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Technologies that really work

Boiling Point

gtz

PRACTICAL ACTION
Technology challenging poverty

We would like to extend our thanks to Practical Action and GTZ for financial and editorial support toward this edition of Boiling Point.

Editor's note:

Welcome to the latest edition of Boiling Point, and the first one to be produced under the HEDON Household Energy Network (www.hedon.info). We at HEDON, are proud and pleased to have the exciting opportunity to build knowledge and capacity in the Household Energy community through Boiling Point. We are also deeply indebted to Liz Bates and Practical Action who have, over the years, created and established Boiling Point as a leading journal in the field of household energy.

The journal will be produced by Eco Ltd, and has an Editorial Team including Practical Action and GTZ. Current issues are sponsored by both Practical Action and GTZ. The aim of the journal will be the same- to provide accessible information on household energy to practioners, researchers and users worldwide. In the future we plan to make the journal even more accessible and participative, and would ask for your assistance in this by updating your address details and sending us feedback using the personalised web address enclosed with this edition, or providing us with your details by email or post. You can contact us at Boiling Point on: boilingpoint@hedon.info.

The theme of this edition is 'Technologies that really work' and we are pleased to welcome Crispin Pemberton-Pigott as theme editor. Crispin is well known to many Boiling Point readers and has worked in the field of stoves for over 25 years. His editorial discusses changes that have happened within the household energy sector over the years and looks at what the future challenges could be.

This edition covers a range of energy technologies and looks at what has made them successful and used by people in Africa, Asia and Latin America. There is also a discussion around the issues needed to make a technology successful including the social, economic, marketing, environmental and political factors.

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Back issues of Boiling Point

Previous issues of Boiling Point can be found at:

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Previous issues of Boiling Point include:
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51 - Sharing information and communicating knowledge
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49 - Forests, fuels and food

PRACTICAL ANSWERS

Practical Answers was created to provide a means of accessing the wealth of technical information held by Practical Action. It comprises:

- Information on appropriate technology in subjects including energy, construction, water, food processing, transport and manufacturing, which can be downloaded free of charge from the Practical Answers website: http://practicalaction.org/practicalanswers/
- Resource centres based in the Practical Action offices, open to the public and holding a distinctive collection of appropriate technology and development literature.
- The Technical Enquiry Service supplying, free of charge, technical and developmental information to development workers, community-based organisations, NGOs and other agencies using appropriate technologies to implement sustainable development. It can be called upon by contacting Practical Action at:

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Contributions to Boiling Point

• BP54: Improved energy access for local institutions

Where groups of people find themselves gathered, institutional stoves and lighting can be important to their well-being. Clean and efficient institutional stoves can provide food for schools, hospitals, prisons and can assist where communal facilities are needed in emergency situations. Bread and other staple foods can be cooked on a community basis. Street lighting can allow markets to trade for longer and for people to feel safe. Generators owned by the community can allow people to light their homes. Hospitals and clinics need a 'cold chain' to keep vaccines in good order. This edition is not only interested in the technologies, but also in the infrastructure to make them work: tariffs, energy efficiency, impacts, communal responsibilities and maintenance etc. If you have experience of these issues, HEDON would love to hear about them.

• BP55: Effective Monitoring and Evaluating of household energy projects

Monitoring and Evaluating the impact of a household energy project or programme is critical in order to measure its success, whether in technical, social, economic, environmental or political terms, so that we can learn from the indicator results to improve future interventions and improve future interventions. This edition will look at techniques and methodologies for monitoring and evaluating household energy projects. It will also consider lessons learnt and best practice for incorporating M&E outcomes into future energy initiatives.

Articles should be no more than 1500 words in length. Illustrations, such as drawings, photographs, graphs and bar charts are essential. Articles can be submitted on disc, email or transcript.

Opinions expressed in contributory articles are those of the authors and not necessarily those of HEDON. We do not charge a subscription to Boiling Point, but welcome donations to cover the cost of production and dispatch.

Cover photo: Woman sitting beside improved stove with smoke hood (photo: Practical Action UK)

THEME EDITORIAL

Taking Science to Hearth

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A generation ago Prasad, Sangen and Visser wrote in their book, "Woodburning Cookstoves", that the great majority of stove development work had been done by people, "who have had no benefit of specific technical training." Today, a mountain of new stove work is being heaped up. From top of that pile a new horizon can be seen. It is important to recognise new trends, especially as it takes us from the elusive promise of accessible, improved stoves to their emerging reality. This is the beginning of the age of clean cooking.

Attracting engineering graduates into a new field such as domestic energy is a chick-and-egg problem: which comes first, the new careers or the people who want them? Where would you train and what do you study? Professionalism in domestic energy engineering (DEE) was always needed but without funding for research posts and long term career prospects, it was difficult to apply the vast power of modern science and engineering to the problems of the average domestic cook. Interventions were brief, expectations unrealistic and the result disappointing. Cooking health problems were largely viewed as a poverty issue with the solution being to move the poor 'up the energy ladder'. Meanwhile biomass, though locally produced, widely distributed, requiring no foreign exchange and supporting local employment was invariably dismissed as dirty, smokey and unhealthy. Non-biomass kerosene received similar treatment in every major article. But the problem was not the fuels, it was the devices!

The first problem we must address is that of stove smoke causing illness in a billion lungs. Stove combustion technologies have to be transformed to drastically reduce emissions. It is the key to saving more than one million lives lost and hundreds of millions more sickened annually by biofuel emissions.

The second problem is the quantity of fuel available. While land clearing for agriculture appears to be the major cause of deforestation, biomass-dependent cooks soon find themselves competing for what is left standing, and being blamed for the shortage. Not many countries have, like Swaziland, a National Energy Policy with a section on Security of Supply to protect the needs of the biomass users who make up 75% of the population.

Figure 1 Testing of a commercially manufactured Rocket Stove from Uganda, at GTZ Technical Workshop in Mulanje, Malawi (*photo: Elmar Dimpl*)

When biomass security of supply is given the same importance as petroleum energy a very different attitude to energy efficiency and afforestation emerges automatically. Without paying attention to this vital, natural, renewable energy source, a situation can quickly develop where the imported petroleum fuel cost of moving the remaining biomass equals the cash value of the fuel being transported. In other words, without replanting forests in the immediate area, foreign exchange for oil is required to access the 'local' energy supply from neighbouring regions. It is surprising that most energy policies do not view biomass as an import-substituting, renewable energy source, most often referring instead to solar, wind and wave power.

Large urban charcoal-burning populations like Maputo, Mozambique earn enough income to pay the rural poor to supply them over 350 tons of charcoal a day from as far as 600 km away. Dakar and other towns in Senegal provide comparable examples. Stove body design must be transformed to greatly increase the heat transfer efficiency and to burn far less fuel per meal. New low cost stoves can save two thirds of the charcoal.

It is only recently that portable scientific instruments capable of determining with accuracy what is emitted by a stove in the home environment have been available. It is most fortunate that just as the technologies arrive to quantify what we breathe and locate where it comes from, the funding to hire the engineers and technicians to operate the equipment is also hitting the bank accounts. This is truly a time

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of transformation in the domestic stove industry.

It began with a simple change in focus. For decades stove projects were always 'developing an improved stove'. The stove business was exciting because there was no qualification to enter it. The targets were not demanding; the scale of potential damage, limited. It was the age of the enthusiast and the backyard inventor, frequently using poor quality materials in an artisanal workshop. A generation later, millions of dollars was spent around the world and, frankly, there is very little show for it.

Now major donors, private and public, have started demanding that cooking stove projects begin to deliver an impact 'at scale'. This demand for production volumes directly related to the universe of need requires a transformation of the products, the manufacturing methods and the financial models. The implications are broad and daunting.

With tinkers in Bamako, Mali producing 4000 improved stoves a month from scrap metal, one might expect that 'scaling up' means more tinkers and more stoves - what you might call the Jiko model of expansion. But that scrap metal is not locally manufactured so its supply is quite limited. The idea that half a million improved stoves can be produced per year from scrap metal in Bamako is a non-starter. We need a new approach to materials, production methods and marketing if the masses are to benefit. People will soon treat stoves as another consumer product. They will be more demanding about quality and performance, treating them as they do watches or radios. It is a fact that quality sells. What are we offering?

The donor response to this has been realistic. Modern stove programmes now include professional product designers, marketing expertise, field testing of products for emissions and fuel efficiency, business model advisors, private sector funding agents, materials experts and social scientists. The core capacities for large scale success are accumulating, generating a buzz that can attract the best and brightest with promises of a career that not only demands scientific prowess, but that offers an opportunity to 'really make a difference'. The entry of large numbers of women into the materials and combustion sciences during the last generation may be crucial to defining the new field of DEE. Why? Because gender balance is always transforming. These are career opportunities offering first rate science to their sisters in the kitchen.

For the first time there is a prospect for core funding for permanent stove research institutes. The wave of inventions, both products and processes, emerging from these new initiatives, these continental stove programmes, promises to attract private capital and the entrepreneurship that lies behind it. Opportunities abound.

Today, household brands like BP, Philips and Shell are moving swiftly into the market with a sense of urgency. They can only succeed in their 'Bottom of the Pyramid" ventures if they make products cheap and attractive, functional and worth owning. The poor are very astute buyers who plan carefully before investing in an appliance. With the corporate financial power to bring the cost of technologies down by an order of magnitude, it may not be long before a 'ballpoint pen' of stoves is seen in every home.

Have you ever pondered why there is no 'appropriate technology' ballpoint pen, or an 'appropriate technology' cell phone? It is because the genius and wealth of human experience has been applied to solving those problems comprehensively, and at scale. It takes only eight seconds to make a cell phone circuit board. Why should it take two or three days to make a stove?

When it comes to combusting biomass cleanly, safely, on demand and in the home, these are 'early days' but there is still much to talk about. In this issue of Boiling Point we present a number of domestic energy technologies that are already working. Some of them incorporate high-tech ideas or components. Appropriate technologies are not really about being low tech, they are about being right for the customers, wherever they may be.

Many of the most recent developments in stove technology involve new materials like advanced ceramics and fuel treatment like densification and gasification. It will be noted by the reader that these cooking technologies fall into two categories: those that use processed fuels and those that do not (apart from cutting and splitting). Processed fuels like charcoal, biogas and gasifiers offer an opportunity to greatly increase the stove performance and greatly reduce emissions. If the fuel is predictable, it is far easier to make a stove that performs well when burning it.

The other major use of domestic energy is for lighting and this has not been ignored in these pages. The price of light emitting diodes has been dropping even as their brilliance has increased. Now is the perfect time to combine electronic and biofuel technologies. On that new horizon are novel water purifiers. We are offered stoves that produce enough electric power to charge batteries and operate electronic equipment. Bio-gasifiers are able to use a range of agro-wastes that have previously not been considered to be viable domestic fuels. Dr AD Karve noted that in India alone, 550 million tons of bio-fuels suited to gasifiers and charcoal production lie unused each year.

As you read these articles, watch for the application of the basics: energy efficiency, combustion efficiency, heat transfer efficiency and getting the smoke out of the room. Here are described some of the many imaginative and practical technologies making their grand appearance as we confidently take science to hearth.

Profile of the author

C*rispin Pemberton-Pigott has been working in the field of Appropriate Technology for 30 years, in particular rural water and manual production equipment. He has also been making stoves for 25 years, and was the winner of the Design Institute of South Africa Chairman's Award 2004 for the Vesto Stove, described by Agnes Klingshirn as the first new stove in 20 years. He is also the owner of New Dawn Engineering in Swaziland, a manufacturer of labour-based production systems for rural employment and co-founded the Renewable Energy Association of Swaziland. He is the Regional Technical Advisor for ProBEC and active on the boards of the Sustainable Energy Society of Southern Africa (SESSA), the Association for Renewable Energy Cooking Appliances (AFRECA) and a member of South African Bureau of Standards technical committees for paraffin and gel fuel stoves. For more information visit: www.newdawnengineering.com*

Theme

Good technologies…but do they really work?

