independent hut-by-hut arrangements.

It may be possible for agencies to further encourage the process of energy-saving under a multi-family cooking system by offering incentives for conservation on the part of the refugees. For example, if each family in a cluster constructs a mud-stove, in return the whole unit can be provided with a simple cooking shed.

➤ ***Institutional cooking***

Institutional cooking, in which UNHCR or other agencies control the supply of food and manage food preparation, should be considered a last resort for normal refugee cooking under exceptional conditions such as extreme shortage of food, fuel or water. It is generally confined to hospitals, schools, supplementary feeding centres, transit centres and other support institutions where the family unit is not providing feeding.

There are a variety of improved cooking systems available for institutions, mostly using firewood. These tend to increase in cost with efficiency and durability from simple brick platforms with sunken fireboxes (US$0.50 per person catered for) to free-standing, galvanised steel cylinder stoves with integrated stainless steel cooking pots and chimneys (up to US$8 per person). Energy savings of over 50% compared with open fires are achievable using the more expensive systems, even allowing for a certain amount of mismanagement by untrained cooks.

The principal obstacles to institutional cooking are not likely to be technical but managerial and social. Institutional cooking is resisted by those caring for refugees because it can lead to loss of individuality and self-respect and may promote a hand-out mentality. Refugees themselves may fear loss of control over food stuffs, the imposition of more rigorous scheduling of meals, the risk of smaller food portions and even poisoning by other refugees.

3.4 Summary

This section of the Handbook has presented a number of ideas for improved stoves and energy-saving practices that may be appropriate for refugee and returnee situations. Many of these technologies and techniques are already well known, but there is always room for the introduction of additional ways to conserve energy. Most important, however, is to ensure that some, if not all, of the above have been introduced, are being used and are being adhered to. Questions should be asked if these simple, but effective, practices have been used for a while and then abandoned.

The ideas that have been offered are appropriate for situations where the principle fuels are firewood and charcoal. The next section of the Handbook goes on to look at other energy sources that may be less familiar to refugees and returnees, such as loose wastes and residues, briquettes, grass, peat, biogas, kerosene and solar energy.

4

Alternative Energy — *Looking At Other Options*

The preceding section covered the ideas of improved stoves and energy-saving practices. These ideas have been proven time and again in refugee and returnee situations where firewood and charcoal are the main fuels.

There are, however, situations where other energy sources may be appropriate. There may, for example, be a total lack of firewood in the immediate vicinity of a refugee camp; or it may be illegal or unsafe for refugees to collect fuel. Under these (and other) conditions it can be advisable to look at other energy options.

The following alternative energy sources are presented in this section and their potential assessed, where possible, based on experience from refugee situations:

- *loose wastes and residues;*
- *fuel briquettes;*
- *grass;*
- *peat;*
- *biogas;*
- *kerosene; and*
- *solar energy.*

4.1 Loose Wastes and Residues

In situations of firewood shortage it is not uncommon for refugees to turn to loose wastes and residues that can be scavenged around camps and settlements or in nearby cultivated fields. Such wastes may include maize cobs, rice husks, cotton (or other crop) stalks, cow dung, twigs and leaves. Most of these loose wastes are considered inferior to firewood and charcoal because they have a much lower energy content and are harder to burn. Energy values of 10-13MJ/kg are typical, compared with 16MJ/kg for dry firewood and 30MJ/kg for charcoal. Such materials can also be difficult to light and may give off excessive smoke. They may even require a special kind of stove to provide sufficient ventilation.

Some apparent 'wastes' also have value as soil improvers, sustaining structure and nutrient levels within agricultural land. Their use as a fuel may preclude essential nutrients from returning to the soil.

Such fuels nevertheless represent a form of seasonal energy reserve in case refugees' preferred fuels are not available. In the case of cow dung the long slow burn of the fuel may even be considered superior for cooking certain slow-cooking dishes, especially in parts of South Asia where the cow itself is considered sacred.

There are no formally documented experiences of refugees depending upon loose wastes and residues as cooking fuel on a large scale, though it is known that their use is widespread in times of energy shortage. Refugees in Bangladesh were observed gathering leaves from the ground in local forest reserves for use as kindling when they could not acquire sufficient firewood. The same refugees also used cow dung plastered onto jute sticks as a substitute for wooden sticks. Refugees in Uganda have access to agricultural land and use various crop residues as fuel on a seasonal basis, including pigeon pea stalks and cassava stems. The use of such residues is, however, rarely observed in places where refugees have access to abundant firewood – in Thailand, Liberia or parts of Tanzania, for example, where refugees are situated in or adjacent to forests.

In summary, loose wastes and agricultural residues are normally supplementary energy options, useful as a fall-back in times of firewood shortage. Due to their low energy content and poor combustion characteristics they do not represent a viable source of energy for mass consumption or widespread substitution. They are fuels that can meet the spontaneous requirements of refugee households according to seasonal availability and their own needs and preferences.

4.2 Fuel Briquettes

One way to convert loose residues into a more energy-rich and user-friendly form is to compact them into fuel briquettes. Fuel briquettes are defined as "manufactured fuel pellets produced from organic matter through compaction, external charring, complete carbonisation or a combination of these processes". They are basically compressed fuel blocks made from plant wastes or sawdust. But, as the definition suggests, they come in a number of varieties:

(a) Densified briquettes are fuel blocks produced through simple compaction of biomass, usually plants or plant residues, in combination with a binding material such as molasses or resin. Suitable raw materials include sugar cane bagasse, coffee husk, rice husk or sawdust. They have an energy value of around 16MJ/kg, comparable to that of dry firewood. There is no known example of densified briquettes being used in any long term manner in a refugee programme. Experience from non-refugee situations, however, suggests that these fuels tend to be difficult to light and unacceptably smoky, with a cost much higher than that of firewood for the same energy content. This probably explains their absence from refugee programmes.

(b) Charred briquettes are fuel blocks produced through a process of compaction with no binder at much higher pressures than standard densified briquettes. The high pressures (and associated high temperatures) break down the structure of the material and create a hardened external shell that holds the briquette together. Charred briquettes made from rice husk were supplied in Bangladesh to refugees from Myanmar during the mid-1990s. They proved technically satisfactory but were subject to re-sale locally (see boxed case study).

(c) Charcoal briquettes are fuel pellets of higher energy content produced from material that has either been carbonised prior to its compaction, or compacted first and then carbonised. Either way, energy values of up to 30MJ/kg can be achieved. This puts some of these briquettes on a par with regular lumpwood charcoal in terms of combustive quality. Charcoal briquettes have been supplied to refugees in Thailand since 1997

Briquette Supply in Bangladesh

The Bangladesh programme supplied fuel during the 1990s to refugees from Myanmar located in camps in the southeast. This was an area of high population density and acute fuelwood shortage. There was, however, an abundance of rice husks. Several millers had experience of briquetting these husks using high pressure screw extruders to make fuel for local brick burners.

The Government of Bangladesh had made known its concern that refugees were damaging forest reserves to meet their cooking fuel needs. UNHCR was therefore looking for alternative energy sources. With rice husk briquetting already underway close by, UNHCR could tap into existing knowledge and production capacity and begin purchasing briquettes with no need to invest in new ideas or machinery. UNHCR purchased large quantities of charred rice husk briquettes from the local mills and distributed them to the refugees.

The supply programme continued until the refugees repatriated. It was deemed successful by UNHCR and satisfied government demands for action to reduce wood cutting by refugees. However, up to one-third of the fuel ration was sold, especially to commercial brick burners, at one-quarter of the price paid for it by UNHCR. Refugees, meanwhile, continued to source firewood from local forests reserves. They also continued to work for local businessmen involved in illegal logging. This was, in fact, the likely root cause of the government's claim that they were damaging the environment. It implied local acquiescence and indeed direct employment of refugees, who were a cheap labour force. The fuel supply response was perhaps not the most appropriate in retrospect, given the significant level of re-sale of the briquettes and the continued refugee involvement in commercial lumbering.

