Biomass Energy for Cook Stoves and Other Energy Needs of the Off-Grid Household Sector

Introduction

Biomass fuels provide 51% of Sri Lanka's energy and 80% of this biomass is actually consumed for cooking food on fires and stoves. For this reason much attention is given to this sector by governmental and development agencies working on energy, especially since there is much scope for improving this cooking operation - both in terms of use and supply of fuelwood, and for the health and welfare of householders.

This is a global issue common to many developing countries. According to HERA, the Household Energy Programme of the German aid agency GTZ this continuing high dependency on fuelwood for cooking causes environmental problems through excessive felling of trees and deforestation; and also has serious impacts on health, workloads, and budgets of householders. Smoke from traditional open fires or simple stoves causes respiratory diseases with women and children more affected. (GTZ, 2006)

This section will look at developments in household energy in Sri Lanka with a focus on cook stoves. Examples of improved cook stove programmes in other countries in this region will be provided. Also some outline will be given of how the wider energy needs of households for lighting and for operating domestic appliances are being met, particularly though appropriate use of biomass energy. Energy needs for transportation are dealt with elsewhere. (see Biomass Energy Toolbox - Technical Aspects/Transport Sector SubSection)

Cook Stoves

Present Situation

Cooking on an open-fire arrangement has many shortcomings. These include: very low cooking efficiency, diffusion of heat during windy conditions, difficulty over control of the fire, exposure to heat and smoke, and fire hazards. Development of cook stoves to create a fire-shield became a necessity with the evolution of pots of various shapes and sizes. The simplest and most common form of fire-shield was the three-stone stove. This arrangement allowed a stable positioning of the cooking pot, partly saved the fire from wind effects, and slightly improved cooking efficiency. Yet, the three-stone cook stove had similar drawbacks as the open-fire.

Subsequently, the three-stone configuration was changed to a U-shaped semi-enclosed mud stove or chulah with an opening in the front for feeding the fuel and entry of combustion air. Later users in light of experience made a number of modifications. One of these innovations was the addition of three small humps at the top rim of the enclosure. This provided support for the cooking pot. It also created an entry point for secondary air needed to complete combustion of volatile matter and an exit for the exhaust gas. Another major modification that occurred was the inclusion of additional pothole enclosures, which are connected to each other by a tunnel. These evolutions improved the cooking efficiency substantially, but health and other hazards remained. Despite such developments in stoves and fuels, most of the people living in rural areas of developing countries still largely employ the three-stone or the U-shaped mud stove for cooking fuelled by traditional sources of energy such as fuelwood and other biomass.

At present, a number of designs are in use in the domestic sector of the country. These are both traditional cook stoves (TCS) and improved cook stoves (ICS). This variety and their comparative fuel efficiency is outlined in table 1.

Type of stove	**TCS/ICS**	**Efficiency (%)**	**Fuel type**
Traditional cook stoves			
Three stone stove	TCS	8.0	Fuelwood, agri-residues
Single and two pot mud stove	TCS	13.0	Fuelwood, agri-residues
Improved cook stoves			
Anagi stove 1 & 2	ICS	18.0	Fuelwood
Sarvodaya two pot stove	ICS	22.0	Fuelwood
CISIR'S single pot stove	ICS	24.0	Fuelwood
IDB stove	ICS	20.0	Fuelwood
NERD stove	ICS	27.0	Fuelwood
Charcoal cook stove			
Ceylon charcoal stove	ICS	30.0	Charcoal

Table 1 - Fuel efficiency of differing types of cook stoves used in Sri Lanka

Most widely used TCSs are the three-stone stove and semi-enclosed single and two pot mud stove similar to the U-chulah (also known as "Sinhala Lipa").

Various ICS designs have been introduced since the late seventies through a number development and dissemination programmes launched by different governmental and non-governmental organizations. However the two-pot "Anagi-2" stove is the only ICS design that has so far really gained popularity. Practical Action (formerly ITDG) report that since 1991 about half a million 'Anagi' stoves have been produced and sold in Sri Lanka and that more than 400 potters and installers trained in their construction and installation. It is estimated that future production will reach around 120,000 per year. (Practical Action, 2006)

According to a recent study, the percentage shares of fuelwood consumed in three categories of stoves are predicted as 60.4% in three-stone cook-stoves, 27.4% in semi-enclosed stoves and 12.2% in ICS.

