

Cooking Fuel options Help guide

UNJLC Khartoum - Sudan

1. Summary

This document is a quick introduction to cooking fuels and technologies. All information's come from different documents gathered within UN documents and research on Internet.

This document has no other ambition than the one to help you decide which technologies to use. It does not give any solution but bring some information as well as a check list to ask you the right questions.

You can find the complete documentation from where I have taken information's to make this document at <http://www.unhcr.ch> and www.itdg.org

2. Light introduction to energy scale and efficiency rate

The source of energy is an important factor, directly link to the energy output.

One Kilogram's of charcoal is equivalent to 2 kilogram's of dried wood and 4 kilogram's of wet/freshly cut wood. One Kilogram of Kerosene is equivalent to over 5 Kgs of wet wood, 3 Kgs of dried wood and 1,5 Kgs of charcoal

Energy Value of Various Fuels	
Description:	Heating Value Fuel (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
<i>Note: Heating Value = Energy Value = Calorific Content</i>	

Data from Page 45 [UNHCR Cooking options in refugee situation](#)

It is so very important to choose a good type source of energy, to increase fuel efficiency and to reduce logistics costs (Loading/Unloading, transport, storage and distribution).

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Efficiency rate of the stove is also important. The typical open wood fire (3 stones with 4 pieces of wood in the middle use) use only 15% of the fuel to cook, 85% goes in smoke, heat radiation basically to the atmosphere.

A simple mud stove increase the efficiency rate by 20% (35% of the fuel is used to cook).

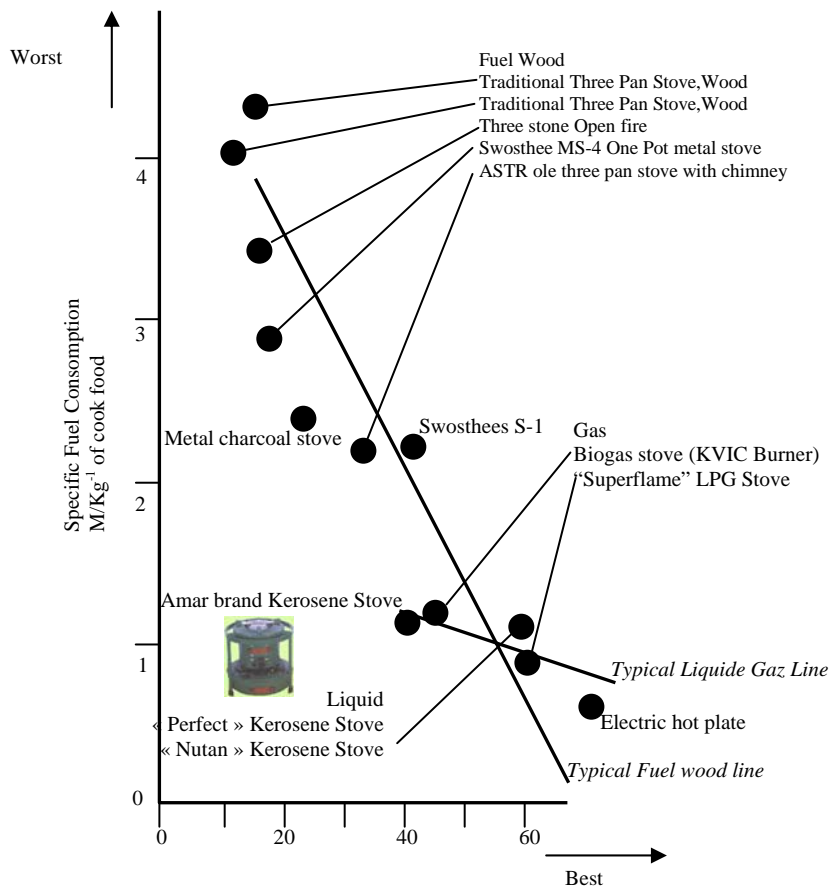


Fig 6 from <http://cookstove.grency.info/others/fuel-economy.html>

Availability of fuel source will depend on the location. South Darfur may have a better source for fire wood and charcoal due to higher density forest. More questions and support can be found in the 3.Assessment/Checking list. Section