There are several types of fuel briquettes. Charcoalled briquettes resemble standard wood charcoal, but come in more regular shapes such as cylinders.

ⓘ Briquette Supply in Thailand

As in Bangladesh, the fuel supply programme in Thailand was a response to government concerns for the environment. Given that most refugees were settled inside forest reserves, there was also a legal justification for looking at alternative fuels.

Fuel supply was initiated on a small scale in 1995 using charred briquettes made from sawdust, similar to the rice husk briquettes in Bangladesh. But the refugees found them smoky and difficult to light and there was a progressive switch to charcoaled briquettes. By 2000, over 8,500 tonnes of these briquettes were being supplied at an annual cost of US$2.1 million.

Some 17% of the briquettes were derived from sawdust, which was dried, compressed using screw extruders and carbonised in kilns by a number of private companies in western Thailand under contract with the Burmese Border Consortium (BBC), a network of refugee support agencies. This method produced charcoaled briquettes with high energy content (29MJ/kg) and little ash (6%).

The remaining 83% of the briquettes were derived from raw material already carbonised before being briquetted. This material included various types of charcoaled waste from industrial operations in central Thailand, predominantly derived from bamboo from village industries making chopsticks and meat skewers. Under this system, the charcoaled material was crushed, sieved and combined with a tapioca flour binder, before being wetted and fed through a screw extruder to make a briquette which was then oven-dried. The bamboo-derived briquettes contained 24.5MJ/kg of energy and had 18% ash.

Both types of briquette had a much higher energy value than firewood and hence cooked more quickly and conveniently. They were popular with the refugees, who adapted their traditional stoves to use the briquettes alongside firewood that they were already gathering.

The fuel was delivered to the camps by the private producers and distributed by refugee committees under the supervision of BBC. The ration averaged 6-7kg/person/month, which met up to half of total demand. Given the remote siting of the camps there was little market for refugees who might wish to sell part of their ration. The supply programme therefore made a direct contribution to substituting for wood that would otherwise have been cut from forest reserves.

But apart from its high cost, the programme demanded constant monitoring of suppliers and prices to ensure competitiveness, transparency and consistency in fuel quality. It was therefore decided to experiment with the supply of firewood from eucalyptus plantations instead of briquettes and, by 2001, firewood was being progressively introduced as a cheaper, more standardised alternative in some of the northern-most camps. Not surprisingly, resistance to this switch was encountered. But, in the longer term, it may mean that more can be done in terms of energy supply with significantly less money.

(see case study above). The fuel has been of high quality but very costly to produce and distribute.

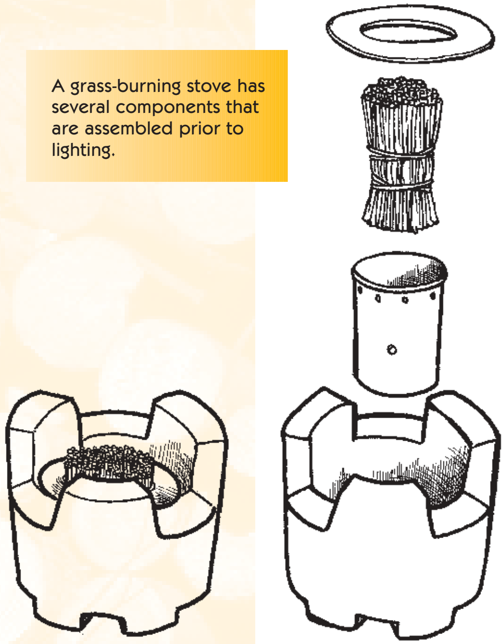
The Bangladesh and Thailand experiences suggest that refugees previously used to firewood are generally willing to accept charred briquettes and charcoaled briquettes as alternatives. Both can be handled in a similar manner to firewood and no major behavioural changes are required. Charcoaled briquettes are actually somewhat superior to firewood, having a higher energy content and a longer burn time. If funding is assured for several years and some controls are set in place at the outset to restrict re-sale (which could be as simple as the remoteness of a camp/settlement), then the supply of charred and charcoaled briquettes may be a viable option to prevent or contain refugee-related environmental damage.

4.3 Grass

Where refugees or returnees have been settled in relatively open land there is often a shortage of trees. This shortage may be exacerbated if farming is promoted. In such situations it may make sense to look at other plant resources that can serve as a source of energy, grass being one example.

Two refugee-hosting areas with an abundance of grass exist in northern Uganda and western Tanzania. The relative shortage of firewood and availability of grass in these areas prompted the introduction of a new type of cooking stove in the mid-1990s that was designed to burn bundles of locally cut grass.

A grass-burning stove has several components that are assembled prior to lighting.



Grass Stoves in East Africa

The original grass stove was a free-standing, portable device made from sheet metal. An outer cylinder provided support, stability, heat retention and ventilation, while an inner removable cylinder with perforations contained the grass fuel load. On top of this inner cylinder a metal ring was placed to direct heat to the centre of the pot. The complete stove was 34cm high, 20cm in diameter and weighed 1.5kg. It became known as the *peko pe*, meaning 'no problem' in the Acholi language of Uganda.

The stove was designed to take a fuel load of 500-600g of grass stems, cut to even lengths and tied together with bark or string. It could boil three litres of water in 15 minutes using a standard refugee cooking pot. Total burn time was typically about 45 minutes. The stove could then be refilled and used again for longer cooking tasks, or a second pre-filled cylinder could be kept ready to facilitate more rapid changeover from one fuel load to the next.

Several agencies were involved in the development and promotion of the grass stove and introduced various design modifications and promotional techniques over a period of three to four years. In Tanzania, for example, the design was modified to reduce the stove's cost by substituting a user-built clay exterior for the original metal shell. This change was estimated to halve its price to US$2.25 as it required only the inner fuel chamber and top ring to be made from metal. However, the stove failed to take off as expected and promotion had been abandoned in Uganda by 1999. It continued at a modest level in Tanzania through 2000, but outside the refugee camps.

The reasons for the rejection of the stove were numerous, but essentially related to the labour, inconvenience and change in cooking habits that its adoption demanded. The *peko pe* was efficiently designed and emitted considerable heat from a small fuel load, but the effort involved in collecting, drying, storing and preparing the grass proved considerable. It was especially daunting to have to gather and store large volumes of grass during the dry season to ensure that there would be sufficient dried bundles available for use during the wet season. Efforts to encourage refugees to cut and store grass in communal shelters for this purpose were not successful. The short burn time of each fuel load was also an inconvenience and essentially precluded the use of the stove for any dish that took more than 45 minutes to prepare – staple beans, for example. Thus, the overall impact on reducing wood consumption was minimal, even if a family were to adopt the grass stove for all of its fast-cooking dishes (such as tea or maize porridge).

Grass itself was not the free and unlimited energy resource that had been assumed, but was considered the property of local communities. In some cases they resisted its uncontrolled harvesting by refugees. In others they persisted with the traditional practice of burning for land clearance and to improve grazing, which effectively destroyed the value of these grasses as a potential refugee fuel source.

Based on the experiences of Uganda and Tanzania it seems important to note that promotion of a new and unusual fuel such as grass must be seen first and foremost as a community mobilisation activity, not as an effort to disseminate a technological innovation. The refugee projects were very much led by the stove itself, with insufficient consideration given to the complex social and cultural issues related to the cutting, drying, preparation and use of grass cut from local people's land as a cooking fuel. The stove was an impressive and efficient invention, and the various adaptations that led to the final clay-metal version in Tanzania were sound technical innovations. But grass is an inferior fuel to firewood and charcoal with a 20% lower energy content per unit of weight, more smoke, a shorter combustion time and limited seasonal availability. Its promotion will never be easy unless woodfuels are very hard to come by and the use of grass is addressed as an issue of resource ownership and management, not as a cooking fuel promotional activity. In general, therefore, grass is deemed an inappropriate fuel for refugee use.

