Advice on the Charcoal Briquette Stove in the Khumbu Region, Nepal

Field Visit – October 2002

Report by: Sjoerd Nienhuys, Senior Renewable Energy Advisor, SNV, Nepal
Willem Boers, Research Advisor, SNV/BSP, Nepal

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Note:
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Copies of the report can be obtained from the SNV office in Nepal.

The Director of SNV/Nepal
P.O. Box 1966, Kathmandu, Nepal
Tel: 00977-1-523444 and 523445
Fax: 00977-1-528516 and 523155
E-mail: snv@snv.org.np

Or from the Director of the Biogas Support Programme (BSP), same address.
E-mail: snvbsp@snv.org.np

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1. INTRODUCTION

1.1 OBJECTIVE

The current report is related to a visit the team made to assess the performance of the two High Altitude Biogas Reactors (HABR) built in Lukla/Mosi (8,000 ft. = 2634m) and Khumjung (11,800 ft. = 3882m) and includes some observations about other sources of renewable energy (RE), such as cooking energy.

The observations in this advisory report are related to the potential use of biomass charcoal briquettes and improved briquette stoves at high altitudes in Nepal. With proper application of the available technology, biomass briquettes can be a means of providing a convenient source of energy for cooking and space heating, being complementary to the use of biogas.

The need for the improvement of the locally manufactured biomass charcoal briquettes has been identified by WWF. These charcoal briquettes are manufactured from agricultural residue and forest waste products. High firewood consumption for domestic cooking and heating purposes is depleting forest reserves because at the higher altitudes, where tree growth is slower, regeneration of firewood cannot meet the demands. The mission looked at some of the technical, social and financial implications of the produced briquettes and stove.

Mission Members

Willem	Boers	SNV/BSP	SNV/Biogas Support Programme Research Advisor, Mission Coordinator
Sjoerd	Nienhuys	SNV/N	Netherlands Development Organisation, Nepal Senior Renewable Energy Advisor, Architect
Rinji	Sherpa	BSP	Biogas Support Programme, Nepal Quality Management Associate
Rajendra	Gurung	WWF	World Wildlife Fund, Nepal Programme Coordinator Khumbu Region
Preveen	Mahato	Student	Centre for Energy Studies (CES) of the Institute of Engineering, Kathmandu
Ang Chokpa	Sherpa	SPCC	Sagarmatha Pollution Cleaning Centre Local Coordinator Lukla Region

Mission Period

The mission was conducted from 27 October to 2 November 2002 and included:

- Air transport from Kathmandu to Lukla and staff meetings in Lukla and Pandung.
- Preliminary investigations in Lukla, organization of a meeting with farmers.
- Trekking to Namche Bazaar and Khumjung village.

Consultations

In Kathmandu several consultations were held in relation to the charcoal briquettes:

- Mr. Kamal Rijal, Renewable Energy Specialist from ICIMOD, with whom we visited the ICIMOD Research and Demonstration Centre in Godavari.
  P.O. Box 3226, Kathmandu, Nepal. Tel: +977-1-525313 E-mail: krijal@icimod.org.np
- Mr. Lumin Shrestra, Director Centre for Rural Technology Nepal (CRT/N)
  P.O. Box 3628, Kathmandu, Nepal. E-mail: crt@wlink.com.np
- Dr. Krishna Raj Shrestha, Chairman Centre for Energy and Environment (CEE), who has conducted training programmes on briquette making and stove manufacturing.
  P.O. Box 1037, Kathmandu, Nepal. Tel: +977-1-242993 E-mail: cee@mail.com.np

1.2 BACKGROUND

The region of the Sagarmanta Natural Reserve has suffered severe deforestation in the last 20 years due to the increasing demand for:

- Firewood, to support the rise in population growth and tourist activities, and
- Timber, needed for the construction of housing and hotel accommodation.

As a measurement to reduce firewood collection for use in the tourist industry, travel organisations are now obliged to import kerosene into the region for heating fuel and to carry this kerosene to the mountain base-camps. Cutting of firewood has been recently prohibited (year 2002). The local population is allowed to use, to a very limited extent, deadwood (branches) for local firewood needs, collect forest waste products and cow dung.

Local Briquette Production

In Pandung, the Lukla women group has undertaken the production of the "beehive" biomass charcoal briquettes. The product has limited application and has had marginal economical success or impact. A five-day hands-on training was provided three years ago with the assistance of the Centre for Energy and Environment (CEE)[1], which had developed a Nepali training programme on the subject.