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Good technologies – but are they working?

There is a property that is common to every successful technology, which is that people use it. Although this seems obvious, one has only to look around to find the world littered with well-meaning but inappropriate technologies.

Although improving the livelihood of the entrepreneur is important, at household level, the prime focus of the technology should be to enhance the lives and livelihoods of those using it. Particularly where subsidies are given, respecting the wishes of the cook and her family is particularly important. For example, if an entrepreneur gets a good subsidy for a particular stove, they will naturally be inclined to promote that stove rather than one that might be more appropriate. On the other hand, the subsidy may make it possible for a more desirable product to reach a greater number of people… but who should decide which product is best? How can we be sure that we are making the right choices if we do not live in the recipient household and cook their food each day? What criteria should we be using to make sure that the technology not only works… but is put to work? The only way is to consult the recipient families and make sure one is getting it right for them.

Box 1: Smoke hoods

Practical Action worked with communities in Nepal to find a technology that would remove smoke whilst keeping the room warm, as people like to sit around the fire. Their traditional stove was a metal tripod and the smoke had nowhere to escape, making the room smoky and the walls black (Figure 1). Insulating the dry-stone walls kept some of the heat in, and stopped the wind blowing through them, the tripod stove is partially built in with mud, whilst smoke is vented through a smoke hood – hinged at the sides so that the fire can be opened up in the cold evenings once it is burning fiercely and less smoke is being emitted (Figure 2). There are also bars inside the hood to allow people to smoke meat, and the flue, which vents through the roof, has a small, protected vent in the roof space to allow some of the smoke to escape into the roof space to preserve the timber roof tiles.

Figure 1 Family close to traditional fire; house with non- insulated walls (*photo: Practical Action Nepal*)

Figure 2 Woman sitting beside improved stove with smoke hood: house with insulated walls (*photo: Practical Action UK*)

Key factors for a working technology

For a technology to be acceptable it needs to exhibit ‘desirable product attributes’ – characteristics that make it so much better that people are not only willing to accept it, but really want it at a price which they can afford. Some key attributes include:

Effectiveness

A project may set out, say, to alleviate smoke, but through the participatory process it becomes evident that the key criterion for the cook is to save fuel. Thus, the final design must save fuel if the cook is to use it - but does it still reduce smoke? It is important that in the participatory process, the key objectives are not lost.

Prestige

Does the product look attractive? If we want to improve a kitchen, then the cook may want it to look modern, to make the kitchen more welcoming, to keep the place tidier and cleaner. Even if we are installing an ‘off-the-shelf’ stove, we may still welcome advice on how to install it so that it enhances the appearance of the kitchen. If you were the cook, would you want to invite people in to see it?

Time-saving

A stove which requires constant tending, or needs a lot of fuel preparation will take much longer overall to use. It will only be acceptable if some other factor (such as cost or availability of fuel) means people are willing to take this extra time. If a chimney stove is used, it will not be cleaned unless it is easy to clean, and good training and instructions are part of the package.

Quality

For some people, buying a technology will be a major investment relative to their income. Are we confident that the product will last? This is vital, both to ensure that people with little money are satisfied, and to maintain the market for that product – bad news travels fast, so high quality training is important (Figure 5).

Figures 3 & 4 Woman cleaning the flue from a HELPS stove in Guatemala (*photos: Don O'Neal, HELPS Inernational*)

Box 2: HELPS stove

The ONIL stove, disseminated widely in Central America, is a chimney stove with a difference. It uses Rocket stove principles (see BP47 page 36, and BP52, page 8), and also has a chimney that is easy to dismantle and clean. This latter point is hugely important. Don O'Neal, the founder of the organisation, explains 'training, training and more training on chimney cleaning' is one reason why this stove works so well and is extremely popular with those who use it. The chimneys are cleaned every couple of weeks (Figures 3 & 4) – but it is easy to do. In return, the stove uses around 70% less wood, so much less time spent gathering, the cooks experience around 99% less smoke, and children do not get burnt due to the increased cooking surface height.

Accessibility

Where can I buy one? For those without access to public transport, a few miles can be an insuperable barrier to buying a new household technology. Are there local outlets that allow people to discuss products before purchasing them? Access to fuel is another issue that can affect the purchasing of a technology – can I buy or get fuel easily? In the Sudan study shown in Box 3, a kiosk selling bottled gas could not be installed until thirty households had gas. Early adopters frequently reverted to woodfuel when they ran out of gas as the walk with a heavy bottle was too long. Once the kiosk was installed, the situation improved.

Spare parts and maintenance

What happens if something goes wrong? If some small component breaks, is a 'spare' available? Is someone there who can fix it safely? Is the model one that has a good policy of spare parts being available for several years…? If something goes wrong, do people know whom they should contact?

Safety

Burning fuels, and houses made of thatch and wood are a dangerous mix. Any fire that is out of control has the potential to cause injury and destruction. Those using new technologies should expect that their safety has been considered very carefully, and that it is easy for the product to be used correctly. Have good instructions for the use of the technology been given? Have community and individual demonstrations been planned?

Figure 5 Training entrepreneurs to make smoke hoods in Kenya (*photo: Practical Action East Africa*)

Familiarity

People with very little money cannot afford to make the wrong choice. Thus some communities will only make small changes in their cooking practices. The best technology for them may therefore not be the best technical choice. The more expensive, or different, the technology that is being introduced, the greater is the risk. The Nepal case study in Box 1 below is a good example. In this project, several hoods were installed that adhered exactly to the demands of the community even though the team felt that they would only remove some of the smoke. Once the rather indifferent findings were discussed with the community, they were happy to install much more effective smoke hoods as they were active participants in the initiative and felt more comfortable with the technology.

Affordability

The greatest barrier to improving household energy provision is undoubtedly the 'up-front' cost of the product – thus cost and availability of credit will be key factors. People's 'willingness to pay' and the way they prioritise what they buy means that our technology has to have 'Desirable Product Attributes' if it is to be an asset. Since men often have more available money than women, does our technology appeal to them too? A marketing survey commissioned by Practical Action as part of its smoke alleviation project showed that this was the overwhelming barrier to purchasing products. Making revolving funds available made a substantial increase in market size.

Consumer-driven technologies

Technology has the potential to change people's lives for the better, but if we start with the technology, there are real dangers that we will not get the best results from our efforts. The evaluation involving the World Bank, TERI, and Winrock-India in collaboration with the Ministry of Non-Conventional Energy Sources, Government of India

Box3: Introducing LPG stoves to displaced communities in Kassala, Sudan

Woodfuel is both scarce and expensive in Kassala region, and women have all elected to use bottled (LPG) gas which is cheaper, cleaner and more environmentally friendly. Practical Action is supported by the government-run Civil Defence in training women to use bottled gas safely (Figure 6). Many houses are made with walls of woven reeds, and the women smear the walls with mud to prevent sparks from igniting them (Figure 7). Some of the women also lock the gas bottles into cages to prevent small children from tampering with them.

Figure 6 Safety training involving the local civil defence (*photo: Ahmed Hood*)

Figure 7 Woman using LPG stove safely, with mud smeared on walls behind to prevent ignition (*photo: Practical Action UK*)

indicated that stoves need 'better adaptation to user needs'.

Imposing solutions can create dependency rather than independence, and the same study shows that people purchased stoves if they were subsidised, but did not replace them when they wore out. An approach that starts with people and stays with them will do more than just introduce a technology – it will provide a framework for future participation and development. Looking at the factors that have been identified above – are the important ones all there? Who knows? The only way to find out is to ask representative groups from within the community what they feel is important and to ensure that those needs are met (Figure 8).

Do the appliances work? Appliances which work beautifully using standard tests in a laboratory test rig may not work well in the field, so although background studies are valuable, the only way to get a true picture is to install them in people's homes and ask them to use it and comment on them. This could be due to chimneys getting blocked, people using fuel that is not exactly the same shape, fuel that is damp, whilst others may be much more experienced at feeding the fuel well than the researcher.

Feedback can be useful to those making the technologies, so making feedback known to the entrepreneur can benefit both households and manufacturers. The GTZ team in Malawi asked the entrepreneur to accompany them on their reviews and it proved very successful. The best demonstration of whether the technology really works is when there are more consumers waiting for appliances than there are entrepreneurs making them – and a growing sustainable market develops. Good news also travels fast.

Supply chains for goods and services can provide new jobs and income. Do the gas companies provide low-cost loans for gas bottles? They make their money out of the sale of gas – has anyone discussed the benefits to them of making gas bottles easily available- Could energy outlets be set up in local stores or markets to sell stoves, spare parts, fuels for lighting, solar cookers, gas bottles and to provide information on maintenance, safety issues, and where to get help. In Kenya, the local store is now able to sell LPG (among other energy goods) thanks to the Practical Action staff lobbying the gas company to provide a safe storage cage (Figure 9).

In the end, the end-users are the people who will decide if a technology really works, and when one hears people say 'but how do you get people to use them….' then something is going wrong. If one starts with people, provides information so that they can make informed decisions, and respond to the requirements they desire, then we can be very confident that we have helped to provide technologies that really work.

Profile of the author

Liz Bates has worked in the household energy field for several years. Currently, she is managing an international project on reduction of indoor air pollution for Practical Action. Until very recently, Liz was editor of Boiling Point and enjoys writing and editing. Liz continues to be very active in the HEDON Household Energy Network, having contributed numerous Knowledge Base articles on Indoor Air Pollution, and being the founding moderator of the Cooking and Carbon Special Interest Group (CarbonSIG). She is now actively involved in the Clean Air Special Interest Group.

www.hedon.info/goto.php/User:LizBates

Figure 8 Community meeting, Nepal – people should feel comfortable to express what they themselves want (*photo: Practical Action Nepal*)

Figure 9 Opening celebrations for LPG bottle exchange following agreement with gas company to supply a safe storage cage for bottles (*photo: Practical Action East Africa*)

Rocket mud stoves in Kenya

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Background information

The former GTZ Special Energy Project in Kenya was one of the pioneers in research and development of improved cook stoves in the 1980s. These initiatives resulted in the Kenya Ceramic Jiko (KCJ), a charcoal stove, and the Maendeleo liner which showed a 35% reduction in firewood for the Maendeleo liner and a 50% reduction in charcoal for the KCJ (Figures 1 & 2).

A second outcome was the establishment of stove production centres, the majority of which were owned by women groups (sometimes with men as members). Most of these centres were significantly subsidized by the project until 1995, when the project was phased out. A post-evaluation in 1999 showed that only a small number of these centres had survived and a few new ones started on their own. These centres are all now commercial and the annual sustainable production rate is between 12 000 and 15 000 stoves. This figure did not include production in the refugee camps, which amounted to several thousand as well.

Figure 1 Maendeleo liner "Kuni mbili" (metal cladded) firewood stove (*photo: Anna Ingwe*)

Figure 2 Kenya Ceramic Jiko (KCJ), a charcoal stove with the Maendeloe liner, centre. (*photo: Anna Ingwe*)

After the closure of the project in 1995, the production and marketing of the KCJ charcoal stove took a different direction, as its production and marketing became more commercial. To date in Kenya the charcoal stove can be commonly seen for sale in any of the urban centres.

However, the Maendeleo firewood stove has encountered several difficulties in the move from the production centers to the market for a number of reasons. Firstly, there is no monetary value attached to the firewood collected by people living in rural areas, and hence little incentive or need to reduce firewood consumption. A second reason is that the stove is a semi-finished product, and requires skilled personnel to install the stove once bought. Stove production is also limited to clay deposits areas, and once produced and transported, the price of the stove can increase so that it becomes too expensive for some to afford. In Kenya today, the KCJ costs between Ksh. 280 to 600, depending on the size (about \$4 – \$8); and the maendeleo stove costs between Ksh. 250 to 300, including installation (about \$3.50 – \$4.20).