With the majority of the existing biomass energy cook stove devices used in the country continuing to be of traditional and therefore inefficient design, this perpetuates the wastage of energy and the associated environmental and health problems as previously described. Therefore there is still a considerable potential for biomass conservation and mitigation of greenhouse gas (GHG) and other pollutants emission through greater deployment of modern biomass energy technologies. There is a great interest and demand for improvements of conversion efficiency but lack of funding, expertise and institutional support limit the implementation of such improvements. A number of institutes are actively involved with different aspects of biomass energy, such as research and development of conversion technologies, case studies, country studies, feasibility studies, resource assessments and country-wide energy plantation programme. A recent addition to the available ICS technology is the NERD or "Lanka Shakthi" wood stove that is described in more detail below.

NERD wood stove

The National Engineering Research and Development Centre of Sri Lanka (NERD Centre) recently launched the "Lanka Shakthi" wood gas stove to the local market under the auspices of the Ministry of Science and Technology. A demonstration on the working of the stove was provided for the benefit of those present at the launch.

Initially known as the NERD Gasifier Stove, it was designed by D. M. P. Bandara, a mechanical engineer at the institute. This stove received the Presidential Award for the best local innovation in the year 2000, as well as a silver medal and certificate in 2002 at a competition held in Switzerland for the best innovations for resolving technological problems encountered by third world countries. After receiving the patent in 2000, the stove continued to be manufactured but with limited numbers being sold. The "Lanka Shakthi" wood gas stove is a new and improved version of the NERD Gasifier Stove. Priced at around Rs. 2,500, it operates solely on firewood unlike the earlier version that required a limited input of electricity.

It is claimed that the stove, which uses wood chips, pieces of coconut shell and firewood sticks as fuel provides a good alternative to the traditional firewood stoves. This is due to its high fuel efficiency, so that the cost that needs to be incurred for the operation of the stove is vastly reduced. It is also claimed that the "Lanka Shakthi" wood gas stove is a viable alternative to gas stoves as now used by around 25 per cent of the households, especially in the light of the fact that regulation of gas prices is not possible for a country like Sri Lanka.

Positive impacts of this stove are that it: enables a lower grade fuel to compete with modern fuels, reduces the use of firewood, improves the kitchen environment and related health hazards, promotes the use of an indigenous and renewable energy resource, enables the transfer from a primitive to a more modern technology, and helps to elevate the social status and health of women and children. These aspects contribute towards poverty eradication and economic growth.

It was noted at the launch that wood smoke is considered a serious health hazard with evidence revealing that the risks of acute respiratory infection and chronic obstructive pulmonary disease increase significantly in persons exposed to the levels of wood smoke emitted by traditional firewood stoves. A study done on the incidences of acute respiratory infection and conjunctivitis in women and children in Kenya has shown a considerable reduction in incidences in the case of those using improved stoves as compared to open fires. According to a report of the World Health Organization, solid fuel use is also the fourth highest risk factor of mortality and morbidity and accounts for 2.2 per cent of the total number of deaths and 2.7 per cent of the life years lost due to illness. Studies done in developing countries have shown that the use of improved wood stoves and influencing the behavioral patterns in the kitchen are effective in mitigating the adverse effects of wood smoke. (GTZ, 2006)

While switching completely to cleaner fuels such as LPG or electricity is the most effective way of eliminating the health hazards of biomass, this is not feasible for most households owing to the incremental costs so the "Lanka Shakthi" wood gas stove provides a practical and affordable solution. Given that around 88 per cent of the kitchens in Sri Lanka use firewood for cooking and the fact that women and children spend considerable periods of time in the kitchen there is a social responsibility to mitigate the negative impacts that can be found in such an environment.

Indian Experience

TERI reports have recently issued that describe the status of improved cook stove programmes in Andhra Pradesh and in Haryana.

It is reported that in Andhra Pradesh about 2.5 million ICS were disseminated in the State by end-2000 under a programme that has been running since 1984. The scheme targets rural households and uses various means of promotion for both chula type stoves and portable stoves. Fixed mud or concrete chula-type stoves have fuel efficiency in the range 20-40% and stove life of 2 – 5 years. Portable metallic stoves have 25-29% fuel efficiency and 5 year life. Women are major participants in training programmes. A 50% subsidy given to the stove cost by the government was a key element of this scheme but this has been withdrawn since 2003. (Jalajakshi, 2005)

TERI has implemented an ICS project in Haryana State under the Community Forestry Project. It was focussed on four villages and 234 ICS were constructed. Under the programme TERI trained 50 members of women users groups and 9 masons. Evaluation of the programme has shown that fuel savings were about 15% and timesavings 0.5 – 1.0 hour per day. An evaluation survey after 5 months determined that the stoves were recognised as being easier and more efficent to use. Also smoke was removed from the kitchen and this reduced respiratory problems and eye irritation experienced using traditional stoves. (Pal & Sethi, 2005)