The "beehive" charcoal briquettes are made from charcoal produced from agricultural residues, such as rice husk and wheat chaff, and forest "waste" vegetation (fallen pine needles, pinecones, grassy weeds, Banmarachar[2] shrubs, lantana, etc.). In some cases dried cow-dung cakes have been added, but this is strongly discouraged as it is far more beneficial to use the cow dung for fertilizer purposes. Cow dung is preferably processed in a biogas reactor, which provides clean gas, whereas the slurry still contains the fertilizer that can be used for agriculture. This biomass material is first sun dried until it has a humidity below 15%. It is then heated in a 200-litre metal charring drum. The resulting charcoal is ground to dust and (in Pandung) mixed with 30% dry clay-soil (in volume). Water is then added to make a paste. Using a hand weight, the paste is compressed into a round mould, containing 19 pins. The compacting pressure may vary, but is probably not more 2-3 kg/cm^2. The 19 round pins create 10mm holes throughout the height of the charcoal briquette after de-moulding. These holes not only allow the briquette to dry evenly, but they also result in an even burning process by allowing flames and gasses to escape evenly from the briquette.

The briquettes are dried for at least three days in the open air and sun before being marketed. Marketing is targeted mainly to some hotel owners and individuals in the Lukla and Pandung region. The briquettes are generally used for additional fuel in the large hotel stoves and for space heating in small metal stoves.

In addition to the making of the charcoal briquettes, a sheet metal stove is marketed, which holds one briquette and provides easy transportation of the fire/heat source. (See photo on cover of a locally made stove with a "beehive" briquette.)

Photo: Banmara weed

[1] See attached leaflet in English, a Nepali version is also available.

[2] Banmara weed or Eupatorium adenophorum, an undesired forest weed.

1.3 MANUFACTURING PROCESS

The Charring Drum

The charring drum is a 200-litre drum of 3mm sheet metal with a gutter for a water seal along the upper rim. Inside the drum a perforated cone is placed with a chimney. The cover gives water seal and has an additional chimney extension. The drum and drum components are tarred as rust protection and the drum alone weighs about 50 kg. The current design can be transported by one person and has a life span of more than three years with continuous use. The complete charring drum set costs about NPR 12-15,000 in Kathmandu[3]. Smaller (lighter) drums have been tested, but these do not give a practical output.

The compact filling of the 200-litre drum with dried biomass material and subsequent firing requires about two hours, whereas the cooling down of the drum (one batch) would also require about two hours. Total one day production would therefore be of two full cycles and would produce two batches of less than 200 litres of charcoal.

According information from ICIMOD, a fixed-dome construction made from stone is commonly used in India for making charcoal from woody biomass. The making of charcoal from the fine forest waste products, however, does not seem to give a good result and is therefore, without additional research, not yet recommended by the CEE.

The Grinder

The charcoal that is produced in the drum needs to be ground to small particles for filling the mould. This can be done by using grinding stones or by a special grinder. The grinding stones follow the same principle as for the grinding of flour and produces a very fine dust. To reduce this awkward and very dusty work, the CEE has developed a grinder that reduces the dust generation and produces particles which are less fine. The grinder costs about NPR 10,000.

The Mould

The hand mould consists of three parts and is manufactured by local blacksmiths from thick steel plate and smooth iron concrete reinforcement bars (10mm). The 19 holes in the footplate are 12mm or ½ inch to allow easy lifting of the briquette out of the mould. The mould costs about NPR 5,000.

Hand moulding requires a small metal weight to tap the mixture into the mould. This, however, does not produce a high briquette density. Estimated moulding pressure may be even less than 2 kg/cm^2. With hand moulding one person can make about 30 briquettes per hour, provided the charcoal-clay mix is ready.

It was noted that the non-precise positioning of the 19 pins (in a star pattern) on the mould base would allow the base-plate to be fitted in only one position. During the manufacturing of new moulds it is recommended to use a precise welding jig for the 19 pins and a drilling jig for the holes. This way the perforated plate can be placed in any position over the 19 pins.

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[3] One Euro is about 75 NPR.

The inner diameter of the mould is 5" (12.5cm), with a net height of 4" (10cm). The weight of the hand-made, dried briquette is about ½ kg. Overall manufacturing cost is estimated to be around NPR 2.50–3 per piece, whereas the briquette can be marketed at about NPR 4 per piece. The local cost of pure charcoal (used by blacksmiths) and copper workers is about NPR 7 per kg.

Mould Open en Closed

The CEE, with the financial assistance of the AEPC[4] has started to develop a pedal-operated briquette press. This project was not completed. This press would provide an improved pressing/compacting power of about 1000kgf, which translates into about 10 kg/cm^2 on the briquette. The briquette would be compacter and stronger than the hand-moulded briquette, thus providing longer burning time and better transportability, factors which can be of importance in the marketing and acceptability by its users. The cost of the pedal-operated press in Kathmandu would be about NPR 25,000. A testing period and precise budgeting would be needed to assess if the additional equipment costs can be recuperated from a better product with a higher price.

Caloric Value

Pure woody biomass charcoal would produce about 29 Mega Joule/kg.