Therefore, the continued, commercial, firewood stove production has been determined by market forces. Whilst some centres had to close or reduce production substantially due to the lack of a supply chain, other businesses were joined by private entrepreneurs.

New Initiatives

Since January 2006, GTZ – Private Sector Development in Agriculture (PSDA) has promoted the utilization of fuel saving stoves in Kenya at household and institutional level with support from BMZ (German)/DGIS (Dutch). This has principally involved the promotion of the Maendeleo stove (Figures 3, 4 & 5).

In the early stages of the project the reasons limiting the Maendeleo stove producers achieving their full potential in production and marketing, were assessed. A survey of 29 stove production centers (10 of these had been supported by GTZ in the 80s), in 16 districts was carried out in August 2005, and the results formed the basis for the intervention by the new project.

A second survey conducted in February 2006 showed that:

- 96.8 % of the population use firewood for cooking.
- 87.5 % of the population use traditional three-stones cooking.
- 4.8% of the households used maendeleo stoves (improved firewood stove), which corroborated the findings of the Ministry of Energy study, 2002, in which the results showed that 4% of the population used the improved stoves.
- The average firewood consumption is 1.2 kg per person per day (ppd), while the national figure stands at 1.5 kg per ppd.

The project has focused on addressing the problems identified during the assessment in August 2005; namely to scale up the production and sales of the maendeleo stove (branded Jiko Kisasa). The following targets were set:

Targets

At household level: 225,000 people
At institutional level: 9,000 people
Private entrepreneurs: 1,000 people

To achieve these targets, the project has been:

- Stimulating private sector and community-based organizations (CBOs) to participate on all levels of the stove development chain.

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Figure 3 Single maendeleo liner installed (*photo: Anna Ingwe*)

Figure 4 Using local pots for cooking (*photo: Anna Ingwe*)

Figure 5 Two maendeleo liner installed (*photo: Anna Ingwe*)

- Promoting a commercial approach to all stove activities, by persuading households to invest in buying stoves, and setting up private business ventures, as this will be the driving force which will eventually ensure sustainability.
- Focusing on each level of the market (sales, installation and utilization), so that all activities and strategies are geared to increasing uptake of the stoves (Figure 6).
- Capacity building to empower community members with the appropriate technical skills. This will reduce the role of institutions in the quality control, coordination, monitoring and evaluation of the stoves.
- Operating within existing government structures and staff, to bring on board local networks and political ownership, vital in supporting the project.
- Creating opportunities in stove activities for those directly and indirectly affected by HIV/AIDS in order to create opportunities to save time, money and labour.
- Sensitizing the community to support the creation of a market for stoves.

Focal areas

- Western:
  - Kakamega
  - Vihiga
  - Bungoma
  - Kisumu
  - Siaya

- Transmara:
  - Kisii
  - Transmara
  - Bomet

- Central:
  - Thika
  - Kiambu
  - Muranga

Achievements

- More than 29,000 stoves have been disseminated on a commercial basis (between Jan to Dec 2006). They are all produced by private stove producers, sold out through various marketing groups and installed by private entrepreneurs.
- 13 producer groups have been developed so that they are able to undertake stove production and marketing as a business.

Figure 6 Stove promotion on a market day (*photo: Anna Ingwe*)

- Support has been gained from two Members of Parliament.
- 15 groups have been trained with installation skills and are marketing stoves as an income generating activity.
- The support and backing of a financing institution has been acquired to offer loans for stove activities

Providing a choice

Despite the fact that the Maendeleo liner stove has been promoted in Kenya for nearly twenty years and has recently been produced on a more commercial basis, the stove has remained at a low level of use within rural communities- only 4% of the population were using this stove.

The provision of an energy saving stove to the majority of the population is one of the major objectives of GTZ. As a result of this concern, GTZ PSDA has introduced the rocket mud stove into Kenya, which has an even higher efficiency, to provide a choice between technologies to the consumers.

Following the success of the rocket mud stove in Uganda, where 100 000 stoves were built in only one year, it was decided to introduce the same stove to Kenya (see Boiling Point 52). The rocket mud stove is a wood-burning stove, which is available as a mobile unit or can be fixed in the kitchen by a trained stove installer. The stove is designed for household use and is suitable for both large and small families.

Advantages of the rocket mud stove:

- Easy to build using locally available materials.
- The rocket mud stove is clean burning and together with the chimney, significantly reduces the amount of smoke produced.
- The stove gives a potential 50-70% saving on firewood.

The decision to introduce the rocket mud stove in Kenya was based on the following reasoning:

- The maendeleo liner is produced in areas near clay deposits.
- The cost of the maendeleo stove can increase significantly once it is transported from the production

site to other areas for marketing. This has the effect that the stove becomes out of the price range from many people to buy.
- It is important to provide an alternative choice of firewood stove, especially to cater for areas that are not producing the Maendeleo liner.
- The communities and rural life in Uganda where the rocket mud stove has been very successful are similar to those in Kenya, and therefore could apply lessons from Uganda to adapting the stove for the Kenyan environment.

It was decided that the first step would be to introduce the stove as part of a pilot scheme in Kisii, as the stove is a new technology to Kenya. The experience gained from the pilot project would also help the project to develop a suitable strategy to promote the stove in other parts of Kenya. The stove was introduced in May 2006.

Kenya experience with the Rocket Mud Stove

- The stove has had high acceptability in the pilot scheme in Kisii, which increases its chances for replication. Between June and October 2006, approximately 7,800 stoves have been installed in the Keumbu Division (Figures 7 & 8). This covers around 80% of the division.
- The major investment has been training people in the skills needed to construct the stoves. Income generation is an incentive for the stove builders to continue building stoves, however, out of 480 stove builders trained, only 98 stove builders are constructing this stove on a commercial basis.
- It is a good idea to train a large number of stove builders as it increases the rate at which a stove becomes utilized over an area. However, in the long run, there can be negative consequences to this strategy, in that if the area is rapidly saturated with stoves there will be few jobs for the trained stove builders, unless they move to other areas. The benefits of training a few, local people to build stoves are that their skills are perfected through the continued process of building and that the cost of the stoves is reduced now that there are no transport costs. At present, the cost of construction of a stove is between Ksh. 50 to 200.
- In some areas, depending on the soil type, the fire chamber can erode at a rapid rate as a result of wear through use, especially in places where the firewood touches the back of the fire chamber. The erosion of the fire chamber interferes with the efficiency of the stove- a fact which had prompted the development of the maendeleo liner twenty years earlier.
- The pot rest tends to wear out fast because cooking ugali, one of the most common foods cooked in Kenya, requires a large amount of strong stiring which affects the pot rest. In Uganda this was less of a problem because the staple food is banana cooked in a way that does not affect the pot rest.

Figure 7 Rocket stove in use (*photo: Anna Ingwe*)

Way forward

- Train only a few stove builders so that they have a continuous market over time and are able to perfect their skills. This should also help to keep the price of the stoves stable since excessive competition between stove builders for clients would drive the price too low.
- Carrying out field tests using ceramic product insertion for the fire chamber.
- Field test with ceramic pot rests.

Figure 8 One can also sit while cooking on the rocket stove (*photo: Anna Ingwe*)

It is evident that the inclusion of two separate ceramic parts in the product may affect the price of the stove. Nonetheless, it is also important to make sure that the necessary adjustments are made to ensure that the technology lasts.

Recent evaluations show a positive uptake of the stove by the Kenya community of Kisii, although there are a few technical problems that require attention in order to provide the community with a more efficient stove that will last longer.

Profile of the author

Anna holds an MSc in Renewable Energy from University of Oldenburg. She- has been involved in Household Energy since the early 90ties and is currently heading the GTZ Household Energy Project in Kenya.

Theme

Green Power - Lighting up Rural India

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Introduction

The following article discusses the use of solar home systems/lanterns that have been successfully employed in India and have displaced carbon emitting fuels such as kerosene and diesel. All information presented is in the context of the Photovoltaic Market Transformation Initiative (PVMTI).

The photovoltaic (PV) Solar Home Systems (SHS) under discussion are sold mostly to rural and semi urban households in India. Many of the regions in rural India are completely off -grid (around 46%); others are connected to the grid but have intermittent or no supply, so there is a real need for these consumers to find alternative power solutions. The SHS provides reliable power for lighting and other low-power appliances, such as radio and television. Customers today understand the benefits of installing SHS and see the value of investing in one. Though initial applications of these SHS were restricted to domestic lighting, today there are many instances of installations in schools, small hospitals, community centres, and a multitude of micro-enterprises, where SHS can extend viable working hours into the night and provide power for operations. The SHS have great intangible benefits too – smoky and carbon intensive kerosene lights are avoided and people have new leisure and educational opportunities.

However, in the initial years, it was an uphill task for the SHS integrators (entrepreneurs). There were many challenges – a negative image of solar due to bad experiences with unscrupulous operators; solar was considered too expensive and unaffordable since there was no concept of credit sales; customers' insisted on using available government subsidies, which were not always paid on time and meant the entrepreneurs had to find extra working capital.

Figure 1 Mobile educational service van SHELL (*photo: Shell Solar India*)

Over time, several initiatives were undertaken by the solar integrators to overcome these barriers:

- Establishing Credit Sales:
  The integrators invested considerable time and effort to create awareness of solar energy among various local financiers and to provide loans for the purchase of SHS. At present, around 90% of all sales are credit sales as against the cash sales that existed 4 – 5 years ago. The customers can now pay for these systems over 3 – 5 years with monthly instalments not exceeding the total monthly expenditure on kerosene.
- Prompt and reliable after sales services:
  There are various models that integrators have adopted. However, whether this is the setting up of their own service infrastructure or developing a strong dealer network, the key to success has been prompt after sales delivery. All integrators have technicians regularly visiting customers thus giving them the comfort level about product reliability. In some cases the entrepreneurs have also trained local people to look after basic maintenance of the systems with their technicians handling more complex issues.
- Establish linkages with the grassroots level organisations:
  India has a multitude of cooperatives, self help groups, NGOs etc. operating at the village level. Almost all the entrepreneurs have developed strong partnerships with these organisations. They have been instrumental in marketing, creating awareness, appraising customers and in some cases extending financing for purchase of the SHS (Figure 1).
- Design for the customer needs:
  Whether it is technical or financial requirements, some integrators focus on customisation. This reflects in the type of systems sold and the loan products offered. The systems sold are not standard off the shelf products. Technicians have studied the requirements of the users and solutions are offered based on their need. For example some households have only one light installed but it is installed in a manner that lights up at least 2 rooms.
- Move beyond simple lighting:
  Use of SHS for increasing employment income (Figure 2). In some cases the entrepreneurs

Figure 2 Silk rearing - SELCO installation (*photo: ITPI personnel*)

Figure 3 Woman entrepreneur - SELCO installation (*photo: ITPI personnel*)

Table 1 Projects/Installations supported by PVMTI in India

Company	Nature of Business
Shell Solar India Pvt. Ltd.	A solar home system integrator based out of South India. Current areas of operations are Karnataka, Kerala and Andhra Pradesh.
SELCO Solar (P) Ltd.	A solar home system integrator based out of South India. Current areas of operations are Karnataka, Kerala and Andhra Pradesh. Recently started operations in Gujarat.
SREI Infrastructure Finance Ltd.	A Non Banking Finance Corporation providing working capital finance to system integrators and end consumer loans for purchase of SHS in West Bengal, now expanding into surrounding regions.
Shri Shakti Alternate Energy Ltd.	A private company promoting sales of solar and gas based appliances in urban areas. The company has also set up independent PV plants awarded to it through government tenders.

have worked with the users to generate additional income from use of SHS. These income streams have then been used to service the loans. An example of this would be the purchase of small lighting systems by street hawkers[1] (Figure 3). The solar systems generate savings over the use of kerosene lamps. These savings are then set aside on a daily basis and repay the monthly instalments to banks. These savings are more than adequate to repay the banks.