4.4 Peat

Peat is a form of organic matter that develops as a result of incomplete decomposition of wetland vegetation under conditions of excess moisture and oxygen deficiency. Well decomposed peat has an energy value of over 20MJ/kg, exceeding that of dry firewood. It has been a traditional fuel in high latitude areas for centuries.

Under the hotter, damper conditions found in equatorial swamps, peat develops rather more quickly and, as a result, has a lower density and less energy. But it can still serve as a domestic fuel if properly dried and used in a well ventilated stove.

The only refugee programme in which peat has been tested was in Kagera Region, Tanzania between January 1995 and November 1996. Rwandan refugees from the Kagenyi and Rubwera camps were involved in a programme of peat extraction from swamps along the adjacent Kagera river.

Peat harvesting is a labour-intensive exercise. It must be cut from the swamp, transported to dry land, laid out in the sun to dry, and eventually carried to refugee homes where it can be burned.

Peat Harvesting in Tanzania

The Kagera peat was formed by the decomposition of papyrus and other reeds. It had a slightly higher energy content than wood when dry (18MJ/kg) and an average ash content of 15%.

The extraction programme was organised around 80-strong teams of refugees. By October 1996 over 50 such teams were involved on a daily incentive rate equivalent to US$0.34. Each refugee had a cutting target of 160 sods per day, which were dried for 4-5 days on cleared areas next to the swamp then collected in sacks and carried up to the camps for domestic use.

A mid-1996 survey found that 98% of refugee families had adopted peat as a supplementary cooking fuel. This had brought firewood consumption down to an average of 0.65kg per person per day, the lowest across the 11 camps in Kagera Region. Supplementary peat consumption averaged 1.65kg per person per day.

When asked what they liked and disliked about cooking with peat, refugees highlighted the close proximity of the swamps as a strong incentive to use this unfamiliar fuel, and the fact that it was available freely whereas firewood often had to be purchased. They noted that it was relatively lightweight and easy to carry once bagged. It also burned for a long time which made it good for simmering slow-cooking foods such as beans and rice. On the negative side, peat was said to be difficult to light and smoky, particularly in rainy weather. It could not be lit directly so the fire was usually started with dry grass, papyrus or firewood. It was said that peat necessitated stove modifications to raise the pot and allow sufficient ventilation.

There were unresolved questions on the environmental impacts of the peat cutting programme and fears that it was being harvested at a rate well above what was likely to be sustainable. There was also a trend among local farmers to begin agricultural cultivation on drying sites and expand cultivation into the swamp margins from which peat had been extracted. The high rate of cutting and expansion of cultivation was essentially leading to conversion of wetland into farmland.

It was intended that the daily incentive payments would be withdrawn by the end of 1996 and that refugee teams would continue cutting peat under their own initiative. But the unexpected repatriation to Rwanda meant that the move to fuel self-sufficiency never took place. This makes it hard to judge how sustainable the peat cutting programme might have been in the absence of cash incentives, a useful indicator of viability and refugees' willingness to participate voluntarily.

Nevertheless, in the situation of firewood shortage that prevailed, peat clearly represented an acceptable fuel supplement. The majority of refugees were using it for particular cooking tasks and both Tanzanian nationals and refugees were benefiting from the injection of up to US$40,000 per month into the local economy in the form of labourers' incentives.

While the question of sustainability remained unresolved, it can be assumed that at least some refugees would have found it worthwhile to cut peat voluntarily after the withdrawal of cash incentives, though it is unlikely that it would have been an attractive prospect for the majority.

Where it is available within a short walking distance of a refugee camp, and where it is of relatively high quality (at least 18MJ/kg), the Tanzanian refugee experience suggests that peat may represent a useful supplement for woodfuel. Its slow burning qualities make it suited to cooking certain types of food that require long simmering.

Any peat cutting should be organised under a systematic, group-based system to maximise output, as uncontrolled extraction by individuals would result in lower yields, inefficient use of the resource and greater environmental impacts. Where these concerns can be fully addressed, extraction of peat should be promoted without cash incentives in order to elicit genuine and sustainable refugee participation.

Peat must be dried before use and this will require large open areas adjacent to the swamps and reliable periods of sunny weather. The fuel can be hard to light and is often smoky, meaning that kindling will generally be needed and cooking should be done outside on well-ventilated stoves to avoid smoke-related health problems.

In summary, peat is a fuel with the potential to supplement firewood or charcoal in camps/settlements that are adjacent to swamps. Peat is suitable for certain cooking tasks on well-ventilated, outdoor stoves, provided that due attention is paid to sustainability and the potential impacts of cutting programmes on wetland – local and downstream – ecology.

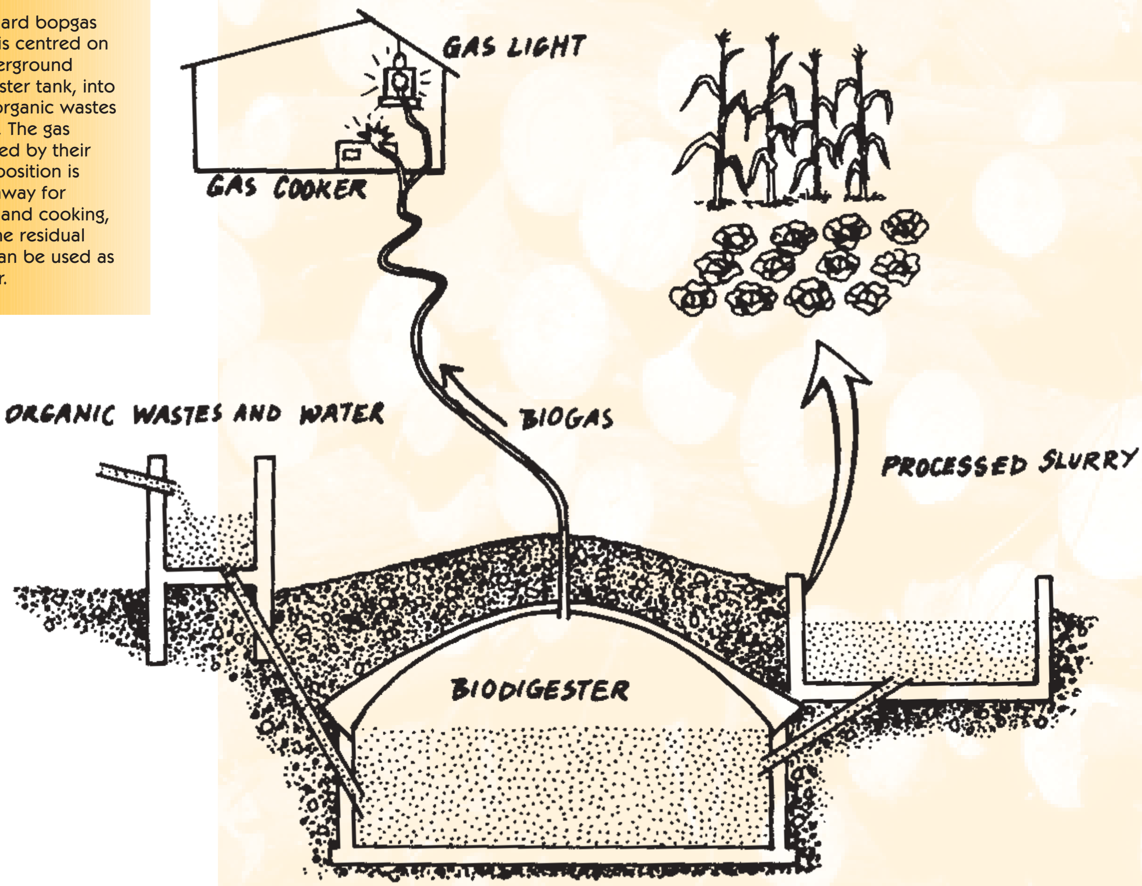
4.5 Biogas

Biogas is a mixture of methane and carbon dioxide given off during the digestion of organic matter in the absence of oxygen. With a methane content normally above 60%, biogas burns with a hot blue flame and can be used both in cookers and gas mantle lighting. It has a calorific value of 21.3MJ/m^3, about the same energy as contained in 1.4kg of air dried wood.