- Woody biomass charcoal briquettes with 20% clay content would produce about 18-19 MJ/kg or about 9 MJ/briquette. In practice this would heat 2 litre. water in 15-20 minutes using the insulated (one briquette) metal stove (from about 20ºC - 98ºC at 1300m altitude). The total burning duration of this type is about 1,5 hours.
- Forest and agricultural waste charcoal briquettes, also with 20% clay, would produce about 12-14 MJ/kg or 6-7 MJ per briquette, depending on the composition of the charcoal. In practice this would heat 2 litre water in 30-45 minutes using the single briquette stove. The total burning period of one briquette would be about one hour. Because the Banmara-charcoal type is less pure, more volatile particles will be emitted during burning, which makes them less convenient for use in fully closed living rooms.
- In China and Tibet some types of briquettes are made from charcoal to which coal dust (Anthracite) is mixed. These also have a high caloric value, but produce more volatile particles and bad gasses than the charcoal briquettes. These are used outside the house/room or require a very well ventilated kitchen (photo page 8).
- Lignite[5] briquettes were tested a few years ago by RONAST in Kathmandu, with some funding from JICA (Japan International Cooperation Agency), but results were unsatisfactory due to low caloric value and rather high particle and undesirable smoke emissions. Also coal was used in

[4] Alternative Energy Promotion Centre of the Ministry of Science and Technology of Nepal.

[5] Lignite is a low quality coal product that is mined in the Kathmandu valley. Anthracite, a high quality coal with high caloric value, is brought into Nepal by lorry from India.

combination with the Banmara vegetation. On some occasions these coal-Banmara briquettes were promoted as alternative energy source, but the emissions of large quantities of smoke particles and NOx and SOx gasses makes the product only useful for use outside the house or workshop. Because of the coal-gas emissions, this coal product cannot be considered as environmentally advantageous.

The Metal Stoves

The metal stove fits one briquette of ½ kg inside. The stove in Pandung was made from scrap metal and old oil drums, 0.6mm thick. The lined stoves of CEE had thinner sheet metal.

Two models were presented by the CEE, one with a one-inch thick inner lining of clay, the other with cement. The inner clay lining would be dried and partly cooked by the briquette fire. The cemented lining would become burned and with time will disintegrate. Both are easy to replace. The inner lining will conserve heat towards the centre of the stove and increase the heat efficiency when used for cooking. In addition, the briquette will burn more completely with the lining than without. In the case of the Pandung stove, the inner lining had been removed, possibly because at the higher altitudes the small portable stove was used only for space heating.

Because charcoal is frequently used for barbeques and by restaurants requiring large heat capacity for cooking or grills, the CEE developed a metal barbeque stand in which eight charcoal briquettes could be placed. Ventilation holes were provided in the bottom through which the briquettes could be fired. This barbeque model would cost about NPR 4,000.

Insulated Metal Stove en Baked Clay Stove

Clay Stove[6]

The CEE has manufactured a prototype portable baked clay stove that can be used for either space heating or cooking. The unit may be rather fragile for its use.

[6] The Centre For Rural Technology (CRT) has also tried to produce a low-cost mud-stove design that would allow the firing of a single biomass briquette (Sankhuwasabha District).

List of Production Articles and Estimated Cost in Nepalese Rupees

Weed harvesting tools		?
Charring drum, 200 litre	3mm sheet metal, 4 pieces	12,000
Grinder	Metal, rotating	10,000
Dust masks	Cotton/cloth filters	?
Mould, 19 pins, three piece	5" diameter and 4" high	5,000
Barbe que	8 briquettes	4,000
Thongs for briquettes	To fit into holes	?
Thick metal stove	One briquette, lined	400
Thin metal stove	One briquette, lined	300
Clay stove, three piece	One briquette, double wall	?
Tibetan stove	3 Briquettes, double wall	?
Briquettes, hand compacted	½ kg with Banmara	3
Compacting machine	1000 kgf, pedal operated	25,000
Briquettes, press compacted	0,6 kg with Banmara	4
Transport container	To be designed	?

Barbeque

2. THE "BEEHIVE" STOVE

The "Beehive" Briquette Stove in Pandung

The WWF has been supportive towards the local "beehive" briquette manufacturing as a source of renewable energy and has detected the following shortcomings or problems:

1. The briquettes are not very much in demand, probably because they have a large solid (30% clay-soil) content and subsequently produce large amounts of ashes.
2. The briquettes are not very strong and disintegrate rapidly, thus making them impractical for transportation over large distances (see photo page 15).
3. The making of the briquettes was a dusty affair and disliked by the women because of the high emission of black charcoal dust.

The WWF supported the women in reducing the dust in the manufacturing process and provided dust masks. The WWF local representative (member Rinji Sherpa) showed the mission team a sample of the briquette and the "beehive"briquette stove (see cover photo).