Today, these entrepreneurs have clearly demonstrated that SHS are a viable and affordable option for low income households. Figure 4 shows the installed capacity across India due to PVMTI.

Of course no technology will work on a stand alone basis and it needs to be supported by an equally strong financing and service infrastructure.

From PVMTI's perspective, what is crucial to the success of a technology are entrepreneurs who are committed to the technology. The companies sponsored by PVMTI have taken a few years to develop the required infrastructure but they run profitable businesses today. What is also needed is for financial institutions to come forward and support such entrepreneurs by offering flexible financing options that would allow them to pursue their goals. PVMTI has been flexible in adapting to the changing times and to help the entrepreneurs readjust their business models according to the need of the time.

About PVMTI

Funded by the International Finance Corporation (IFC) and the Global Environment Facility (GEF), PVMTI promotes sustainable commercialisation of PV technology in the developing world by introducing successful, replicable business models. Since 1998, about US$ 16.6 million have been committed to nine projects in India, Kenya and Morocco and finalization of additional projects for the remaining funds is underway. The program has financed 4 projects in India, committing around US$ 10.8 million (as debt, grants, equity and guarantees) to these projects.

Projects/Installations supported by PVMTI in India are shown in Table 1.

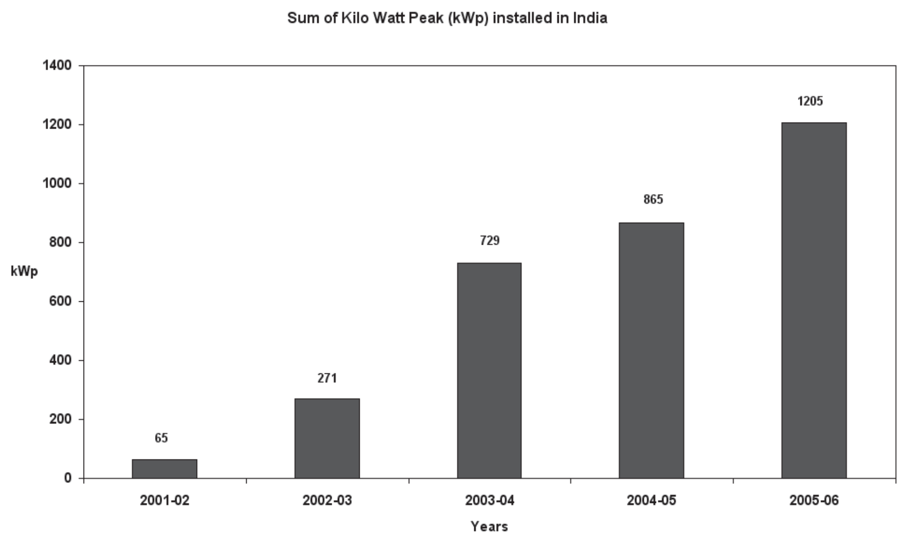

Figure 4 Installed Capacity (kWp) in India under PVMTI

The funds available under PVMTI are concessional in nature. However, PVMTI's strength has been the flexibility it has offered in terms of guarantees and repayments. The program has looked at new and innovative projects and has worked with entrepreneurs to readjust their business strategy when the need arose.

IT Power India Pvt. Ltd. (ITPI), a member of the IT Power Group based out of UK, is a reputable renewable energy and environmental management consultancy firm, based in Pondicherry, India with regional offices in Pune and New Delhi.

ITPI's core expertise lies in the following areas: harnessing alternative energy, designing and developing rural electrification systems, managing funds for financing renewable energy technologies, facilitating phase-out of ozone depleting substances, implementing Clean Development Mechanism (CDM), tackling waste management, R&D in appropriate technology for health, and developing and elaborating standards..

Under the PVMTI project, ITPI is part of the External Management Team which manages PVMTI's investments in India and Morocco.

[1]Model promoted by SELCO India. More details can be found at:

www.ashdenawards.org/winners/selco

Profile of the author

Ms Hari is a commerce graduate from Sri Ram College of Commerce, Delhi and holds a postgraduate degree, Masters in Finance from the prestigious Indian Institute of Management, Bangalore. As manager of the Financial Solutions Group at IT Power India, she is also the Deputy Country Manager for PVMTI India. She was previously employed by JP Morgan Chase and has worked in Singapore, Hong Kong, Tokyo and Mumbai.

The Biogas Programme in Vietnam; Amazing results in poverty reduction and economic development

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Introduction

It is widely recognized that access to energy services has strong linkages with development. Most rural households in developing countries are forced to draw on traditional biomass materials – wood, charcoal, agricultural residue and animal dung – to meet their daily domestic energy needs. By doing so they not only exhaust these resources, but also pollute the air they breathe at home by burning these substances. They often fall prey to acute and chronic respiratory illnesses. The collection of the traditional fuels devours precious daylight hours that children and women in particular might otherwise spend at school, in income-generating or social activities. In short, the current unsustainable consumption of these traditional energy sources damages not only the biosphere, our greatest reserve of natural capital, but human capital as well.

Domestic biogas: a low-cost, sustainable anti-poverty agent

One very promising approach to fight poverty and address the urgent energy needs of rural households is the Biogas Practice that SNV – Netherlands Development Organisation has developed for Laos, Bangladesh Cambodia, Nepal and Vietnam. Since 1989 SNV – with financial support from the Netherlands Ministry of Foreign Affairs (DGIS) and the German Kreditanstalt für Wiederaufbau (KfW) - have worked with local partners to develop and carry out large-scale programmes for domestic biogas. The model maximizes the utilization of the energy of the hot combustion gases by prolonging their contact with the maximum surface area of the pot before their evacuation through the chimney. For this purpose a skirt with hoop seals on the top is needed.

SNV adds value

SNV's capacity building activities help to develop a self sustaining biogas market. SNV, together with local partners, supports enterprises and credit institutions with business training and on-site coaching to meet the increasing demand for domestic biogas. This is done in several national biogas programmes, in which it is establishing sound quality control systems and develops appropriate policies to spur this new sector. By now about 200,000 farming households in Nepal and Vietnam tap their biogas plants to meet domestic fuel needs, and many more people will benefit in the near future.

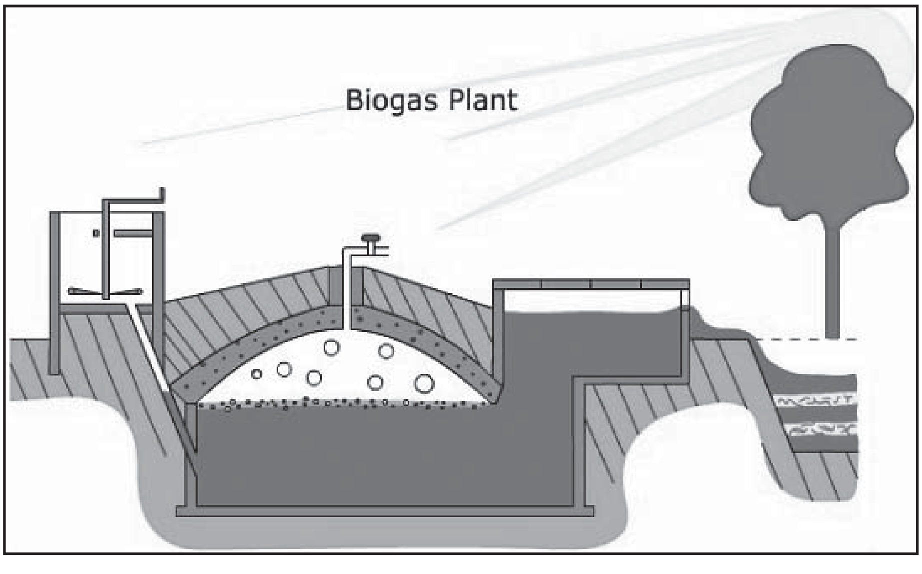

Figure 1 Diagram of a cross section through a Biogas Plant

Turning Natural Waste into Safe, Affordable Fuel

Biogas technology is about capturing the gas that results from the anaerobic fermentation of biomass. The plant uses the natural processes of anaerobic digestion to produce biogas from animal dung and night soil. Biogas consists of methane that can be used for cooking and lighting. The trick is to store dung and night soil in such a manner that air cannot enter during the storage. The biogas plants promoted by SNV are simple underground structures of bricks and cement – known as the "fixed dome type" - that last at least 15 years. See a cross section in Figure 1.

Farmers who keep more than two heads of cattle or seven pigs generate enough fuel to meet their daily cooking needs. Larger livestock populations may produce enough energy for further commercial use as well.

Small risks, big gains

The success of the biogas programmes springs from the direct benefits it brings to the daily lives of poor farming households, most importantly cleaner kitchens and the reduction of indoor air pollution. Other benefits also include: money saving, time reduction in searching for fuel and hence more hours available for schooling, productive activities or to socialise. The residue, "bioslurry", increasingly used as fertilizer, increases agricultural yields and reduces the use of chemical fertilizers and pesticides, therefore increas-

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ing income. On an investment of about 250 Euro, the payback period of a digester is only 2 to 3 years. Apart from the advantages for the household, the use of biogas also improves the quality of the local environment, such as the groundwater, soil and air. These improvements alone, farmers affirm, justify their investment. On a far broader scale, biogas use reduces greenhouse gas emissions, protects forests and stimulates private sector development.

Global warming

Since July 1992 some 165,000 biogas plants have been built in Nepal for families in the rural areas. This has saved an estimated 475,000 tons of firewood and 950,000 litres of kerosene, preventing 700,000 tons of greenhouse gases (GHG) from being emitted in the atmosphere. With 25,000 biogas plants completed by the end of 2006 in Vietnam, the estimated reduction of GHG in this country amounts to 75,000 tons of CO_2 per year. Together this equals the green house gas emission of over 500,000 tourists flying from Amsterdam to Bangkok!

The Clean Development Mechanism (CDM), one of the agreements of the Kyoto Protocol, opens the opportunity to capitalize on green house gas emission reduction. On a carbon market, developing countries can sell their quantity of green house gas emission reduction (Certified Emission Reductions) and generate revenues. This mechanism will generate funds for the biogas programmes which in their turn will reduce the farmer's investment costs. The Nepal programme has already managed to secure their CERs and the Vietnam programme is on its way to acquire CERs as well.

Table 1 Outputs Biogas Programme Vietnam period 2003 to 2007

Constructed biogas plants	27,000
Number of Provinces	20
Savings on workload/household	1 to 1.5 hours per day
Savings of fuel/household	5 Euro per month
Rural job creation for masons	300,000 labour days
Income masons	2.5 Euro per day
Turnover labour costs	750,000 Euro
Sanitation	40% have now toilets attached to digester

Biogas works in Vietnam

Different domestic biogas digester programmes have been implemented in Vietnam over the past 50 years, but none have aimed at large scale dissemination or long-term operational success. This is despite the fact that conditions in Vietnam are favourable for biogas and that people are interested in the technology because of the obvious benefits that biogas can provide.

Against this background, the Vietnamese and Netherlands Governments agreed on the implementation of a domestic biogas dissemination project in January 2003. The Vietnam Biogas Programme uniquely joins Vietnam's technical knowledge on biogas technology with Netherlands' experience with large-scale dissemination and capacity development. The first phase was successfully completed in January 2006 with the accomplishment of completing 18,000 plants. In 2006 the programme expanded from 12 to 20 provinces and increased the number of installations with another 9,000 (Figure 2 & 3). The planning up to 2011 is to reach about 35 provinces and install a total of 150,000 plants, which will provide 800,000 people with improved energy services (Figure 4). But the programme is about more than enabling access to sustainable energy services; it also creates jobs, generates economies, and improves sanitation. In table 1 you can find the results from 2003 to 2006.