Local habits is also an important factor. Is communal kitchen acceptable?. Does the population knows how to use a kerosene stove?. Is it possible to train these communities?. More questions and support can be found in the 3. Assessment/Checking list. Section

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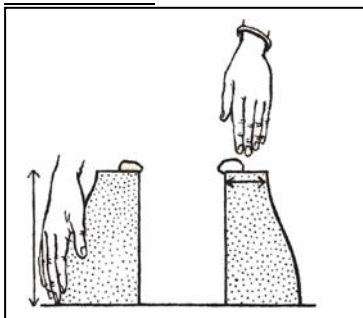
3. Assessment/Checking list.

Choosing the best adapted/cost effective/possible solution is not an easy task.

UNHCR in their publication [Cooking options in refugee situation](#) (PDF format) have produced a good checklist to help organisations to analyse the situation and take of course the right decision. See annexe A

4. Some of the Cooking stove efficient options:

Mud Stove:



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.

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.

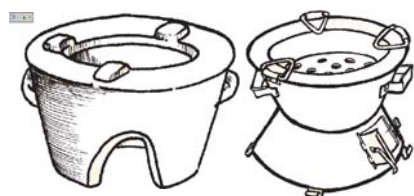
The 'jiko sanifu' (improved stove) of Mwanza in Tanzania is often built using 1 part sand: 2 parts clay while the 'Kilakala' stove from Morogoro uses 3 parts clayey soil: 1 part pounded grass and a small amount of cow dung and ash.

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.

Fired Clay Stove and Combination Clay/Metal Stoves:



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

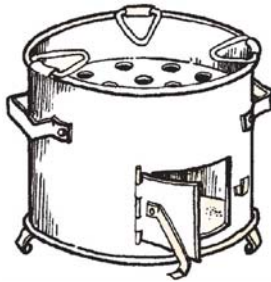
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and considerably more durable. Well known ceramic stoves include the East African Maendeleo or Upesi.

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.

Metal Stove:



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.

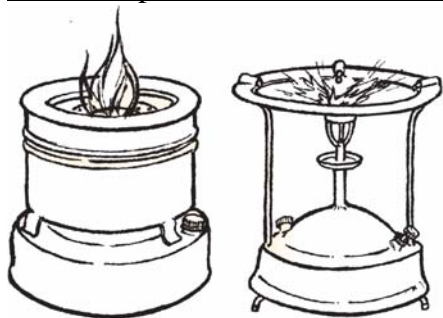
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Advantages and Disadvantages of commonly – used Stoves

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

Wick and pressure Kerosene stove: (source http://www.itdg.org/html/technical_enquiries/docs/kerosene_lpg.pdf)



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.

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In most cases, 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.

The wick stove

Wick stoves can have one or more wicks. Improved kerosene wick stoves can have up to 30 or 40 wicks and produce a maximum power of around 5kW with an efficiency of up to 50%. A common design incorporates a series of wicks, usually made of loosely twisted or woven cotton, placed in a holder such that they can be moved up and down by a control lever or knob. They emerge into an annular space surrounded by two concentric perforated steel walls (the flame holder) which are spaced slightly wider than the wick thickness. The lower part of the wick sits in a kerosene reservoir. The whole unit is situated inside a suitably designed potholder and casing which will have legs to allow the stove to sit easily on an uneven floor. The stove is lit by removing the perforated steel flame holder, raising the wicks and lighting them. The holder is then replaced. The flames fill the gap between the two walls of the holder and emerge at the top of the stove. The flame can be raised or lowered by operating the lever; when raised the flame burns more intensely and vice versa. The flame will normally burn a blue colour but if raised too high the flame will become yellow and soot will be given off. After normal operation for some time, the flame holder will glow red-hot.