2.1 ANALYSIS CURRENT PRODUCT

From the brief analysis of the stove presented by WWF and the biomass briquettes, the following observations can be made:

1. The briquette is a standard round size (about 5" = 12,5cm diameter and 4" = 10 cm high). In other regions of the world similar sized round briquettes are manufactured with the same 19 vertical ventilation/burner holes.
2. The stove is locally manufactured by metal workers and is commonly made from recycled sheet steel using old oil drums (0.6mm = 22 gauge) or thinner as basic source material.
3. The stove allows only one briquette to be burned at the time, thus requiring for every new briquette also new burning material for starting the fire in the lower part.
4. The burning height inside the stove was too low for the briquette and the pot supports were actually lying on top of the new briquette, causing damage to the fuel brick. As a result the burning fire/gas from the briquette would have difficulties emerging from the holes. The height of the stove would be less relevant if the stove is only used for space heating.
5. The ash plate in the middle of the height of the stove had 19 hole punched into it (diameter about ½ inch). This would require the fairly exact positioning of the new briquette holes over the holes in the ash plate. This is not problem.
6. The side space around the briquette inside the stove was rather wide, more than one inch, as compared with the actual minimum space needed, about ¼ inch only. This was caused because the one inch insulating lining had been removed.
7. The ventilation or air access hole under the ash plate was rather large (more than 10cm x 10cm) and there was no possibility for regulating the air intake. The hole was kept large to allow a small fire to be made under the ash plate to start the briquette burning.
8. The overall ventilation space around the briquette would allow the briquette to burn rather fast and uncontrolled for a limited period.
9. The briquette already crumbled at the corners with handling. This was caused by a too high soil content and insufficient compacting/binding during production.
10. Villagers complained about too much ashes. This is caused by a too high soil content and removal of the thermal insulation of the stove (lining). The space heating capacity due to the removed insulation would probably not increase at all.

Simple or clear information about the briquette were apparently unavailable with, or easily accessible for, the WWF office in Pandung. There was no knowledge on where to get information on the improvement of the production process.

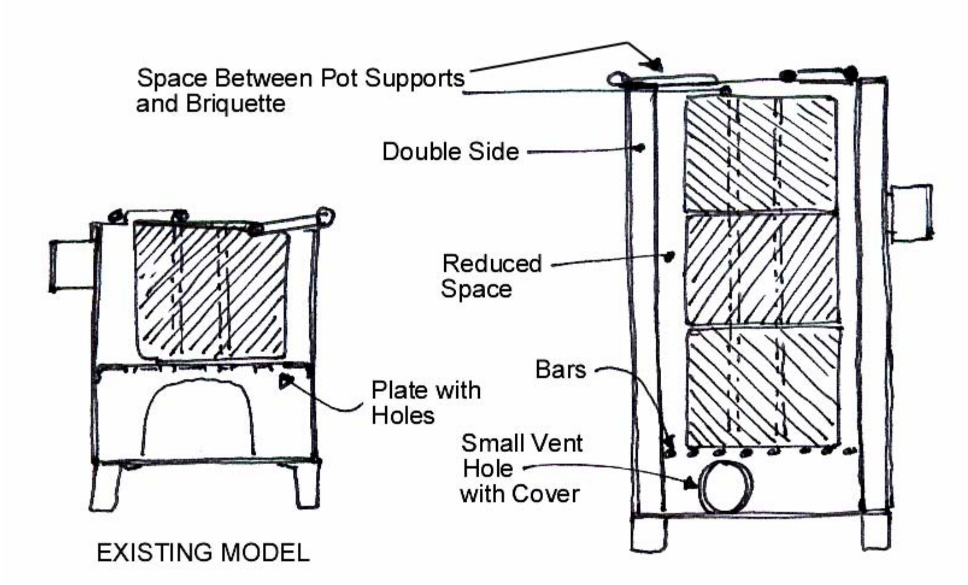
2.2 COPY FROM TIBET

The mission advised WWF to import a sample briquette stove from Tibet, where these are mass manufactured and very popular. The Tibetan traders who regularly visit Kumjung, Namche Bazaar and Lukla villages for trading clothes and Chinese products during the tourist seasons would be able to bring a new or used example. The Tibetan copy of the briquette stove can be studied by local metal workers and copied. It would be simpler to negotiate with some trader to bring a copy of the Tibetan stove, rather than make new elaborate drawings, and then try to explain these drawings and the required end-product to local metal workers.

The Tibetan briquette stove is very popular because of the following reasons:

A. There is on this high altitude plateau (4000m = 12,000 ft.) absolutely no firewood available and neither charcoal from woody biomass.
B. All cooking fuel needs to be bought, and transport costs are rather high.
C. The Tibetan briquette stove is thermally insulated so wind cooling is minimal.
D. The model allows for three briquettes to be placed on top of each other, so a hotter fire and a fire of longer duration can be generated.
E. The model can be well regulated through two times 2-2½ inch round pipes and corresponding closing lids/caps, thus precisely allowing to temperate the air and oxygen intake and reduce burning (in the picture some caps are removed for increased burning).
F. At the bottom of the stove the ash plate is an open grating and allows sufficient air to get to the briquettes from below, without the need of precise positioning of the bottom briquette over holes in the ash plate.
G. The model comes with special thongs that allow the higher briquettes to be placed exactly in the right position on top of the lower briquette, lining up the vertical channels.
H. Pots and kettles placed on the stove have a wide base, as wide as the insulated stove, so the use of the fire heat is optimised.
I. Briquettes are of strong composition, marketed in large packs (two or three dozen) and have minimal damage during transport.
J. Briquettes do include ground coal (Anthracite) that has a higher heat value (caloric value) than charcoal and agricultural residues.
K. Because of the coal content, the briquette stoves are used outside the house or restaurant to allow the poisonous gases safely to escape.
L. The wire handle allows easy transportation.