Figure 2 Construction of a biogas plant (*photo: Biogas Programme Vietnam*)

Goals of the Programme

The overall objective of the project is "to further develop the commercial and structural deployment of biogas, at the same time avoiding the use of fossil fuels and biomass resource depletion". The specific objectives contributing to this overall objective are to achieve economic, environmental and social sustainability, with a specific focus on economics, as the programme has to result in a commercially viable biogas sector supported by independent businesses. This will guarantee the continuation of biogas activities after the programme finishes in 2011.

One of the strategies is to enable biogas builders in becoming (formal) businesses with knowledge on marketing, planning and management. Already many masons take care of advertisement, after sales and management, and work independently from the programme's support; a development that - as long as the quality is to standard - the programme welcomes.

A technology that works

A technology may be right on the drawing table and it may even have been proven to work in some developing countries; but this does not guarantee successful dissemination in other localities. Successful large-scale dissemination depends on the interaction of a chain of actors from management- to household level, and involves many factors. One weak link can frustrate the balance between supply and demand, either within the programme's group or outside its scope. An analysis of the

Figure 3 A completed biogas plant, only a small part of the plant is visible above ground (*photo: Biogas Programme Vietnam*)

situation in Vietnam is made next.

In the context of Vietnam, dissemination of a product heavily depends on the support of the public sector; lobbying and good communication are paramount. The Ministry of Agriculture, under which the programme resides, has proven to be a great supporter in achieving the goals of the programme and tries to commit other Ministries to facilitate its endeavours. Also, high-level support from the Netherlands and international donors has helped the programme grow.

A nationwide implementation programme like this one is too big to control centrally and therefore decentralisation of tasks and responsibilities is required. Through extensive meetings and training at provincial and district level, awareness and capacity building is enhanced, and by sharing responsibilities all feel more responsible in their role. Provinces have to pay a financial contribution to join the programme and so to prove their commitment.

Another critical factor for successful dissemination are the masons who actually build the biogas plants and are responsible for providing high quality services. By regular quality control, workshops, refreshment training, and even through competitions organised by the programme, all mason teams are trained to a high professional level.

Eventually households (customers) are the ones who decide whether to purchase a biogas plant or not, and in doing so they define the demand for a biogas market. According to our survey, the environmental benefits, like smell and pollution, are the main incentives for buying a digester, whereas money savings also help to increase popularity. In rural Vietnam awareness and information diffusion progress mainly by word of mouth and through meetings held at the communal level. After exchanging positive experiences, it becomes clear that purchasing a biogas plant is a good investment.

Challenges in the future

So far, clients seem very satisfied with the progress and achievements of the Biogas Programme Vietnam. Recently, the programme has won the prestigious international price for sustainable development programmes, the ENERGY GLOBE AWARD.

However, ample room for improvements remains. The focal point for the coming period is securing high quality services. Where demand is high, quantity may compromise quality, and therefore the Biogas Programme puts in a lot effort to ensure that quality and reliability are the starting points of any biogas activity in Vietnam.

Figure 4 The biogas plants provide houses with improved energy services (*photo: Biogas Programme Vietnam*)

The programme is treading new roads in trying to secure possible CDM revenues. Biogas plants indeed reduce GHG emissions, but complying with rules and regulations proves to be complicated; energy and manure related data for each and every household has to be collected. A possible threat is that monitoring costs will be higher than the benefits, a problem that is shared with many small decentralised energy projects applying for CDM. Innovative solutions are required to enable CDM flows to reach poor households in rural Vietnam.

In terms of economic sustainability the development and strengthening of the private sector is a challenge that will increasingly be at the centre of the programme's attention. This will require cooperation and willingness of both the public and private sectors, in which SNV will play a strong facilitating and advisory role.

We hope to inform you about more interesting progress and challenges in the period ahead. For more information please be visit: www.biogas.org.vn and feel free to contact us for any information.

Profile of the author

SNV is a Netherlands-based, international development organisation that provides advisory services to nearly 1800 local organisations in over 30 developing countries to support their fight against poverty. With a background in energy and poverty issues, Bastiaan Teune has worked for 1.5 years as a SNV advisor to facilitate the Biogas Programme in Vietnam and contributes to create innovative approaches and by linking actors together to the benefit of better biogas dissemination.

Pico hydro for cost-effective lighting

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Introduction

In communities with no access to electricity, lighting is provided by kerosene lamps, torches or candles, all of which give poor quality light at relatively high cost. Lighting is usually the primary use of electricity, when it does become available, but the cost will depend on the technology used. Traditional water-power technology has often been used in remote communities for small scale processing of agricultural produce. Pico hydropower adapts this technology to meet modern requirements for electricity and mechanical power. Through recent developments pico hydro has become even more cost-effective for rural electrification. There is already widespread use of this technology in Nepal and significant potential in many other countries.

Pico hydro usually refers to schemes of up to 5 kW output. The available power is related to the water flow rate and the available head between intake and power house. Where only low heads are available (less than 10 m) the flow rate must be greater to compensate for the lower water pressure and the cost of pico hydro tends to be slightly greater. There are a number of different approaches to implementing pico hydro, but those that are cost-effective rely on the use of standardised equipment. In some cases schemes supply only one household, while in others a whole community may be served.

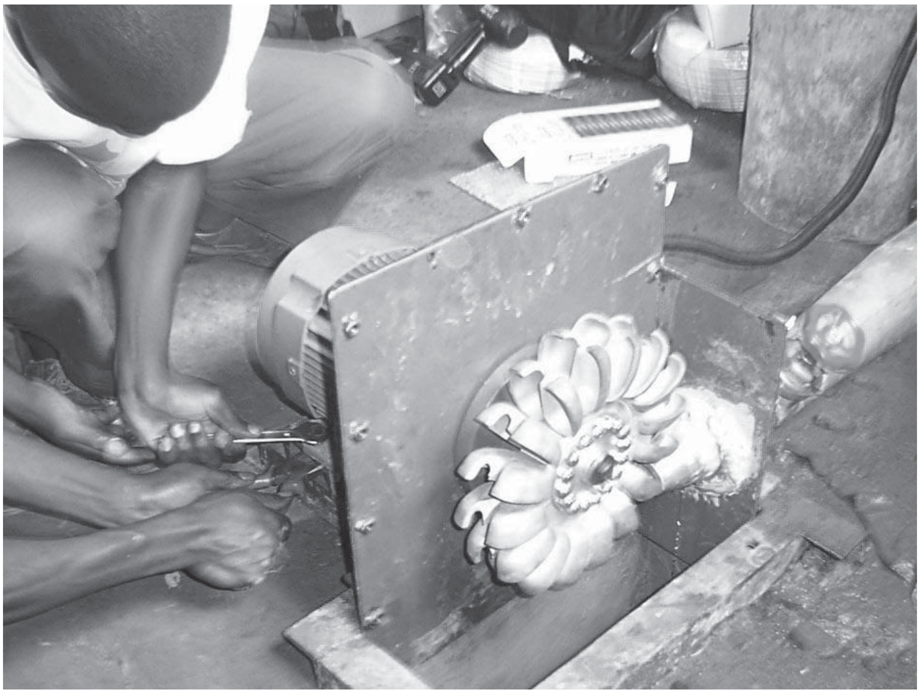

Figure 1 Bolting a Pico Power Pack (*photo: Phil Maher, Pico Energy Ltd.*)

Overall scheme design

Designing a pico hydro scheme is time-consuming because each site has different characteristics in terms of head and flow available and the relative position of intake, power-house and consumers. Carrying out thorough site surveys and designing equipment for each site can increase the engineering costs out of proportion to the size of the scheme. One focus of recent research has been the reduction of engineering time through new implementation approaches. Through standardisation and use of new technology, it has been possible to reduce costs while maintaining performance and reliability.

It is difficult to obtain accurate hydrological data from maps or databases, as the catchment areas are too small. Flow measurements, often using low-tech methods, are best made at the driest time of year in order to design the scheme to supply continuously available power. For higher head schemes, height measurements can be made using a hand-held digital altimeter with sufficient accuracy (± 1 m) to carry out the scheme design.

All the site survey data can be collected during one site visit using a standard GPS unit, and this data can later be downloaded to a computer and used to calculate lengths of pipes and cables. Software is becoming available that can optimise the pipe sizes and cable layouts, leading to economic selection of materials while saving many hours of skilled engineering time.

Larger hydro schemes have all of the equipment custom designed for each scheme, but for pico hydro this is not cost-effective. Turbines are often made in a range of standard sizes and adapted to site conditions by changing the operating speed. Local manufacture of turbines can keep costs down, but the designs have to be appropriate for available materials and manufacturing equipment. Pico turbines are often produced in small workshops so the designs have been simplified still further, with no variable guide vanes or spear valve to control flow rates. Often a direct drive to a fixed speed generator is used, in which case the site layout may be designed to fit the closest available turbine option, rather than the other way round. Turbine costs can be further reduced if batch production methods are introduced.

Standard industrial three-phase motors have been adapted for use as induction generators to supply single-phase loads. They have no slip rings or brushes and are therefore more reliable than small alternators. An electronic induction generator controller (IGC) is now being manufactured in several countries in Asia, Africa and Latin America. The controller senses the

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voltage and uses "ballast" or "dump" loads to maintain the generator speed as required.

Examples of Pico Hydro schemes

In 2001-2 two pico hydro schemes were commissioned in the Kirinyaga district of Kenya (Maher et al. 2003). Since they are demonstration projects, some of the equipment costs were covered through an EU funded project, but the schemes were designed to be cost-effective. Each community contributed time, some materials and finance. A management system was set up to collect monthly charges and oversee maintenance. Households were given the option of one or two compact fluorescent lamps, and they pay according to the number of lamps. Load limiters ensure that each house takes only their allocated share of power.

At Kathamba, a Pico Power Pack (Figure 1) was installed with the turbine runner attached to a shaft extension from the generator. This is a Pelton turbine that can be locally manufactured but still has an efficiency of 70% for only 1.1 kW output. At Thima a centrifugal pump has been used as a turbine (Figure 2). An additional shaft extension has been fitted at the other end of the generator to drive mechanical equipment.

At Magdalena in northern Peru, a low head site uses an axial-flow propeller turbine (Figure 3). Again this is a demonstration scheme, from which valuable information on turbine performance has been gained. It is planned to produce a guide to design (del. of) such turbines as part of a project funded by the Leverhulme Trust (Simpson & Williams 2006).

Figure 2 PAT at Thima (*photo: Phil Maher, Pico Energy Ltd.*)

Figure 3 The low-head turbine at Magdalena drives an induction motor as generator (IMAG) with controller (*photo: Robert Simpson*)

In Nepal and in the northern parts of India, the traditional wooden waterwheel (pani ghatta) has a vertical axis. Improved designs using steel have been successfully implemented. They are cost effective as they require less maintenance and produce more power from the same head and flow so that modern processing machinery, such as rice-hullers, can be driven. Examples of such schemes have recently been installed in Himachel Pradesh, where seven mill owners have been given assistance to install 5 kW generators (Kashyap & Arvind 2006).

Technology Dissemination

For small-scale rural electrification projects there has gradually been a move away from projects funded purely by outside agencies such as regional governments or development charities. Many successful projects are now being implemented through local entrepreneurs and a market is being developed for pico hydro equipment. An example of this is in Kenya, one of the local technicians trained during the installation of the demonstration schemes in Kirinyaga, has set up his own business and has started installing similar schemes in other villages in the district (Figure 4). For successful dissemination of the technology, manufacturers need to be capable of producing a reliable product and consumers need to have access to small-scale finance. Development organisations are taking on the role of enablers within this process.

For pico hydro schemes, the cost per household has been reduced by the use of compact fluorescent lamps (CFLs), which are now widely available. Only 20 watts is then enough power to light a typical rural house, so 2 kW is enough to supply up to 100 households with electricity, with power available during the day-time for charging batteries or driving agro-processing equipment. Similar technology has been installed in remote parts of Thailand under the direction of an organisation called Border Green Energy (BGET 2006). Information on the technology has been disseminated partly through web-based resources.