The kerosene pressure stove

The standard kerosene pressure stove comprises a fuel tank (which can be pressurised by means of a hand-operated plunger pump), a vapour burner and a pot holder (see Figure 3). Vaporised kerosene fuel is passed under pressure through a nozzle and mixes with primary air to form a strong blue flame. To initiate the process the vaporiser has to be preheated using an alcohol based flame which burns for several minutes in a tray placed below the vaporiser. Once the temperature of the vaporiser is raised sufficiently the kerosene can then be vaporised by the heat of the cooking flame and the alcohol flame can be allowed to extinguish. The pressure forces kerosene through the vaporiser continuously and is controlled by the adjustment valve or by regulating the pressure of the tank, which in turn controls the flame intensity. Again there are various designs based on the same operating principle, some with more than one vaporiser fitted to provide multiple cooking rings. Another means of pressurising the kerosene is to use a header tank. This does away with the need for a pressurised tank but also makes the stove more cumbersome. Typical maximum power output is in the range of 3 - 10 kW.

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Whether considering a pressure or wick stove certain requirements should be fulfilled for the stove to be considered suitable in a given situation. Below are some guidelines:

Usage and performance

- May be either a wick or pressure stove.
- Suitable for the type of pots commonly found in the region - this usually means that a variety of pot of various shapes and sizes can be accommodated on the stove. The pot should stand firmly on the stove even when being stirred vigorously.
- Should be easy to ignite and preferably not require a separate starting fuel - it should also be easy to light in a wind.
- Maximum power sufficient for cooking meals in pots of the largest common size.
- Low specific energy consumption at high power.
- Low fuel consumption when simmering.
- Easy power regulation - suitable turn-down ratio.
- No unintended flame extinguishing at low power, even in wind.
- No very hot outer parts.
- Easy placing and removal of pots without getting burnt.
- Good quality combustion - no smoke, smell or emissions.
- Low fuel indicator.
- Easy filling of fuel - even when hot.
- Stable on a variety of surfaces.
- Simple instruction for use.
- No danger of fires or spillage even if mishandled.
- Durable - life span of several years

Maintenance and Servicing

- Simple maintenance and cleaning.
- Should withstand boiling over of food.
- Free moving, reliable, mechanical moving parts.
- Tolerant of sand, dust, etc. in the fuel.
- Tolerant of moderate mishandling and being left unused for a long time.
- Repairable by owner - simple wearing parts at least e.g. wick.
- Simple spares, easily available and fitted at local retailer.
- Designed to use standard items and spares e.g. wicks, seals, etc.
- No complicated tools or training required for maintenance.
- Exchangeability of parts between different models.
- Not possible to reassemble wrongly.

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Annex A : Cooking Energy Checklist

Source : [Cooking options in refugee situation](#) UNHCR Publication

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

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	<p>Is there any significant reason why they should not continue using their usual fuels in the current situation?</p> <p>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.)</p> <p>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?</p> <p>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?</p>
Energy Utilisation	Determine energy consumption habits & implications	<p>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.)</p> <p>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.)</p>

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Topic	Action	Appropriate Questions
Potential Interventions	Identify need for interventions & ensure a diverse strategy	<p>Are interventions required to save fuel? (Interventions may not be cost-effective if energy is abundant & refugee populations are low.)</p> <p>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.</p>
	Improved Stoves	<p>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?</p> <p>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?</p>
	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)?
	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?

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Topic	Action	Appropriate Questions
	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 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?
	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?

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Topic	Action	Appropriate Questions
	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?
	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	Solar Energy 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? 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?
Organised supply	Energy Identify need for organised energy supply, Supply appropriate fuel & mode of implementation	<p>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?</p> <p>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?</p> <p>Have the logistical requirements & costs been determined (e.g. for firewood: site selection, tree marking, harvesting, felling, cutting, stacking, loading, transport, drying & distributing)?</p> <p>Are complementary measures in place to control access to local natural resources for energy?</p>