Gas production takes place in sealed digester units. Suitable feed materials are animal dung, vegetable matter or human waste: units that use human waste are known as bio-latrines. An important pre-requisite for biogas production is an adequate supply of water, which is normally added in a ratio of between one and three parts water to one part feed material. After a period of 30 to 70 days in the digester, the waste materials produce gas that can be collected and piped to wherever it is needed. The slurry that remains after digestion makes a high quality organic fertilizer.

If human waste is used then the gas output is likely to be sufficient to provide gas for cooking and lighting to approximately 10% of the people who have used the latrine. In other words, ten families using a bio-latrine will supply the gas needs of one beneficiary family.

A standard bopgas system is centred on an underground biodigester tank, into which organic wastes are fed. The gas produced by their decomposition is piped away for lighting and cooking, while the residual slurry can be used as fertilizer.



UNHCR has experience of biogas from pilot projects in south-eastern Nepa and eastern Afghanistan.

The Nepal and Afghanistan biogas projects differed both in motivation and approach. The Nepal project was prompted by a communal health problem and this led to a communally-oriented response. The Afghanistan project arose out of an environmental concern and was approached by targeting individual households with privately owned biogas systems.

The Nepal project took off well because it acknowledged the community-based nature of the sanitation problem at hand. It benefited from strong village leadership and concerted efforts to convince

Biogas in Nepal

A biogas unit was installed in Pathare village adjacent to the Bhutanese refugee camp of Sanischare in 1997. The project was not in fact a refugee project, but was intended to improve the hygiene and energy situation of local people in a community that had been heavily affected by the presence of over 18,000 refugees less than 1km away.

Pathare village was notable for its poor sanitation situation arising from the dumping of vegetable waste during market days, uncontrolled human defecation around the marketplace and village in general and some 3,000 free-ranging pigs that exacerbated the situation of poor hygiene around homes and along the adjacent stream – which also served as the village's only water source and open washing area.

It was proposed by the local UNHCR office that a community latrine-cum-biodigester should be set up. Bio-latrine technology enables material which would otherwise be wasted to serve several useful functions. The Pathare project was to provide much-needed toilet facilities for the village, produce gas for cooking and lighting, supply pathogen-free fertilizer for local farmers, and act as an entry point for community health and environmental programmes.

It was clear that the project could not be seen as a straightforward technological intervention. It was intended to address multiple problems in the community related as much to poor sanitation as energy shortage, and therefore demanded the active participation of community members – namely their use of the bio-latrines and of the gas and fertilizer produced by the biodigester. The project therefore began with a community-oriented training programme that addressed the existing situation of poor hygiene and solid waste management and its implications for health. It then reviewed alternative ways to manage waste and prevent disease, highlighting the importance of community involvement and the role to be played by all villagers. Appreciating the importance of such social as much as technological issues, the training programme involved community health workers, waste management experts and socio-economists, as well as energy specialists from the project's implementing agency. The result was that the biogas initiative became part of a larger effort to promote waste recycling, environmental care and improvement of sanitary conditions, with energy supply becoming a less significant goal.

The biogas system itself comprised 10 latrines and 3 urinals which fed into a 15m^3 underground biodigester. Related structures included compost pits for the mixing of biodigester sludge with household waste, a guard house, a water storage and supply system, and two observation wells to monitor any effects on groundwater.

The community-based approach was justified as the bio-latrines were well used by both the Pathare villagers and those attending the market. In fact the system had been designed for 400 users per day but was soon overwhelmed by more than double this figure. This led to an overflow of the biodigester into the compost pits and much shorter retention times than required, with incomplete digestion, low biogas production and overflow of potentially dangerous sludge. Though at face value this represented a partial failure of the biogas technology, it was in fact a sign of the project's value and popularity.

The project did not however supply either fertilizer or cooking gas as originally envisaged. This was due partly to the excessive use of the biolatrine, which over-burdened the system and resulted in lower than expected outputs, as well as a taboo against using biogas for cooking and disagreements within the community about who should be chosen to benefit from the gas supply.

Biogas in Afghanistan

As part of a larger environmental management programme with returnees from Pakistan, UNHCR supported the installation of biogas units in eastern Afghanistan between 1999 and 2001. In contrast with the Nepalese example, where the initiative was prompted by a public health problem, the principle motivation in this case was environmental. Biogas was to provide a viable alternative to commercially harvested firewood as fuel for cooking and lighting, and hence relieve pressure on the montane forests of the lower Hindu Kush.

During the first year of the project 110 people were trained in the construction and use of brick and cement biogas units in Nangahar and Laghman Provinces. Some 45 households (with 417 members) were provided with subsidised biogas systems, for which each contributed around 30% of the total value. Having been well received, the project was extended in its second year to a further 60 households in Jalalabad and Laghman provinces, as well as ten in Kabul Province as an experiment to see how the units would perform in the markedly colder weather conditions experienced in that part of the country. Again, families were asked to pay the equivalent of about US$160 out of a total cost of US$485 per unit.

A firewood saving of 2.5 tonnes per household per annum was claimed by the project implementors for those adopting the new biogas systems for cooking, implying a total saving of over 250 tonnes across all beneficiaries. The project was not subjected to an external review, but from implementation reports it seems that the unfamiliar energy technology was well accepted and widely taken up. One of the reasons for the apparent success may have been the project's household-focussed approach. Each unit was the clear property of a specific family and that family made a financial contribution towards its installation. This made ownership – and hence management responsibility – well defined. It was clear who had the obligation to feed and maintain each unit, and equally clear who had the rights to use the gas produced.

community members of the need to get involved and make use of the bio-latrine facility. In fact it was ultimately too well-supported and exceeded the design specification of the biodigester. Although the project did not produce sufficiently large amounts of either gas or fertilizer to benefit more than a small number of people, it was nevertheless of benefit in addressing the identified sanitation problem.

Though different in approach, the Afghan project also succeeded in meeting its goals, instilling a sense of ownership from the outset through its family-focussed approach and cost-sharing mechanism, and ensuring that user rights and responsibilities were well defined.

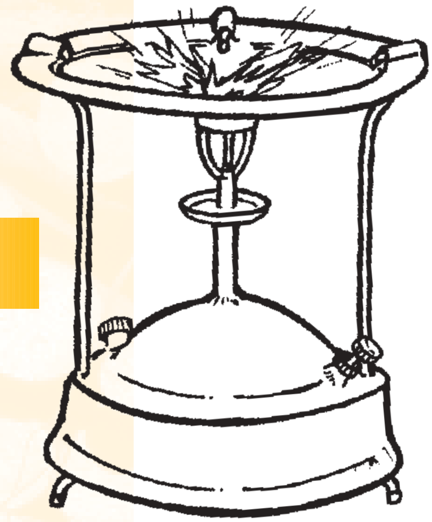
Judging by these two contrasting experiences, it seems that biogas offers a way to address a situation of poor sanitation or environmental degradation as well as producing fertilizer and high quality fuel for cooking and lighting. But it is also apparent that the technology of biogas production is not in itself likely to be the stumbling block of a biogas project. The crucial issues are more closely related to correctly defining the problem, carefully identifying the beneficiary group, and ensuring that the right mechanisms are put in place to ensure proper management and clear definition of rights and responsibilities whether the systems themselves be communally or individually owned.

Communal bio-latrine projects depend by definition upon multiple users. They will work only where a strong community structure exists with a sense of cohesion and self-betterment, in which the majority are willing to provide for the welfare of a minority (at least in terms of cooking fuel supply). Meanwhile household-based systems are likely to work where a reasonable level of wealth exists to build and maintain the units, and where inputs such as water and animal dung are available at the level of individual homes.