Cost Comparisons

Detailed costs of pico hydro schemes are often difficult to obtain. Some schemes for which data are available show a range of costs from US $ 1000 to $ 9000 per kW of power output. Some of the higher scheme costs were due to poor scheme design where the actual output was much lower than the intended plant capacity. However, where schemes have been well designed, average costs are around US $3000/kW. A similar figure of Rs 200,000/kW for schemes up to 10 kW has been estimat-

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Figure 4 Ngewa (*photo: David Kinyua, Dhetcons Engineering*)

ed for new schemes in India (Kulkarni 2004). For schemes where existing water mills have been upgraded to produce electricity, costs as low as US $700/kW have been reported (Kashyap & Arvind 2004). Taking into account that these schemes can provide power up to 24 hours each day, the costs are significantly lower than kerosene lamps, grid connection or a solar home system.

Small petrol or diesel generators and solar home systems, which would be another environmentally friendly option, typically cost at least five times more per unit of energy than pico hydro (Maher et al. 2003; World Bank 2005). For a household that uses pico hydro to supply 20 W CFLs, the monthly cost would be approximately US $0.80. In comparison, with typical costs of kerosene lamps would be between $1.5 and $3 per month, depending on the price of kerosene. In some countries, kerosene is subsidised, but prices of kerosene are predicted to increase significantly over the next decade, whereas renewable energy costs are likely to be stable. In relation to kerosene lamps, electricity from pico hydro has three other advantages: it reduces fossil fuel use, hence CO2 output, cuts down the number of house fires and provides power for recharging portable equipment such as mobile phones.

Even white light-emitting diode (LED) based lamps are becoming a cost-effective option for rural lighting (Mills 2005). Up to 20 LEDs are incorporated into a single lamp, which can be designed for mains operation. Three 1.5 W LED lamps will give a similar light output as a 10 W CFL. Although the initial purchase price of LED lamps is higher, they will last up to 15 years when used 5 hours each day. The future for pico hydro looks brighter than ever.

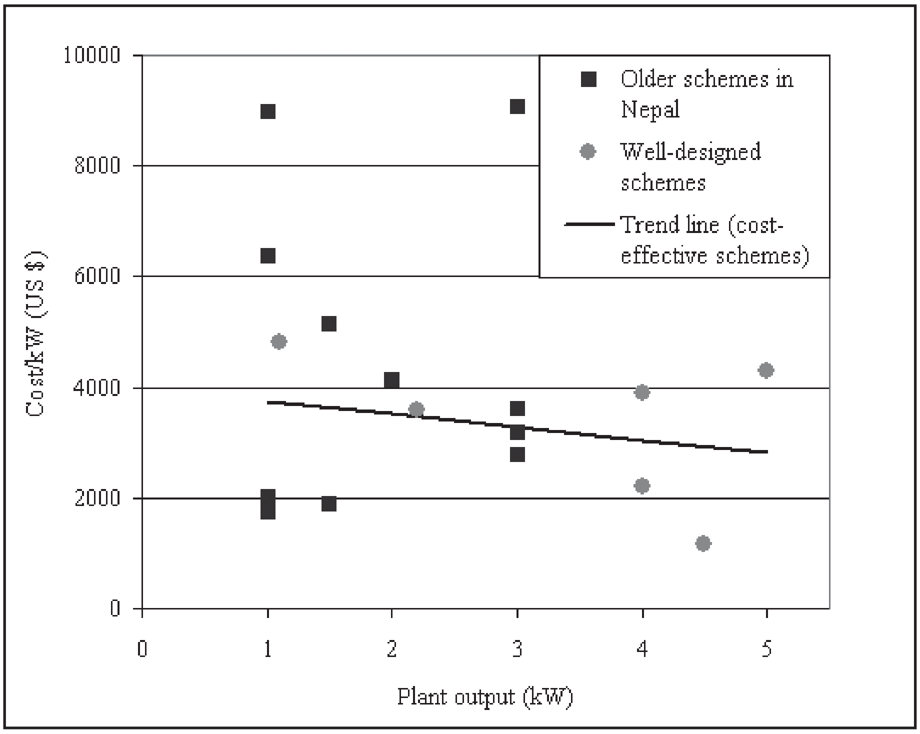

Figure 5 Comparative scheme costs (per kW of output) for various pico-hydro schemes

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Profile of the author

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Theme

Biomass Gasifier Systems for Thermal Applications in Rural Areas

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Introduction

Biomass fuels continue to play an important role both in the domestic and industrial sector in India, as it is an agricultural-based economy. Biomass is the main source of energy for a large number of small, rural, and cottage industries along with the majority of rural households. The majority of these enterprises belong to an unstructured sector and hence information and data on these industries are scarce. These industries provide employment to millions of people and form a very important part of the rural economy. The biomass-consuming industries can be divided into two categories, namely traditional industries and new or potential industries.

Traditional biomass-based industries are essentially rural cottage and small-scale industries. These industries depend predominantly on biomass fuels such as wood, agricultural residues, and animal dung because biomass is cheap and its supply is assured. Biomass energy is used in these industries for direct heating (firing of bricks, lime), indirect firing (drying, baking), boiling, steam raising and distillation.

New or potential biomass-based industries include many medium- and small-sized enterprises that currently use fossil fuels and are willing to switch over, at least partially, to biomass fuels available locally at lower prices. Examples of these industries include textile mills, brick kilns, mini cement plants, steel re-rolling and lime kilns.

This situation calls for the development of a biomass-based but energy efficient and environment friendly system with better environmental acceptability, economic viability, and good process control. The biomass gasifier system is ideal for such applications as it can offer all these qualities.

Biomass gasification is the process of conversion, through partial combustion of solid biomass feed material into combustible gas. The technology may be regarded as fuel switching to convert solid fuel to gaseous fuel. Gasification is achieved in the presence of heat and a limited supply of oxygen, resulting in incomplete combustion of the solid biomass material. The resulting combustible gas mixture can be burnt directly in an oven/burner for thermal applications or cooled, cleaned and fed into a diesel engine to generate electricity.

For over two decades, TERI (The Energy and Resources Institute) has been working on the development of various biomass gasifier designs (downdraft, updraft and natural draft) for both thermal applications as well as for decentralized power generation. So far, more than 350 TERI gasifier systems have been successfully installed in the field throughout India with a cumulative installed capacity of over 13 MW_{th}. This paper gives an account of TERI's efforts in developing and promoting biomass gasification as a sustainable and eco-friendly option to meet energy demand for three selected rural applications: cardamom drying, arecanut processing and community cooking.

Gasifier system for community cooking

In a developing country like India, biomass is still and will remain the major fuel for cooking energy. There are several residential schools and religious places that consume substantial quantities of fuelwood daily. Apart from contributing to deforestation, it also consumes a lot of time and labour in its collection. TERI has designed both downdraft and updraft gasifier based cooking systems and installed these at residential tribal schools at Doimukh in Arunachal Pradesh and Kankia in Orissa (Figure 1 and Figure 2). The updraft gasifier system can also be operated without a blower under natural draft mode in unelectrified villages. The fuel consumption data and time required for cooking using the gasifier system is tabulated in Tables 1 and 2 along with a comparison to the traditional stove.

Wood gas system for large cardamom curing

With an annual production capacity of more than 4 000 Metric Tonnes (MT), India is the largest producer of large cardamom with a 54% share in world production, followed by Nepal and Bhutan. Within India more than 85% of production comes from Sikkim and Darjeeling. To achieve a long storage time and to bring out the characteristic aroma, cardamom capsules have to be dried to reduce the moisture content from about 70-80% to below 10% . Traditionally, an inefficient smoking method is employed, using a bhatti (oven) system. Out of the total large-cardamom cultivation area in Sikkim, more than 85% plantations are very

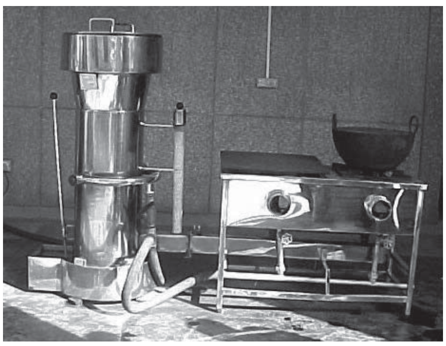

Figure 1 Downdraft gasifier for cooking (*photo: Dr Sanjay Mande & Debajit Palit*)

Figure 2 Updraft gasifier for cooking (*photo: Dr Sanjay Mande & Debajit Palit*)

Theme

Table 1 Summary of performance data of gasifier-based cooking system at Doimukh, Arunachal Pradesh

Item	Fuel consumption (kg)		Cooking time (hrs)	
	Traditional oven	Gasifier system	Traditional oven	Gasifier system
Rice (~ 30 kg)	18 – 20	15 - 20	1.30 – 1.45	1.45 – 2.15
Dal (~ 5 kg)	15 - 20		1.00 – 1.30	
Total	33 - 40	15 - 20	2.30 – 3.15	1.45 – 2.15

small with an area of less than 2 ha, with over 34 000 traditional bhattis, making it a small farmer's business.

The bhatti is made-up of locally available construction materials. It has a 0.60 m thick stonewall structure on three sides and a wide opening in the front for burning large wood logs. About 400-600 kg fresh, large-cardamom capsules are loaded as a thick bed on a bamboo or wiremesh platform and placed on the stonewalls. Large wood logs from within plantations are fed and burnt in the front opening of the bhatti, and the capsules are exposed to a large amount of smoke to dry them. Thus the cardamom bed is exposed to the thick smoke generated during the burning of wet wood and it takes about 30-50 hours to dry the cardamom (Mande et al. 1999).

TERI has developed an appropriate gasifier-based large-cardamom dryer system (Figure 3) to suit local conditions. The system is made of locally available material and can be easily transported into remote forested areas where cardamom plantations are found. More than 150 systems have been installed in the state in collaboration with the state Horticulture Department and these systems have also been pilot tested in Nagaland state in India, as well as in Nepal and Bhutan. Through extensive field performance monitoring it was observed that use of gasifier not only resulted in more than 62% fuelwood saving but also resulted in improving the quality of the product, as the dried cardamom retained 35% more volatile oils and natural reddish colour (Figure 4). Thus induction of a gasifier system cannot only help in the preservation of natural forest but also in increasing the income for farmers. A greater oil content without a burnt smell could also open new industries for large-cardamom by way of extracting its oil.

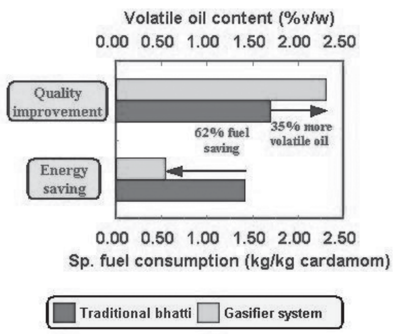

Figure 4 Comparative performance of traditional and gasifier based cardamom-curing system *(Diagram: Dr Sanjay Mande)*

Arecanut processing

Arecanut palm (Areca catechu L.) is cultivated for its kernel, which is chewed in its tender, ripe or processed form. The north-eastern region of India is a major producer of arecanut in India, producing 21% of the total national production. Most of the production is exported to outside the region. The major processing clusters are in northeast India with large (5-7 tonnes of processed arecanut produced weekly) and medium sized (2-3 tonne of processed arecanut produced weekly) units located in Rupahi and Howly, in the state of Assam. Apart from these clusters, thousands of cottage-level processing units are also found in Cachar, Karimganj, Darrang, Dhubri and Kokrajhar districts of Assam.