The following sketch provides the main points of improvements that can be realised in the stove design. On the right hand side the improved model. Also a two-briquette model can be tested.



In making a new model in for Lukla, this model needs to be field tested with the potential users such as he trekking companies and porters. The success of a new product depends on the level of acceptance of the product by the customers. See also the ANNEXE 1 for points to consider.

3. DEVELOPMENT CONSIDERATIONS

3.1 POLICY ON BIOMASS PRODUCT DEVELOPMENT

In the ANNEXE 1 a table is reproduced from the World Bank Technical Report No. 242. This table provides a resume of the most significant points indicating why a product which provides energy from biomass is marketable or not. The points that are to a certain extent applicable for the Lukla briquettes and stoves **are printed bold.**

The main points that relate to the biomass briquettes in the case of the Lukla briquettes are:
Positive:

- Few alternative energy sources are available, especially not at the high altitudes.
- Currently high prices are being paid for buying and transporting fuel.
- Certain types of cooking energy need to be mobile for trekking groups.
- With clean charcoal the stove is useful for space heating.

Negative:

- The energy (caloric) value of the charcoal briquettes is low as compared to kerosene.
- The fuel product (briquette) falls apart, is messy and not easy to transport.
- The weight of the product is rather high for carrying at very high altitudes.
- The stove is not very adequate for the current cooking habits or needs.

3.2 MARKETING

Marketing a New/Improved Product

When improving the design of the stove, first the product itself and subsequently the making and marketing of the entire product needs to be assessed. As indicated above, and related to the table of the WB report, each of the positive points need to be exploited, whereas the negative points need to be eliminated or reduced. An overview and cost calculation of each of the points (reducing or enhancing) should be made before an improvement programme for stoves and briquettes should be developed.

Availability of Raw Biomass Material

The altitude of Pandung is between 2600m and 3000m (8,000 ft. and 10,000 ft.) and has a considerably slower wood and biomass regeneration than at lower altitudes, about ten times.

- In the Terai at 500m (1500 ft.) hardwood trees grow about 5-6 times faster than at an altitude of 2000m (6,000 ft.).
- At 2300m (7,000 ft.) the factor is 7-8 times faster.
- At 3000m (9,000 ft.) the factor is 9-10 times faster.
- At 3600m (11,000 ft.) the factor is 11-15 times faster.
- Above 3800 - 4000m (12,000 ft.) no more trees will grow.

The production of the biomass briquettes is mainly done from agricultural waste and forest by-products such as fallen needles, pine-cones, Banmara and wild forest grass. When charcoal is made, an additional demand can also be made on the local wood growing capability. With the current slow re-generation of biomass and wood at this altitude ($1/10^{th}$ of that in the Terai), it needs to be assessed if the production can be renewable and sustainable, or if the demand is larger than the production.

Due to several forest fires in the recent past in the Lukla region, some hill sections have been deforested and there are large amount of dead trees available which can be used for firewood or charcoal. The use of this material very much depends on local Park regulations or policies.

Most of the agricultural residue is only seasonally available, such as the chaff from the rice, dried bean stalks and peels, dried maize stalks etc., materials that can sometimes be eaten by the cattle. This material is also used as stall bedding and therefore not always available for briquette making. In addition the villagers use the indigestible agricultural waste for kindling their fires throughout the year. Therefore, the amount of available agricultural waste in the village may be very little.

Sawdust and shavings from sawmills may be available in limited supply from lower areas, but this supply will stop immediately when a complete ban on cutting for timber and firewood is enforced. For other regions of the country the woody biomass is very useful for making charcoal briquettes as this material provides a high quality charcoal and the stoves which burn with this material can be used inside the house.

Coal (Anthracite) has not been found in the area, but can be imported into the region from India by truck to Kathmandu. To transport this from Kathmandu to the high areas, without road access, will only be at very high costs. One of the biggest differences of the success of the Tibet briquette may be that the agricultural residue briquette of Pandung has a lower caloric value than the Tibetan coal-dust briquette. The agricultural residue briquette, however, may be able to burn faster and generate the same amount of heat for a short time span.

Low quality Lignite is available in the Kathmandu valley and possibly in other regions, but this material has a much lower caloric value than coal or Anthracite. In addition, because it has a high sulphur content and a lot of volatile matter, it needs to be initially ignited outside the house and burning strongly before it can be brought inside and placed in a well ventilated area.