4.6 Kerosene

Kerosene is a high quality cooking fuel with an energy value of 44MJ/kg, placing it at the upper end of the 'energy ladder'. Most refugees using firewood or charcoal would willingly make a switch to kerosene if they had the resources to do so as it is easy to use, flexible and has a higher social status. In most cases,

Kerosene stoves use either cloth wicks or a presurrised pump system.



Kerosene Supply in Nepal

Kerosene has been distributed to 90,000 Bhutanese refugees in seven camps in south-eastern Nepal since 1992.

The kerosene initiative was prompted by complaints from local people and the government about damage being done to forests by refugees harvesting firewood. This was as much a social and political issue as it was environmental, given that subsequent studies identified minimal forest damage linked to refugees. But it was nonetheless a contentious matter and one leading to conflict.

Kerosene was selected as the most appropriate alternative to firewood, being of high quality and hence readily acceptable to the refugees. Before the project got underway an NGO set about working with refugee women's groups to select appropriate kerosene stoves . Partly as a result of the positive involvement of women at this early stage, the use of kerosene was subsequently accepted swiftly, in spite of its unfamiliarity.

The level of kerosene supply was initially set at 0.5 litres per person per week, later increased to one litre for families of up to three persons and 0.5 extra litres for each additional family member. This was found to cover about 80% of demand, with the shortfall met by local firewood collection. By 1998, UNHCR was supplying around 3.5 million litres of kerosene per year at a cost of US$600,000, and around 10,000 replacement stoves annually at a further cost of US$40,000. Each family was given a new stove every two years and a repair centre was set up in one of the camps.

The refugees took a leading role in the receipt, storage and distribution of the kerosene from underground tanks in each camp. Their own groups managed the distribution operation in its entirety. Refugees also managed the repair of stoves and the distribution of new units. This decentralised approach was highly cost-effective from the relief agencies' point of view.

Kerosene is imported to Nepal and put on the market at a subsidised rate of about US$0.18 per litre. This is relatively cheap compared with, for example, most of Africa and many other countries in Asia. The incentive for local re-sale by the refugees that might be found elsewhere was therefore countered by the benefits and convenience of using kerosene for cooking and the saving in labour that would otherwise have been expended in procuring firewood.

Another factor contributing to the success of the supply programme was the strong support shown by local people and the host government. Rather than drawing negative comparisons between their own energy situation and that of the refugees being supplied with free kerosene, local people actively supported the project as a means by which to protect their natural resources. The full participation of refugees was also vital at all stages of project design and the establishment and maintenance of a kerosene and stove distribution system.

however, kerosene is not an affordable fuel option for refugees using their own resources. It is only likely to be accessible if it is distributed as part of an organised fuel supply programme.

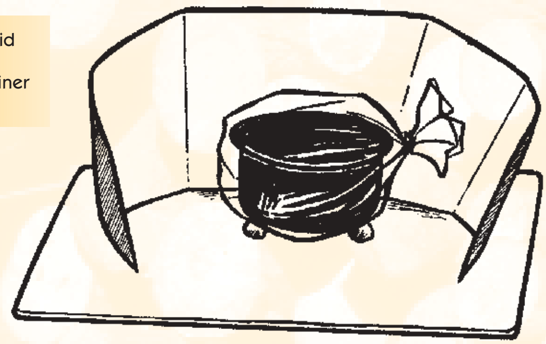
UNHCR has sporadic experience of promoting kerosene in refugee situations, the most well known contemporary example being in Nepal (see Case Study).

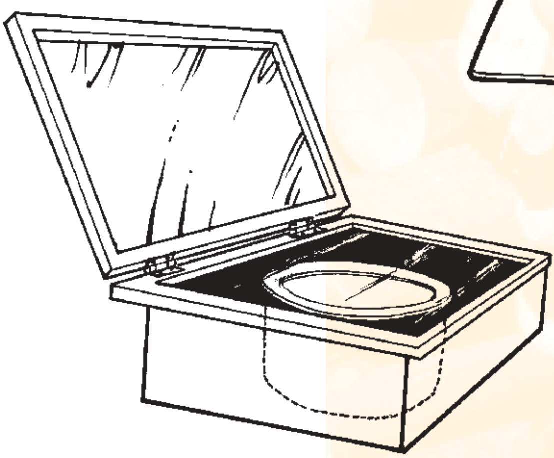
Kerosene is a high quality cooking fuel that most refugees would be happy to receive as an alternative to firewood or charcoal. From UNHCR's point of view, the supply of kerosene carries a number of risks that should be considered at the outset of any potential fuel supply programme. The principal risk is that the fuel will simply be sold by the refugees for cash as they continue to harvest local wood resources instead. This can be largely countered by a low price of kerosene in the host country, as it was in Nepal, though this is something beyond UNHCR's control. Another risk is the institutional commitment to multiple years of funding at a fairly high level. Kerosene stoves are highly efficient and the fuel can be economically utilised, but the overall cost of a supply, storage and distribution programme is nevertheless likely to be considerable and will have to be sustained until such time as the refugees leave.

4.7 Solar Energy

The energy of the sun can be captured in two principle ways. The first is through photovoltaic cells for the generation of electricity. This is a well developed technology but is not suitable for cooking due to its extremely high cost. At around US$10 per installed watt of power, it could cost up to US$10,000 to power a single electric hotplate of 1 kilowatt. The second use of solar energy is for direct application in cooking. For this a solar cooker is required.

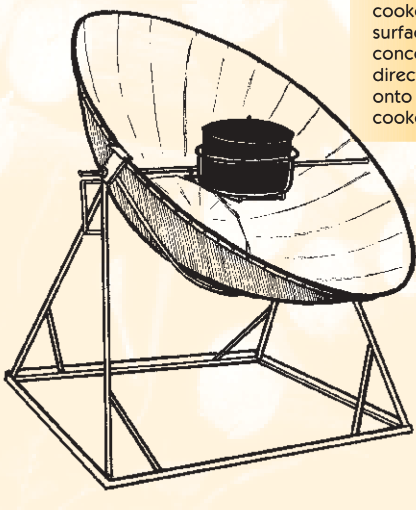
Panel-type cookers are a hybrid type that use both curved reflector and a cooking container into which the food is placed.





Box type solar cookers use plane reflectors to reflect radiation through a glass or plastic window into an insulated cooking container.

Curved reflector solar cookers use reflective surfaces to collect, concentrate and direct the sun's rays onto the food being cooked.



A solar cooker is a device that changes the light energy of the sun to heat energy to cook food. There are three main types of solar cooker:

- ***Curved reflector type:*** A solar cooker that uses reflective surfaces to collect, concentrate and direct the sun's rays onto the food being cooked.

- ***Box-type (or oven-type):*** A solar cooker that uses plane reflectors (such as mirrors) to reflect radiation through a glass or plastic window into an insulated cooking container. The container normally has reflective sides and a black metal base.

- ***Panel-type:*** A hybrid of reflector and box-type solar cookers, using both a curved reflector and a cooking container into which the food is placed. This combines the reflective properties of a curved surface with the heat retaining properties of a container.

Solar cookers were intensively promoted during the 1990s in refugee programmes in Pakistan, Ethiopia and Kenya. In Pakistan a wooden box-type cooker was introduced with a glass lid, costing around US$50 per unit. In Ethiopia a panel-type cooker known as the *CooKit* was piloted, made of reflective cardboard with a plastic bag to contain the food and pot and costing US$7.50. In Kenya both types of cooker were introduced.