There are two varieties of processed arecanut processed in the state of Assam and other states in India: Boiled, dried nuts (red in colour, called chikni) and non-boiled, sun dried nuts (called supari). Tender green arecanut are de-husked, boiled and dried to obtain the chikni. Boiling is done in batches in flat, open, iron pans (4-5 feet diameter) where chopped nut pieces are mixed with colour and boiled at 70–80°C, to cook and absorb the colour (Figure 5). The first batch of boiling in a day takes 50 minutes and subsequent batches

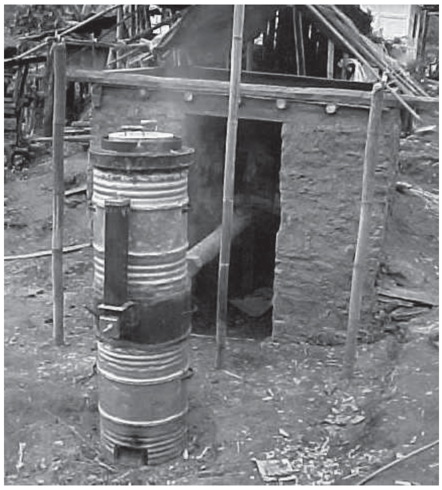

Figure 3 Gasifier for cardamom drying (*photo: Dr Sanjay Mande & Debajit Palit*)

take 30 minutes. Though the nuts should be boiled for 20 minutes to get a good quality boiled nut, owners restrict the boiling time to save the scarce fuelwood. The drying (slow heating) is done in brick-cement/brick-mud frame sheds (7 feet height and 7.5 feet width) with vertical partitions. Thick bamboo mats are used to spread the chopped nuts out for drying and wood is fired in each partition on the ground, well below the bamboo mats. In the large and medium sized units, fire curing is initially done for 12 hours at a temperature of 70-75°C and then the dried product is further sun dried for 2-3 days to remove any residual moisture.

On average 100 to 150 kg fuelwood is used to produce 100 kg of processed arecanut, of which 60% is used for boiling and the rest for drying. The average wood-burning rate for boiling is 115 kg per hour, with SFC (specific fuel consumption) of 0.70 kg wood per kg boiled nut. Detailed water boiling tests carried out on the vessel-bhatti combination currently used, revealed that the useful power requirement is 30-35 kWth.

TERI has successfully developed an integrated gasifier-based system for boiling, as well as drying, and has successfully demonstrated the application in the Rupahi cluster (Figure 6). The gasifier with a wood consumption rate of about 20 kg/hr capacity, was used for boiling arecanut in the existing boiling pan and also utilized the hot flue gases for drying. The gasifier could also be operated successfully using waste arecanut husk (a by-product during de-husking operation) that makes the gasifier option even more attractive

Table 2 Summary of performance data of gasifier based cooking system at Kankia, Orissa

Parameter	Fuel consumption (kg)			Cooking time (hrs)		
	Traditional oven	Gasifier system		Traditional oven	Gasifier system	
		With blower	Without blower		With blower	Without blower
Breakfast						
Upma - 6 kg	45-55	15-19	18-23	2.0-2.5	1.0-1.25	1.75-2.25
Lunch/Dinner						
Rice - 40 kg	45-60	15-19	20-23	2.0-2.5	1.0-1.25	1.50-2.00
Dalma: 6 kg dal+10 kg veg	65-75	23-27	25-28	2.5-3.0	1.5-1.75	2.50-3.00
Total (daily)	265-325	90-109	98-123	7.0-8.5	4.0-4.75	6.75-7.75

Table 3 Field performance of gasifier-based cooking system for arecanut boiling

Item	Traditional oven	Gasifier system
Amount of nuts processed (kg/batch)	140	140
Time required for boiling (hrs)	2.5	1.0
Total curing time (hrs)	4.0	3.0
Total fuelwood consumption (kg/batch)	125	45

Figure 6 Gasifier-based arecanut boiling (*photo: Dr Sanjay Mande & Debajit Palit*)

(Table 3). Further improvements in energy efficiency are achieved by utilizing the hot gases for drying instead of traditionally burning fuelwood.

Conclusions

Biomass gasification technology can help in taking a rural population using biomass as a fuel two steps up on energy ladder (from solid to gaseous fuel). Application of gasifier for heat applications in rural areas has significant fuel saving potential coupled with other benefits such as improving the working environment, improving product quality and processing rates, due to controlled burning of gaseous fuel obtained through gasification of solid biomass.

Figure 5 Traditional arecanut boiling (*photo: Dr Sanjay Mande & Debajit Palit*)

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Profile of the authors

Dr Sanjay Mande is a biomass energy technology expert. He has a Doctorate in Environmental Sciences and Masters in Mechanical Engineering (Thermal & Fluids Engineering), and more than 17 years experience in RDDD (research development demonstration and dissemination) of gasifier for both thermal as well as small scale power applications.

Debajit Palit has a Masters in Physical Sciences with PG Diploma in Non-conventional Energy Technology. He hasover ten years experience in biomass energy resource assessment, demonstration of gasifier technologies, technology evaluation of various renewable energy technologies and policy studies.

Solar cookers in Afghanistan

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Household energy – a rare commodity

Energy for cooking, lighting and heating have become increasingly more expensive. Energy sources that are free of charge (wood, bushes) are no longer available. Thus, in many regions of Afghanistan dung has become the main and often the only source of energy. However dung is also needed and used as the local fertiliser – there is only one single fertiliser factory in all of Afghanistan. Fertiliser has to be imported from neighbouring countries and needs to be transported to remote areas where the difficulty of access increases costs. Therefore there is a conflict of use between dung as a source of energy and as a fertiliser for crops.

Various development organisations have tried to address this situation by distributing solar cookers as Afghanistan has around 300 days of sunshine per year. The UNHCR has distributed solar cookers (parabolic type) for free in various refugee camps, but did not give adequate training on how to use and maintain this new technology. An evaluation of these solar cookers has never been undertaken.

The German Technical Cooperation (GTZ) has also tried to improve the energy situation by distributing the same type of parabolic solar cookers. In a suburb of Kabul the NGO Global Hope Network distributed 20 solar cookers to selected families. Post project evaluations revealed that the cookers had been wrongly assembled with the blind foil strips inside and the reflecting strips outside. This explains why – in spite of reports to the contrary! – the cookers are mainly used as stands for drying clothes.

Figure 1 Brother Schorsch and apprentices (*photo: Barbara Clasen*)

Such errors endanger the image of any new technology. Furthermore, tests at the Department of Renewable Energy which is part of the Ministry of Energy and Water, have shown that this type of cooker is not wind resistant, gets easily scratched and is not suitable for regions like Afghanistan with its regular sand and dust storms.

Thus it is not surprising that the parabolic solar cookers can no longer be found in Afghanistan.

Chinese solar cookers in Tibet – suitable for Afghanistan as well?

In Tibet the energy situation has been a major challenge. Yak dung is used almost exclusively for cooking and heating purposes. The introduction of simple metal semi-parabolic solar cookers – the 'butterfly cooker' – was seen as a way of improving this situation. Today, nearly every family in Tibet has such a cooker that is used for boiling water and for cooking food in pressure cookers. The butterfly cooker has the following advantages:

- Easy to handle, easy to adjust to position of the sun
- At around 30 kgs easy to transport
- At a price of around 50 USD affordable at least for families with a regular income
- Very durable as the cheap reflecting foil can easily be replaced

The drinking and eating habits of Tibetans are almost identical to those of Afghans. Tea is served at any time. It is kept hot in a large thermos – a favourite wedding present. Vegetables and meat are usually cooked together, in a pressure cooker. In both countries people like to eat hot soup based on meat and oil which give energy in the extremely cold winters.

In view of the similar climatic conditions, eating habits and difficult energy situation a successful introduction and dissemination of the Tibetan solar cooker seemed promising in Afghanistan.

Tests regarding the social acceptance of the solar cooker were performed in different rural areas, facilitated by an advisor from the Department of Renewable Energy of the Ministry of Energy and Water. The cookers for the test phase had been imported from China by the GTZ Renewable Energy Project in Afghanistan. The tests revealed that:

- The cooker is socially acceptable and as in Tibet is used mostly for water heating and pressure cooking
- An average family of about 12 family members can save at least 500 AFS (10 USD) per month with regular sunshine
- In all pilot areas people asked to buy solar cookers
- The cooker introduction needs to be accompanied by an intensive training in how to use and how to maintain the cookers
- Women from better off families are harder to convince to use the new cookers – their better financial status leads them to favour the more modern cooking with gas
- The position of the cooker needs to be well chosen (no shade, easy to get to, not visible for non family members)
- The purchasing power is generally there. However, a system of payment in installments should be developed that takes into consideration local financial conditions.

The results of this test phase were very promising. However, all people included were of the opinion that the solar cookers should not be supplied by imports from China. It was agreed to set up a local production facility that

Figure 2 Cooker assembly with Dr. Faruk (*photo: Barbara Clasen*)

Figure 3 Solco and Bamyan assembling cooker (*photo: Barbara Clasen*)

would create jobs and could serve as reference point for repair and maintenance services.

Creation of jobs through production of solar cookers

Two interested persons have been identified, each motivated in different ways. Brother Schorsch, member of the Christian brotherhood community and head of the German Medical Service – GMS in Afghanistan (Figure 1). For 25 years he has been running a workshop in Afghanistan which primarily provides technical services to hospitals. Since 2002 – with the support of MISEREOR - GMS has been engaged in vocational education. Young men from poor families get technical training in mechanics as well as in business management and customer care. At the end of the training they receive basic workshop equipment to enable them to set up their own workshop in their home province and thus build up a private enterprise for sustainable income.

Brother Schorsch is well aware of the precarious energy situation. He has tested the Tibetan cooker and found it to be an ideal product to create sustainable businesses for his apprentices. Together with them he produced a copy of the Tibetan cooker that even included some technical improvements to make the adjustment of the cooker more user friendly, by simplifying the slope angle for easier adjustment. He also used heavier screws which give more stability to the cooker and do not wear out as easily.

Dr. Faruk is an Afghan business man who lived abroad for many years (Figures 2 & 3). He returned 2 years ago to contribute to the reconstruction of his country. He immediately recognized the market potential of the cooker and once he realized there were no prospects for subsidies he started to produce a prototype. After a few alterations his model now complies with the quality standards. Dr. Faruk sees great potential in the local solar cooker market and plans to start a large scale production in Kabul with delivery services to all provinces.

Immediate business development

Neither producer was promised any subsidy. This was to ensure sustainability right from the beginning. The Ministry of Energy and Water/Department of Renewable Energy only promised the following supporting measures:

- Support in getting the contact details for purchasing the reflecting foil
- Support in getting media coverage for the new technology
- Information and guidance regarding the new cookers to be provided in the provinces through the Department's branches, including regular monitoring

Due to long established contacts between the CIM Advisor and the German ISAF the start up of the solar cooker business has been boosted. The public relations unit of the German ISAF within NATO has placed an order of 500 cookers for distribution to different regions in order to build good relations with local populations and to enhance their image. Brother Schorsch got a contract for 300 cookers at 80 EUR each for delivery through to the end of March 2007. Dr. Faruks contract is for 200 cookers at 70 USD each. Brother Schorsch receives more money because of the educational component of his project and the need for workshop equipment for his apprentices. The sales price will be determined by the producers.

In order to guarantee a sustainable dissemination of the new cooker technology the CIM advisor will participate in the first distributions to teach women how to use and maintain the cookers. In due course this guidance will be provided by a female employee of the Department until such time as the businesses are fully established.

Profile of the author

Barbara Clasen has been working in Afghanistan for 5 years now in the field of promotion of income generating activities especially for women, capacity building and for the last 2 years as advisor to the Ministry of Energy and Water. She is particularly happy that the solar cookers from China will now also be introduced into school curricula as an example for the use of solar energy, and is currently developing a respective curricula component. Her previous work was primarily in western African countries.