Cost Relevance

Whether or not a product would be economically acceptable and thereafter widely used is dependant on three factors which the consumer will consider simultaneously:

A. In a wooded area, with access to forest by-products, branches, some firewood and cow-dung for fuel cakes, the higher price that villagers are willing to pay for another heat source for cooking is limited. The value of the new energy source will increase if people are living farther away from the wooded area and transport (delivery cost) of biomass or firewood is rapidly increasing.
B. The price a person wants to pay for an alternative energy source depends largely on the level of comfort that person receives from using that heat source. For example electricity or gas for cooking is very convenient. Charcoal briquettes are convenient when they do not generate smoke and with the stove the heat source is easily transportable, both items that do not apply to an open fire.
C. The additional product-related costs are also relevant, such as transport, storage, easy replacement, availability, equipment needed, matches, dirt, smoke exhaust, pots and pans, cleaning, etc. Using the charcoal briquettes has a number of advantages and disadvantages, which the user will compare with other locally accessible heat sources.

Considering the above points it can be assumed that only in areas where firewood is absolutely forbidden and no electricity exists for cooking purposes, the briquette can possibly effectively compete with kerosene. Kerosene, however, has a very high caloric value; and depending on the equipment a small amount can generate highly concentrated heat.

The preliminary conclusion is that near and above the tree line, about 3600m (11,000 ft.) and higher an improved briquette stove can be an interesting product if the prohibition of using firewood is adhered to. At 5000m (15,000 ft.) and higher the added value and high caloric value of kerosene (as compared to weight and transport costs) may make briquettes again less interesting. This needs to be assessed and depends on the quality of stove and briquettes.

Convenience

The purchase cost of the product has a lot to do with convenience as indicated in point B above. If the briquette falls apart and creates a mess, and cannot be easily transported, it becomes less attractive for the user. Therefore the briquette has to remain solid. First, the internal binding must be good; secondly, it must be transported in a protective casing or box to avoid damage by transport over the long trekking roads.

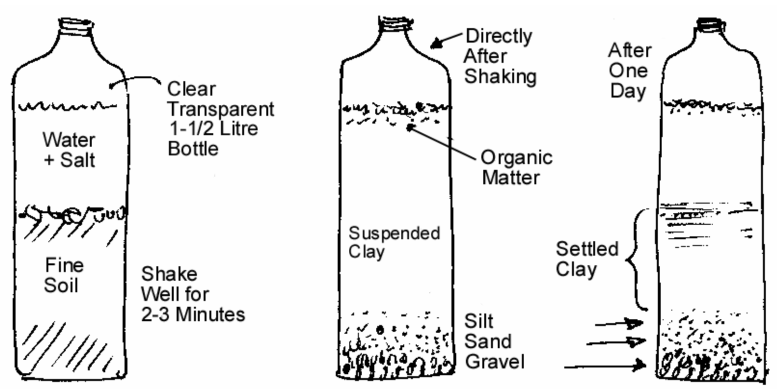
3.3 PRODUCT IMPROVEMENT

Clean Clay

It appears that the 30% soil mix with the charcoal is a too high percentage, adding weight, reducing heat generating capacity and not good enough in binding. As binding material it is recommended to add soft wet clay (about 20% maximum), mix this with the dry agricultural charcoal, press the briquette into shape at high pressure and let it dry. Drying can be done in the open air or in a solar dryer, using a simple UV resistant plastic cover at the high altitudes. The quality of the clay will determine the quality of the bonding.

The available soil can be tested by using a simple method: The Bottle Test:

- A 1½ litre transparent plastic bottle is half filled with finely crushed clay-soil and salt. The bottle is then filled up to ¾ with clean water. Salt will speed up the sedimentation.
- The bottle is shaken for about 2-3 minutes until all particles are fully mixed and the clay is suspended in the water.
- The bottle is placed on a fixed point and observed regularly. First all the solids, such as sand and small pebbles, will sink to the bottom. Then a layer of silt will form on top of the sand. Gradually, over a period of several hours, the clay will settle on the sand. Organic matter will remain floating on top of the water.



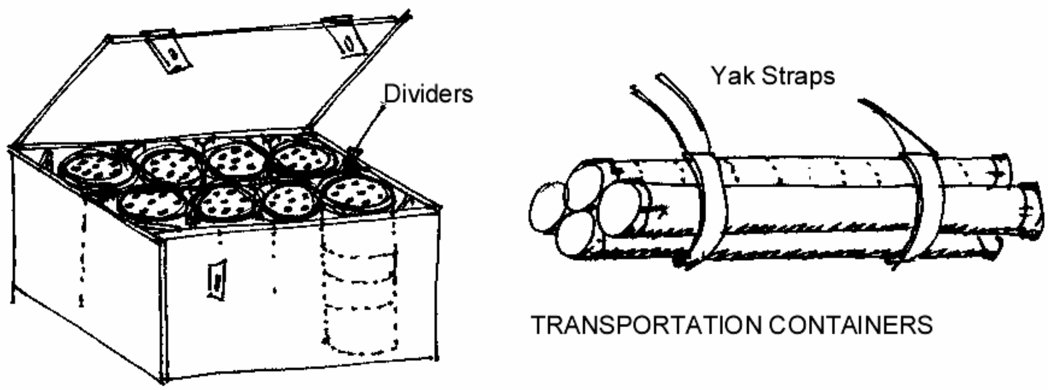
The above test will assist the manufacturer of the briquettes to select the best clay soils. If the soils contain too much sand and silt, these must be washed, using the same principle as with the bottle test. In large tanks the fine clay can be separated in this way. In mixing the dry charcoal material with the fine wet clay, the clay content should be kept as small as possible.