While all new cooking technologies are bound to encounter a number of drawbacks if they are to be promoted in a refugee situation, those associated with solar cooking have proven particularly significant given that cooking with the sun is so culturally alien to communities used to cooking with combustible fuels. The drawbacks encountered in the refugee pilot programmes have included the following:

- ***Low cooker durability:*** Durable solar cookers are expensive and the components are likely to be sold, while cheaper models such as the *CooKit* rarely last for more than a few months, and the plastic bags often less;

- ***Major changes required in cooking practices:*** Assuming the solar conditions are appropriate, solar cooking is an unfamiliar technology that demands significant changes in cooking practices:
  - *cooking must take place when the sun is shining;*
  - *checking the food during cooking results in considerable heat loss;*
  - *food must be prepared well in advance of when it is needed; and*
  - *all cooking must be done outside, while tradition may dictate that cooking is done in the hut or in a kitchen shelter.*

- ***Slow speed of cooking:*** Cooking with the sun is slower than traditional systems and is severely impaired when conditions are windy, hazy, dusty or cloudy, meaning that cooking may need to be finished over a fire;

- ***Inability to cook certain foods:*** Solar cookers cannot cook foods that require grilling, deep frying or regular turning (including staple unleavened breads like *injera* or *chapati*), which means that they become supplementary devices at best and the consumption of traditional fuels is hardly reduced;

- ***Fear of change:*** Refugees may be reluctant to place limited food rations in a sealed container for cooking unless they are very confident in its use, so a comprehensive awareness and training programme is a pre-requisite and may need to run for many years.

All three countries where solar cooking was attempted have high levels of solar insolation and extreme shortages of woodfuels. In some cases refugees also face threats to their personal security when out gathering firewood. So the conditions for solar cooker uptake would seem to have been ideal. Yet in all cases the solar programmes did not get beyond the pilot stage, continuing to depend on agency support, equipment subsidy, and continuous training and re-training.

Solar cooking makes apparent logical sense. The concept of using a free and unlimited energy source to prepare food in a situation where traditional energy sources are in short supply seems to have clear social, economic and environmental benefits. However, the reality of using solar cooking devices has proven less attractive. The changes required to traditional cooking practices are so significant that few refugees have been willing to adopt solar technology, even as a supplementary cooking system. It has therefore not delivered the expected labour savings, energy savings or environmental benefits.

4.8 Summary

In a refugee situation, the default energy source is typically firewood, perhaps supplemented by charcoal. A number of alternatives have been considered in this section and some experiences have been presented based on their trial, testing and endurance in refugee situations.

In reaching a conclusion on the appropriateness of any one of these alternatives it may be useful to conceptualise the idea of the 'energy ladder'. The energy ladder is a practical ranking of energy sources based on their relative sophistication and modernity. Fuels higher up the ladder are generally more convenient but, at the same time, are more costly.

Fuels that are generally placed *above* firewood in the energy ladder include charcoaled briquettes and kerosene. Rarely will refugees object to such fuels or encounter significant cultural obstacles to their adoption. This is because they tend to have a higher energy content than wood and are more convenient and efficient to use. The question of a switch to one of these alternative fuels becomes an issue of cost and sustainability, as any cultural or social constraints are generally outweighed by the improvements in energy output or convenience that can be achieved. Hence, in this Handbook the experiences with briquettes in Bangladesh and Thailand and with kerosene in Nepal have led to the conclusion that such fuels are likely to be practically feasible and culturally appropriate in almost all locations, though may encounter problems of high recurring costs and the potential for re-sale of the fuel onto local markets if sufficiently highly valued.

Energy sources discussed in the Handbook that are generally considered to fall below firewood in the energy ladder include grass, peat and loose wastes and residues. All tend to imply either a greater labour burden for the user, lower cooking efficiency or more

Energy Ladder of Combustible Fuels

Increasing Energy Content

Liquid Propane Gas
Biogas
Kerosene
Charcoaled Briquettes
Charcoal
Charred Briquettes
Dry Firewood
Densified Briquettes
Dry Peat
Grass
Loose Wastes and Residues
Cow Dung

Increasing Convenience and Cost to End User

Note: Solar Energy is omitted because it is not a combustible fuel and cannot be readily assigned an energy content.

Refer to Annex B for a summary of energy values for each of the other fuels.

The diagram is generalised and will not always apply. Costs may not always rise progressively, for example, some briquettes cost more per unit of energy than fuels ranked above them in the energy ladder.

gy ladder is a means by
rative merits of different
end-user convenience,
d to all energy sources and
o account the total cost of
s notwithstanding, any
fuels other than firewood
target only fuels that are
r. This normally implies
erosene, given the right
l economic situation that
aints to adoption of other
be significant, the costs of
ery high, and the switch
financial and social terms.

5

Energy Supply — *The 'When' and 'How' of External Fuel Provision*

5.1 Overview

It is not always reasonable to allow refugees and returnees to source their own cooking fuel. There are situations under which the host government, UNHCR or another support agency may feel it appropriate to provide fuel to a population in an organised manner from an external source. The most common scenario is that of a host government becoming concerned about damage done to forests or woodlands by refugees collecting firewood and then asking UNHCR to provide fuel from outside the immediate area. But there are other scenarios which can lead to a similar request being made, some of which are highlighted below.

For the field manager involved in a refugee assistance programme, the challenge is to balance environmental and other concerns that are raised by the refugees, local people or host government – many of them legitimate and persuasive – with the potentially high costs and uncertain impacts of a fuel supply programme. Fuel supply is not something to enter into lightly and without due consideration of the financial implications and the real prospects for achieving the expected outcomes, be they environmental or otherwise. This section attempts to offer advice on the kinds of situations where fuel supply may be justified ('When to Supply Fuel') and the ways in which it may be implemented to minimise costs and maximise impact and sustainability ('How to Supply Fuel').

5.2 When to Supply Fuel

It is not uncommon for UNHCR and its partners to receive requests for fuel to be supplied to refugees. The task of operational staff is to determine when these requests are justified, affordable and made in good faith.

The following are examples of scenarios under which fuel supply may be considered necessary:

- ***Lack of available fuel.*** There may be a total lack of fuel resources in an area where refugees or returnees are settled. Alternatively – perhaps in an extremely arid situation – such resources may have been so severely depleted by over-harvesting that refugees are forced to spend an unacceptable amount of time and labour to secure sufficient energy to simply cook their basic rations. Under such circumstances the welfare of the refugees may be directly threatened and it could be appropriate to meet part of their fuel needs by external supply, perhaps providing fuel in a targeted manner to certain groups in particular need.

- ***Security risk linked to fuel collection.*** It may be dangerous for refugees to venture out of their camps or settlements. The danger may originate from widespread armed conflict and banditry, or there may be direct targeting of certain groups within the refugee population such as women or refugees of particular ethnicity. With UNHCR's protection mandate it may be considered appropriate to supply fuel to the refugees to obviate the need for them to go out in search of their own fuel. The crucial question in these situations is to what extent the insecurity experienced by firewood collectors is directly related to firewood collection itself, as opposed to more pervasive security risks which will persist whether or not they have to leave the camps or settlements. Fuel supply is not the easy solution to security problems that have more deep-rooted causes.

- ***Governmental pressure.*** It is not untypical for host governments to raise concerns about the damage being done to the environment by refugees as they harvest fuel, especially firewood. Such concerns may be serious and genuine, especially where large refugee populations are placed in close proximity to particularly valuable or ecologically sensitive areas. In other cases there could be a certain amount of political pressure that is not well supported by ecological evidence, and UNHCR and its partners must respond to such pressure with scientifically sound data if they feel it to be exaggerated. Governments may also raise concerns that fuel harvesting forays outside camps and settlements are posing a security risk. In both types of cases the institution of asylum may be under threat, and it may be reasonable to consider supplying fuel to the refugees either to reduce environmental-related political pressure or combat a refugee-related security threat.