Cambodian Experience

The French agency ‘Groupe Energies Renouvelables Environment et Solidadarites’ (GERES) has set up the Cambodian Fuelwood Saving Project (CFSP) which has developed a cheap charcoal stove, the ‘New Lao Stove’ that uses 22% less charcoal than the traditional charcoal stove. It is essentially an adaptation from the Thai Bucket stove which came out of an earlier Regional Wood Energy Development Program of the FAO. Charcoal is the preferred cooking fuel for 50% of the population in the capital Phnom Penh. (GERES, 2006)

In the past 3 years over 130,000 stoves have been produced and sold by 14 entrepreneurs. Currently around 7000 stoves are produced per month. The stove costs about three times that of a traditional stove but this extra outlay is recouped from cost savings in charcoal within two months. There are no subsidies or credit facilities for end users who pay in full for the stove at the time of purchase. CERES helps support the production and distribution network by provision of a micro-credit facility. (CFSP, 2006)

Potential for use of Biogas for Cooking

On-farm biogas plants collect cow dung from adapted cattle sheds, mix it with water and channel it into enclosed fermentation pits known as digesters. In these digesters an anaerobic fermentation occurs which releases biogas, a combustible gas containing around 65% methane. This gas can be stored in a small gasholder and then fed directly to the farmer's household to provide fuel for cooking using simple gas burners. The gas can also be burnt on small mantle lamps to provide light. If sufficient gas is generated, it can be used to power small electricity generators.

Schemes can meet most of household cooking needs. Incomes rise as women and girls are freed from domestic labour associated with cooking by fuel wood, using the time instead for new income generation.

The biogas plants also produce organic waste that is used as fertiliser. As both fertiliser and fuel wood are increasingly expensive in the country, biogas has a potentially important role. It may also be used to manage organic waste in urban settings.

Enthusiasm for introducing biogas as a source of energy goes back to the 70's. There is also scope for disposing of urban, municipal and agricultural waste through recycling and biogas generators. Biogas known as land-fill gas can be recovered from solid wastes disposed in sanitary land-fills but no satisfactory programme has yet been evolved to accomplish this in Sri Lanka.

Biogas technology has been developed at the In-Service Training Centre at the Department of Agriculture and by the NERD Centre. The NERD Centre has developed a unique Batch Type anaerobic digester technology that has been successfully applied for treatment and disposal of market garbage, while producing much valued bio fertiliser and clean biogas for energy. Many organisations have now undertaken to popularise and commercialise this technology throughout Sri Lanka.

A paper on the Practical Action website apparently written about ago 5 years describes earlier biogas experience in Sri Lanka and estimates that the total number of biogas units that had been installed in Sri Lanka was around 5000. then functioning. These were simple design systems operated as single household units to provide gas for use as cooking fuel. A survey at that time indicated that only around 28 % were still working and this information was the motivation for a new Practical Action Biogas Project that is also described on this website. This project was started to improve the success rate of these units by co-ordinating their development at a national level. It has set up demonstration units, restored abandoned units and trained users. One particular case study is described in which biogas is used for cooking, ironing laundry, and for providing heat and light in a home – thereby eliminating any need for woodfuel. (Practical Action 2006)

It has been found that biogas programmes have been successful when they are well integrated with fertilizer supply requirements particularly in farms. Gas supplies from small household scale systems are sufficent for cooking needs but not normally sufficient to generate electricity. Introduction of these technologies by centralized government institutions along with subsidies has frequently failed due to lack of continued support. However, biogas technology remains a potential candidate for widespread application in rural areas in Sri Lanka. It is important in terms of CDM mechanisms since it provides energy by combustion of methane gas, which is one of the main greenhouse gases.

Electricity for Rural Households

Apart from energy requirements for cooking, householders also need electricity to power a variety of domestic appliances. Where households are not connected to the grid, as is the case for many rural areas of Sri Lanka, then some system of small-scale off grid power generation will be considered. One NGO in Sri Lanka, the Energy Forum has focussed on the issues of rural electrification. (www.energyforum.slt.lk/)

There is a balance of 20% of households who will not have grid electricity before 2010 and in the meantime their only option to obtain electricity will be under one of various methods that are being promoted. Two approaches in particular have been addressing this issue in recent years. Around 50,000 solar home systems are now installed and also there are now 400 village hydro-schemes providing electricity to 6000 households. Other technologies for off-grid electricity that are being proposed are wind turbines and dendro-power systems using small-scale gasification.

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