Pressure

The internal binding of the briquette can be also improved by increasing the pressure in the mould and/or by adding starch glue. The CEE has developed a pedal-operated briquette press that can realise a much higher pressure (1000 kgf or 10kg/cm^2) than can be generated with the hand compacted mould. The weight of the briquette will be slightly increased as more charcoal enters the mould. The burning of the briquette will therefore also be longer.

Glue
The dust-dry clay can be wetted with water that has high starch content. Starch is found in rice and/or potatoes and pasta. Left-over food products can be soaked to produce a starchy water. The dry clay should be mixed with this starchy water. Practical tests should be realised to determine the economy of the activity and the amount of starch needed. The binding by starch occurs after drying.

Protective containers
Special transport containers should be designed and field tested for practical usefulness for transport by humans or by yak/nak. Considering that porters or yak may carry a variety of articles, a container of about 20 kg content weight can be designed. The briquettes inside the container can be packed in waste paper, which in turn can be used to light the briquettes in the stove or cooking stand.



TRANSPORTATION CONTAINERS

Production Process
The entire production process in Lukla/Pandung needs to be analysed to assess where economies of efficiency improvements can be generated. The activity was introduced in the high altitude areas as a micro-industrial activity or an income-generating activity. The women group in Pandung earns only a small income out of it. If the product and the marketing options are again assessed and adjustments made, it could become a viable income-generating activity for remote areas and can be a contribution to Renewable Energy sources.

Considering the expanse of high-altitude areas in Nepal, and the high demand for improved cooking methods and access to heating fuel, serious efforts should be made to optimise the production and use of Renewable Energy sources, especially if this also provides some income-generating activities for the local population. The biomass charcoal briquettes can be developed along side the biogas reactors with green house and improved cooking stoves. The need for room heating will reduce with proper thermal insulation[7].

Training and Manuals
To carry the process forward, good documentation and training should be available so that local producer groups can learn how to make the best biomass charcoal briquettes and where to get the moulds, compacting machines, stoves, tools and other appliances for the most efficient manufacturing, and what everything does cost. Manufacturing manuals should be available in local languages and well illustrated with drawings and photographs.

Manufacturing, however, should not be considered when the number of negative points is exceeding the number of positive points in the ANNEXED World Bank table. After resolving the most important points, some of the remaining negative points may be minimised, but all have an influence on the local marketing conditions and price. Marketing options should therefore be studied before training and industry development is undertaken.

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[7] In high altitude areas, more than 50% firewood (for space heating) savings can be obtained by thermal insulation.

4. POSSIBLE LINES OF FUTURE ACTION

Proposed Points of Action

Different stakeholders may be able to realise a number of activities and contribute to a better product and an important source of RE:

A. **AEPC:** The AEPC is mentioned here as a key coordinating organisation, representing national government. Activities can be initiated and monitored, but implemented by other organisations.

- In conjunction with the CEE, stimulate the completion of the development and field testing of the supporting equipment.
- In conjunction with ICIMOD assess the potential national resources and subsequently the potential market in Nepal for the charcoal biomass briquettes, not only for high altitudes, but also for other rural and urban areas.
- Assess where the different RE technologies are complementary to the biomass briquettes, what are the advantages and disadvantages, and how to market these together.
- Provide clear information about the different types of biomass, charcoal, coal and other briquettes and energy products; advantages and disadvantages.
- Distribute information about the briquette to all RE information centres, DDC, VDC's, etc.
- Provide the relevant information of the briquettes and other solutions on the Internet.

B. **CEE:** The CEE is one of the organisations that has implemented the available technology. The CEE in his case can become the driving factor to develop this RE sub-sector .

- Complete the field testing and upgrading testing of the developed supporting equipment, such as grinders, compactors, dust masks, etc.
- Develop clear, simple folders on the production process for managers and users.
- Develop a short curriculum for briefing managers on the possible production of the "Beehive" briquettes by such companies as the Biogas Construction Companies or other local energy suppliers or users, such as blacksmiths.
- Develop a readymade training course for small business groups on the manufacturing of the "Beehive" briquettes[8]. This course should be available in several locations in the country.
- Provide an application form for attending one of the above-mentioned types of courses.
- Provide an updated price, manufacturers and distribution list of all the types of equipment that can be used for the production of the "Beehive" briquettes.
- Provide manufacturing drawings and quality standard information for those who want to manufacture some of the equipment or stoves.
- Provide promotional material for stimulating the use of the biomass briquettes.