- ***Threat to the environment.*** Refugees may be causing direct and irreversible damage to the host environment through fuel harvesting. This may not result in the lodging of formal complaints by either local people or the host government, but UNHCR and its partners nevertheless have institutional obligations to be environmentally sound in their refugee assistance programmes. In UNHCR's case this obligation is formalised in an executive committee resolution and is enshrined as an organisational policy priority. Therefore if a direct link is demonstrated between refugees' fuel harvesting and cases of serious damage to the local environment, particularly where it affects sensitive areas such as wetlands, water catchments, hunting reserves or national parks, then it may be appropriate to look into fuel supply as one of a number of mitigation options. This should be alongside, for example, better law enforcement, reafforestation schemes and energy conservation programmes.

It is advisable to take a conservative approach when assessing the merits of organised refugee fuel supply, erring if in doubt on the side of caution. Once a fuel supply programme is initiated it can be extremely hard to down-size it at a future date, let alone curtail it altogether. Refugees will object to the withdrawal of support, the host government may complain that their concerns are being neglected, and entrepreneurs involved in commercial fuel supply are likely to apply pressure by whatever means they have at their disposal to ensure that funding for fuel supply is sustained. For these and other reasons, the introduction of a fuel supply programme should be confined, where possible, to the types of situations outlined above, and introduced initially at a modest and experimental level with proper monitoring of impacts against objectives, before being scaled up to the refugee population at large.

5.3 How to Supply Fuel

Organised fuel supply can never be a truly sustainable operation because it depends on substantial and prolonged donor support. But it can be made more efficient and cost-effective if the following guidelines are followed:

- ***The selected fuel should be culturally acceptable and easy to use.*** The fuel should be at least as high in the energy ladder as the fuel the refugees are already using. Supplying firewood, charcoaled briquettes or kerosene is therefore likely to be acceptable to refugees currently using firewood, whereas supplying standard densified briquettes is likely to encounter resistance. Similarly, urban refugees previously used to kerosene or bottled gas are unlikely to adapt easily to using firewood or other solid fuels that they may consider inferior.

- ***The selected fuel should be unattractive for re-sale.*** Any distributed fuel is obviously intended for the use of the refugee beneficiaries, not re-sale onto local markets for cash. Otherwise the environmental, social or political objectives of the supply programme will never be met. The main way to limit re-sale is to ensure, before distribution begins, that the local market value of the selected fuel is sufficiently low to ensure that most refugees opt to use it themselves.

- ***Fuel distribution should be targeted.*** It is not cost-effective to supply fuel in equal quantities to all refugees when the reasons for initiating the supply tend to be specific to certain target groups. If, for example, single mothers are identified as a group particularly at risk from firewood-related harassment while outside the camps, this group could be considered in a targeted supply effort. Meanwhile richer refugees may be supporting a healthy firewood trade and need not be given free fuel, especially as this would undermine a productive area of enterprise.

➤ ***Fuel should not, in principle, be given freely.*** It is important that natural resources should have value, and be seen to have value. The bulk provision of free fuel undermines that notion and makes it hard to promote concepts of economy and conservation. Where feasible, it is desirable for refugees to make some form of contribution in exchange for distributed energy. In some refugee programmes this has been in the form of tree planting and various types of community work, whether environment-related or otherwise.

➤ ***Refugees should distribute the fuel themselves.*** There are a number of reasons why refugees should manage the distribution of fuel themselves. A key factor from the donor point of view is cost-effectiveness, as it is bound to be cheaper for refugees to handle and distribute the fuel once it arrives at a camp or settlement than for salaried workers from an NGO to do the same job. Refugee-managed fuel distribution will also develop organisational skills among those involved, create a sense of responsibility for self-support, and perhaps minimise any accusations of bias that might arise if an agency distributed the fuel directly.

➤ ***Impacts of fuel supply should be closely monitored.*** Assuming that fuel supply has been entered into carefully and with specific goals in mind, it should be possible (and is indeed essential) to monitor whether it is proving effective in achieving these goals. Whether the original intentions were related to welfare, protection, politics or the environment, it will be important to determine whether or not progress is being made in improving the situation, and assess to what degree such progress can be attributed to the energy supply programme.

Annex A

Cooking Energy Checklist

A checklist is a simple way to guide decision-making and make sure that no obvious intervention option has been overlooked. The following checklist is intended to provide guidance for assessing cooking fuel options in a refugee situation and making decisions about the most appropriate form of energy, type of stove and cooking practice, and the appropriateness, or otherwise, of organised fuel supply. The checklist is not expected to be exhaustive, but covers the energy sources and situations most commonly encountered in refugee and returnee situations.

Topic	Action	Appropriate Questions
Emergency Phase Considerations	Promote clustered site plans to facilitate multi-household cooking	Are there any cultural reasons why clustered living is not possible, or should be introduced in a modified form?
	Distribute 8-10 litre cooking pots with lids to facilitate multi-household cooking	
	Ensure sufficient clothing & blankets to reduce the need for fires at night	
	Introduce signboards & other measures to highlight environmental restrictions	Is there a competent environmental agency in place to introduce emergency environmental measures?
Cooking Fuel Choice	Identify which cooking fuels the refugees were using back home & determine the justification for any switch	Is there any significant reason why they should not continue using their usual fuels in the current situation?
		If there is an *environmental* reason to switch fuels, can the environmental problem be tackled in other ways? (An example might include supporting law enforcement through protected area demarcation, training & capacity-building; managing fuel harvesting in specific areas at specific times; awareness-raising & education; fuel efficiency campaigns.)
		If there is an *economic* reason to switch fuels, can the cost of traditional fuel be reduced so that it remains affordable, e.g. by fuel subsidy or external supply?
		If there is a *political* reason to switch fuels, is there room for a negotiated settlement that might allow traditional fuel sources to be maintained, e.g. presentation of convincing data; conditional access to certain areas for fuel harvesting, in conjunction with controls elsewhere; capacity-building of host government institutions?

Topic	Action	Appropriate Questions
Energy Utilisation	Determine energy consumption habits & implications	Have energy consumption patterns been assessed? (Survey work to determine fuel consumption & cooking habits of households, institutions, small businesses & agencies, including total fuel used, fuel collection patterns, source areas, & stoves & cooking practices employed.)
		Has the environmental impact of energy demand been assessed? (Survey work to determine areas used for fuel harvesting, annual growth of wood in the area, and/or economic value of resources being affected.)
Potential Interventions	Identify need for interventions & ensure a diverse strategy	Are interventions required to save fuel? (Interventions may not be cost-effective if energy is abundant & refugee populations are low.)
		If interventions are required, can a diversified strategy be put in place to conserve energy? This might involve improved stoves & energy-saving practises; promoting fresh food & better food preparation; management of fuel harvesting/procurement; commoditisation of fuel through taxation & regulation; education & awareness-raising; community energy & environment forums.
	Improved Stoves	Have refugee priorities been determined in terms of stove designs (e.g. fuel-saving, faster cooking, smoke removal, increased safety, better health & hygiene, higher social status)? Are there good reasons for them to switch from existing systems?
		What energy-saving stoves are to be tried? Have they been identified with close refugee collaboration? Are they familiar to the refugees or adaptable to existing practices? Have women been fully involved in their development & testing? Are they part of a broader energy conservation or environmental awareness effort? Does the local community use technologies which can be adapted to the refugee situation? Have these been exhausted before unfamiliar systems tested?
	Mud-stoves	Are suitable soils available? Is an anti-cracking agent available, such as ash, cow dung or straw? Are refugees willing to use stoves made of mud?
	Fabricated Stoves	Is there justification for establishing a programme of manufactured stoves, e.g. no soil for mud-stoves, demand exists for other stoves, income-generating possibilities? Can on-site manufacturing be established? Is there a training programme in stove manufacture? Have the designs been developed with full refugee involvement?
	Stove Dissemination	Have a variety of dissemination methods been designed? Are there any groups who will benefit from hardware donations? How will these groups be identified, & what will free distribution achieve? Can systems of commodity exchange be tried (e.g. stoves for work, stoves for trees, stoves for sale)?