C. **WWF:** The WWF is interested (together with other local organisations) to reduce firewood consumption, but at the same time to provide the people with adequate energy sources for their daily needs.

- Obtain a copy of the Tibetan stove and assess its advantages and disadvantages for high altitude trekking and general use. A two briquette model can possibly be developed.
- Verify the availability of biomass in the high altitude regions with the local population and organisations and calculate the potential for biomass production on a sustainable basis.
- Identify with the local producers the best clay soils and assess if purification of the available soils is possible, to reduce the solids content in the briquettes.
- Allow biomass briquettes to be used within the Park areas, provided special conditions are met by the producers and users.
- Organise that at strategic points the improved and insulated cooking stoves are available and a regular stock has been developed for the briquettes.
- Assess the need for thermal insulation of houses to reduce the demand for space heating.

[8] CEE can currently provide a five day hands-on manufacturing training course for groups of about 10 persons, costing NPR 6,000/per person, excluding travel, food and overnight stay. One metal charring drum and mould is included for the group.

D. **BSP/SNV:** The BSP has a large network of more than 50 Biogas Construction Companies throughout the country and the network is in the process of delivering 100,000 or more biogas reactors. In addition to these biogas reactors the farmers will occasionally have additional fire needs. For this reason they will not only be helped by improved cooking stoves, but also by additional energy sources, such as the biomass charcoal briquettes. The Biogas Construction Companies can therefore become the delivery organisations for RE.

- Provide technical and promotional material about the improved briquette technology to the Biogas Construction Companies to draw their attention to the possibility of expanding their energy supply services with the biomass briquettes, as a complementary source of clean cooking and house heating energy.
- Provide the Biogas Construction Companies with an application form for briefing.
- Organise group briefing sessions for managers, provided for by the CEE.
- Organise group training per district by the CEE for small producers groups.

Poor quality briquettes disintegrate during transport

ANNEXE 1

Copied from the World Bank Technical Paper Number 242, page 14.

What Makes People Cook with Improved Biomass Stoves?

A. Comparative International Review of Stoves Programs
By: Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas.

… it is now understood that women in fuel-short areas often are able to achieve efficiencies in their traditional stoves substantially greater than the 6 percent assumed in many analyses. Finally, planners have shed expectations that huge improvements in efficiency alone would make stoves irresistible and that they would need to do little monitoring, sampling, or statistical work to assess programs' efficacy.

Box 4. Possible Reasons for Success or Failure of Stove Programs[9]

Reasons for success	*Reasons for failure*
1. Program targets region where traditional fuel and stove are purchased or fuel is hard to collect.	1. Program targets region where traditional fuel or stove are not purchased or fuel is easy to collect.
2. People cook in environments where smoke causes health problems and is annoying.	2. People cook in the open, and smoke is not really a problem.
3. Market surveys are undertaken to assess potential market for improved stoves.	3. Outside "experts" determine that improved stoves arl required.
4. Stoves are designed according to consumer preferences, including testing under actual use.	4. Stove is designed as a technical package in the laboratory, ignoring customers' preferences.
5. Stoves are designed with assistance from local artisans.	5. Local artisans are told or even contracted to build stoves according to specifications.
6. Local or scrap materials are used in production of the stove, making it relatively inexpensive.	6. Imported materials are used in the production of the stove, making it expensive.
7. The production of the stove by artisans or manufacturers is not subsidized.	7. The production of the stove by artisans or manufacturers is subsidized.
8. Stove or critical components are mass produced.	8. Critical stove components are custom built.
9. Similar to traditional stove.	**9. Dissimilar to traditional stove.**
10. The stove is easy to light and accepts different-sized wood.	**10. The stove is difficult to light and requires the use of small pieces of wood.**
11. Power output of stove can be adjusted.	**11. Power output cannot be easily controlled.**
12. The government assists only in dissemination, technical advice, and quality control.	12. The government is involved in production.
13. The stove saves fuel, time, and effort.	13. **The stove does not live up to promised economy or convenience under real cooking conditions.**
14. Donor or government support extended over at least 5 years and designed to build local institutions and develop local expertise.	14. Major achievements expected in less than 3 years, all analysis, planning, and management done by outsiders.
15. Monitoring and evaluation criteria and responsibilities chosen during planning stages according to specific goals of project.	15. Monitoring and evaluation needs are not planned and budgeted, or criteria are taken uncritically from other projects or not explicit l y addressed.
16. Consumer payback of 1 to 3 months.	16. Consumer payback of more than 1 year.

[9] The points that are to a certain extent applicable to the Lukla briquette stove and the used briquettes are printed in BOLD. Other points are not known or not assessed.