Topic	Action	Appropriate Questions
	Energy-Saving Practices	What fuel-saving practices are to be tried? Can they be easily adopted without drastic changes to existing practices (at least not at first)? Are they realistic for the refugees given the limitations of their cooking utensils, food & fuel?
	Fuel Preparation	Is firewood cut & split? Is all biomass fuel dried before use?
	Fire Management	Are fires being shielded from draughts? Do the systems being used allow for proper control of air supply to the fire? Are foods being gently simmered rather than over-boiled? Are fires being put out promptly after cooking?
	Food Preparation	Are hard foods being pre-soaked? Has this practice been fully discussed & tried with refugees? Are hard foods being cut small before cooking? Are tenderisers being used for any dishes?
	Cooking Management	Are cooking shelters being used? Can anything be done to support their construction? Are the refugee pots durable, fitted with lids & receiving regular scraping to remove excessive soot build-up? Are 'double-cooking' methods being used to pre-heat food or water?
	Food Supply	Have all milling options been explored (e.g. industrial milling at break-of-bulk points, privately-run camp milling operations, household-level milling using concrete or stone units)? Is local food purchase coming up to target levels? Does the food basket include foods which have high energy demands which can be substituted? Does it include foods used for energy-wasting purposes, e.g. sorghum for brewing?
	Haybasket Cookers	Do they achieve meaningful fuel-savings with refugee food? Are they easy to use? Are suitable materials available, e.g. baskets or boxes, insulated with cloth, banana fibres, newspaper, wood shavings, etc? Will these devices stand alone beside other technologies in dissemination programmes? Can they be made on-site for income-generation?
	Multi-family Cooking	What incentives can be introduced for sharing cooking on the part of the refugees (e.g. common cooking shed if mud-stoves are built)? Can health education component stressing the dangers of disease transmission & means to avoid them be established?
Alternative Fuels	If a switch is justified, Identify the most appropriate alternative fuel(s)	If a fuel switch is unavoidable, can the switch be made up the 'energy ladder' rather than down, e.g. from charcoal to kerosene, or firewood to charcoal briquettes?
	Firewood/Charcoal	Do wood source areas exist that are renewable & can be cut & managed under some control? Have the costs & logistics of supply been fully considered? Do the refugees have access to suitable stoves? Can the fuel be dried & kept dry? In the case of charcoal, can efficient kiln technology be employed?

Topic	Action	Appropriate Questions
	Loose Wastes, Residues & Dung	Are there local point sources of supply of loose wastes or dung? Do sufficient supplies exist at all seasons? Is the cost of the residues likely to fluctuate? Do the residues have existing uses in local land-use systems? Is there proper ventilation in the refugee cooking set-up to allow use of such fuels? Will refugees burn animal dung? Can it make a significant contribution to fuel diversification? Will its use have detrimental effects on soil fertility?
	Densified Briquettes	Have the costs of machinery & manufacture been determined? Are there local point sources of raw material supply? Do sufficient supplies exist at all seasons? Is the value of the resource likely to fluctuate? Do the residues have existing uses in local land-use systems? How will the refugees get the necessary stoves?
	Charcoaled Briquettes	Have the costs of machinery & manufacture been determined for carbonising, binding & densifying? Are there local point sources of raw material supply? Do sufficient supplies exist at all seasons? Is the cost likely to fluctuate? Do the residues have existing uses in local land-use systems? How far will the fuel be transported & at what cost? What stoves are needed & how will refugees get them?
	Peat	Are there source areas available which are not already used? Is the peat properly decomposed (low ash, high energy)? Have extraction & drying systems been worked out? What are the environmental implications of extraction? Will the refugees accept the fuel? Will special training be needed in its use? How will smoke emissions be controlled?
	Biogas	Is there adequate water supply? Are average monthly temperatures above 15°C? What will the slurry be used for? How will it be allocated? What will be the feed materials? If human waste is to be used, what other feed materials will be added? Can they be supplied on a continual basis? Will refugees be willing to use bio-latrines? Where will the gas be used? Will the gas be acceptable as a cooking or lighting fuel? Are durable units available regionally with minimal maintenance demands?
	Kerosene	Are the refugees familiar with the fuel? Will they need training? What sort of stoves will be needed & how will they be disseminated? What measures are in place to restrict sale of the fuel & stoves? Can it be tried in any communal or institutional setting? Have the financial & logistical implications of importation, transport, storing & distribution been considered? What will be done to reduce the fire risk? How will the negative effects of the foreign exchange burden be balanced?
	Solar Energy	Are levels of exposure to the sun's rays high, consistent & predictable? Are other energy sources in short supply so as to encourage acceptance of new alternatives?

Topic	Action	Appropriate Questions
Organised Energy Supply	Identify need for organised energy supply, appropriate fuel & mode of implementation	Are there strong justifications for some form of organised energy supply, e.g. total lack of available energy in the area; insecurity directly linked to fuel procurement; insurmountable political pressure; irreversible damage to valuable environmental assets?
		If fuel supply goes ahead, are basic guidelines being adhered to, e.g. the selected fuel should be culturally acceptable, easy to use & unattractive for re-sale. Distribution should be targeted where it is needed most; fuel should not be given freely where possible; refugees should manage the distribution process; impacts should be closely monitored against objectives?
		Have the logistical requirements & costs been determined (e.g. for firewood: site selection, tree marking, harvesting, felling, cutting, stacking, loading, transport, drying & distributing)?
		Are complementary measures in place to control access to local natural resources for energy?

Annex B

Energy Value of Various Fuels

Fuel	*Heating Value (MJ/kg)*
Wet Firewood (60% moisture content)	**8**
Cow Dung	**10**
Tree Residues (twigs, leaves, etc.)	**13**
Agricultural Residues (straw, cotton stalks, etc.)	**13**
Air Dried Firewood (20% moisture content)	**15**
Densified Briquettes (wheat straw, rice husks, bagasse, etc.)	**16**
Oven Dried Firewood (10% moisture content)	**20**
Peat	**21**
Charcoal	**28**
Charcoaled Briquettes	**30**
Kerosene	**44**
Biogas	**45**
Liquid Propane Gas	**46**

Note: Heating Value = Energy Value = Calorific Content

Annex C

Further Reading

Mud-Stoves

Intermediate Technology Development Group. 1997. *Appropriate Mud Stoves in East Africa.* 1 TDG, Kenya.

Grass

UNHCR. 1998. *Evaluation of Energy-Saving Options for Refugees: Grass Burning Stove, Uganda.* UNHCR, Geneva.

UNHCR. 1998. *Evaluation of Energy-Saving Options for Refugees: Grass Burning Stove, Tanzania.* UNHCR, Geneva.

Peat

UNHCR. 1996. *Energy Consumption in Refugee-hosting Areas of Kagera Region, Tanzania.* UNHCR, Geneva.

UNHCR. 1998. *Environment Guidelines: Domestic Energy in Refugee Situations.* UNHCR, Geneva.

Biogas

UNHCR. 1998. *Environment Guidelines: Domestic Energy in Refugee Situations.* UNHCR, Geneva.

Kerosene

UNHCR. 1998. *Country Report for Kenya and Nepal.* UNHCR, Geneva.

Solar:

UNHCR. 1998. *Experience of UNHCR and its Partners with Solar Cookers in Refugee Camps.* UNHCR, Geneva.

UNHCR's environmental activities are designed to prevent, mitigate and, when necessary, rehabilitate the negative effects of refugee settlements on the environment so as to secure the welfare of refugees and local populations, and foster good relations with host governments who provide asylum to refugees.

Engineering and Environmental Services Section
UNHCR
94 rue de Montbrillant
CH-1202 Geneva
Switzerland
Tel: +41 22 739 8111
Fax: +41 22 739 7371
Website: www.unhcr.ch/environment

UNHCR
United Nations High Commissioner for Refugees
Haut Commissariat des Nations Unies pour les Réfugiés