GTZ

Public Private Partnership - Synergies for all? Jointly fighting Poverty

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Improving living conditions of smallholder tea growers

"I used to manage to pluck about 400 kilos tea leaves, but now that I am managing my field better I can pluck 600 kilos", D. Logeya contently says. The smallholder tea grower benefits from a multifaceted project Lujeri Tea Estates in Mulanje has been operating since 2005. Together with the German Technical Cooperation (GTZ), Lujeri aims to improve the economic and food security of smallholder farmers in 45 villages around the Estate.

The Public-Private Partnership (PPP) project is financed by Lujeri Tea Estates and GTZ on behalf of the German Ministry for Economic Cooperation and Development (BMZ).

Reducing poverty

Investment in the development of the villages near to Lujeri Tea Estate is not only for the benefit of the people themselves, but is also in the interest of the Estate. Through assuming responsibility and strengthening of their social and economic partnership Lujeri Tea Estate hopes to reduce land and labour conflicts and to acquire more tea leaves of better quality from smallholder growers, who provide up to 15% of Lujeri's tea.

Mulanje district is densely populated and demands on land are very high. In the villages bordering the tea estate people rely on purchasing their staple food, as most of this district is not suitable for maize production. While during the main season employment is available, so there is money to buy food, in the dry season there can be a lack of money to buy food

To fight poverty and hunger in the area two main strategies have been developed by Lujeri and GTZ. Firstly, for smallholder tea growers to increase income from the land used for tea production. Secondly, to promote use of improved fuel and food security knowledge and practices so that demand for these can be met by locally available materials.

GTZ's long standing experience with implementing food and fuel security projects makes them a reliable partner. Since 1996, the Integrated Food Security Programme (IFSP) of GTZ was working with 185 communities in Mulanje using an integrated approach in order to stabilize food security. Main areas of intervention were in the fields of agriculture, fuel, income generation, health, as well as food preparation. Since 2004, IFSP (now Information centre for Food & Fuel Security Promotion) has concentrated on the fuel side. The diverse experiences gathered during the last decade have now been expanded to Lujeri Tea Estate.

Participatory approach

Overall, the improved cooperation between the Estate and the surrounding villages has led to a better mutual understanding. In this way the Group Village Headmen have had direct impact on the implementation of projects and can give feedback about how well the initiatives are working in their villages.

Income generation

In order to improve the tea production of the smallholders, the Tea Research Foundation Central Africa (TRFCA), held training courses, which proved to be so successful, that trained growers had an average tea leaf production per hectare, which was almost 25% higher than that of the non-trained growers.

As knowledge transfer is key for development, trainings were held not only in the field of tea agronomy but also in participatory concepts and extension tools. At this workshop Tea Clubs were seen as the ideal platform to pass on training. Now 101 Clubs have formed.

Growers are sharing ideas, making plans for progress, pooling resources and starting bank accounts.

The second challenge was how to make smallholders self-sufficient during the dry season when there are less employment opportunities

Here the solution was to diversify food production away from only growing maize, which does not grow well in the area anyway. Lujera Tea Estate therefore distributed cassava stems and sweet potato vines. The growing, processing and marketing of tubers for the food industry will provide extra income.

Food and fuel security

Another severe problem was how to resolve the firewood shortage. Families in the villages often have to spend 150 kwacha a week for firewood. Consequently, food that has to boil for a long time, e.g. beans, was not cooked so often meaning people lacked a balanced diet, which lead to health problems. Furthermore, illegal gathering of firewood in Lujeri Tea Estate's wood plantations and in the Mulanje mountain reserve was rising, causing not only environmental damages and economic losses, but also conflicts with the estate management and local authorities.

To reduce the firewood requirements, energy efficient cooking stoves, saving 50% firewood, were introduced into the project area. So far, sixteen groups have been established and trained in clay stove production. With support from GTZ interested women were trained to build high quality stoves and to fire them properly in a self constructed kiln. The energy efficient stoves are not only for their own use but the producers can sell them in markets or to their neighbours. Demand is high according to Group Village Headman Mikundi. "Many ladies from my village and even from others that don't have clay sources are asking for stoves." Thus, stoves are not only saving firewood, and therefore money, but also generating some additional income in the villages.

To meet food requirements and to reduce the dependence on maize as stable food, the growing of casssava and sweet potatoes is promoted.

Also, maize-free recipes as an alternative have been introduced, using foods high in energy and nutrients that cater for different user needs. This is part of the promotion of diet diversification and utilization of locally available foods.

Village based voluntary food and fuel promoters were trained by GTZ extension workers to demonstrate these interventions. In this way food security knowledge and best practices remain in the villages.

Outlook

Still, there is work to do. Before the project ends in April 2007 Lujeri and GTZ want to promote nutrition messages for HIV/AIDS affected households. Doing so, Lujeri Tea Estates hopes to improve the health of its workers and their families. For the stove producer groups marketing tools will be established. Furthermore, tea agronomy trainings will be extended so that each Club has a trained member who can provide technical support.

Profile of the author

Lisa Feldmann has a degree in mass communication and journalism. After working half a year for the Centre of Food & Fuel Security Promotion (IFSP) in Malawi on a short term contract for Public Relations and Documentation, she now works for GTZ's household energy programme HERA. Her main tasks are Public Relations and knowledge management.

Energy News from Practical Action

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Preparing for the UN's 15th Commission on Sustainable Development

Practical Action's energy team is again targeting the UN's Commission on Sustainable Development (CSD), and working with GTZ, WHO, and the USEPA, we will be urging governments to commit to tackling energy poverty and the indoor air pollution crisis.

At the Intergovernmental Preparatory Meeting of the CSD we are jointly organising a side event entitled Healthy and affordable household energy - let's scale up what works!' It will be held in the German House in New York on Tuesday 28th February, and speakers from China, Uganda and Sierra Leone have been invited. With our partners, we are also producing a joint position paper on household energy, indoor air pollution and health, which will be used to lobby governments at the CSD. The paper calls on governments to endorse the household energy target: by 2015, to halve the number of people without effective access to modern cooking fuels and to make improved cooking technologies widely available. The position paper will be available through HEDON and the PCIA, along with supporting materials which will help NGOs and civil society groups to lobby their own governments in the build up to the CSD. For further information please visit:

www.hedon.info/goto.php/CSD15

Practical Action has also been lobbying at the national level to ensure that the UK government prioritises energy poverty and indoor air pollution at CSD 15. We have been persuading British MPs to sign a parliamentary motion on the subject (Early Day Motion 421), and have asked our supporters to sign postcards to the government and write letters to their MPs.

Practical Action networking event on Smoke at the World Urban Forum, Vancouver, June 2006

This third session of the World Urban Forum had particular significance because 30 years earlier in 1976 the UN held its first conference on Human settlements in Vancouver. This conference led to the birth of UN-Habitat.

In 2006, the conference was attended by some 10,000 participants from over 100 countries. The conference offers an open platform to all stakeholders (NGOs, grassroots organizations, governments, multi-lateral agencies, the private sector and so on) to present their ideas by hosting networking sessions or contributing to the main dialogue sessions.

Practical Action hosted a networking session which aimed to bring the issue of indoor air pollution to a new audience. We chose to focus on the use of subsidies in programmes to alleviate IPA, as this would be of common interest to a wider audience. The session took the form of a debate around the following statement:

This house believes that direct subsidies for improved technologies to reduce the 1.5million deaths caused by indoor air pollution are always misguided.

Practical Action staff presented examples from our work in Nepal and Sudan. In Nepal, interventions (smoke hoods) have been subsidised. In Sudan, the introduction of LPG gas stoves has been on a fully commercial basis without any subsidies, despite high levels of poverty among the internally displaced people with whom the project has worked.

Speaking against the motion (arguing that direct subsidies can be positive), Don O'Neal of HELPS International argued that well-placed subsidies could be seen as an investment in a more stable world. They help alleviate extreme poverty: quoting Kofi Annan 'A world where millions still live in desperate conditions will not be a world at peace'. Very often the real cause of the problem is badly targeted subsidies that are used to prop up a badly designed project.

Speaking against the motion (arguing that direct subsidies are always misguided), Keith Openshaw (Energy Consultant) showed how subsidies often reach all the wrong people and lead to failures due to market distortion. He cited many instances where fuel subsidies had reached the poorest least. The majority of successful stoves have been introduced through commercial approaches. Subsidies should not subsidise the products themselves, but are better used indirectly to support training, capacity-building, research and so on.

The session was introduced and facilitated by Prof Michael Brauer. There were plenty of questions of clarification about the case studies, and a brief discussion on the appropriateness of three other technologies:

- Solar: good where it is appropriate, but usually too expensive and may not suit lifestyles
- Biodiesel, jatropha oil, methanol from wood. Biodiesel has waste-water issues where produced on a large scale.
- Fireless cookers: generally well-received by all where they fit with local cooking practices.

Overall, there was consensus on the need for indirect subsidies in the form of technical support, loans to producers to kickstart businesses, demand creation and infrastructure development. There was recognition that there are different issues for those who are willing and able to pay compared with those living in extreme poverty. Participants called for more good quality research into the problem, into appropriate and affordable technologies, and into the market for them. Monitoring and evaluation is needed after projects have finished – perhaps for 10-20 years. The motion was narrowly defeated.

What's cooking on the solar cooker front?

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Introduction

The sixth International Solar Cooker Conference was held in Granada, Spain, 11 – 16 July 2006 and attended by 200 delegates from 38 countries. The conference not only brought together project implementers, cook stove designers, producers and government representatives but also individuals interested in solar cooking from a number of business organisations (Figure 1). This was the first time that private businesses showed such a high level of interest in solar cooking since the first international solar conference in 1992. What was also notable were the aesthetic improvements to cookers since the last international solar cooker conference in 2000 in South Africa. This article will reflect on the state of the debate around solar cooking as well as the changes that can be observed in solar cookers available in the world today.

Figure 1 A solar cooker cook-out at the Science Park (*photo: Marlett Balmer*)

The state of the debate in solar cooking circles

Interesting issues

There seems to be general consensus on the need for solar cooking, especially in areas where biomass energy (taken here to include dung, fuel wood and charcoal) is scarce and/or expensive. However, for the first time in the solar cooking debate, there was an emphasis on the need to "mainstream" solar cookers, and to stop seeing solar cooking as an excellent solution for "someone else" or "someone in Africa".

Subsidies

Energy subsidies were discussed in a number of presentations, not only subsidies received by other fuels in a country, but also subsidies and incentives offered in developed countries for the utilisation of renewable energy. Subsidies for solar cookers became anathema in the structural adjustment period of the late 80's and early 90's but the re-emergence of the topic in the debate was interesting. It was noted for example that a number of countries offer substantial subsidies on fuels such as LPG, IP (kerosene) and electricity. These subsidies benefit those who already have access to some form of commercial fuel as well as those who are in a position to afford commercial fuels. Subsidies are therefore benefiting not the poor and marginalised but those better off. It was questioned why these (non-renewable) fuel subsidies were acceptable and subsidies for solar cookers considered so unacceptable. It was recommended that Governments look at existing subsidies and include solar cookers.

An interesting solution was offered by Grupp (2006) in the form of installed 'use meters' in solar cookers. The use meter would record actual solar cooker use and calculate the amount of fuel and green house gas saved, and credit the user with the monetary value of the GHG savings. Grupp proposed linking the use meter to the electricity grid and that the credits be given to the user in the form of free electricity (for those who are already connected to the electricity grid.) However, the scheme is also perfectly suited to reward the user in monetary terms, which can be used to pay off the solar cooker purchased on credit, enabling poor households to purchase a cooker and pay it off out of savings, using CDM (Clean Development Mechanism) funding to provide the upfront capital.

Co-ordination, information sharing and exchange

The lack of co-ordination and information availability was recognised. It was noted that little comparative information was available on solar cooker products and technologies, little performance data and virtually no monitoring and impact data either. It was recommended that a database of technical specifications of existing solar cookers was established that ranked each cooker according to specific requirements to enable promoters to choose the most suitable cooker for their project.

Improved networking and sharing of experiences are generally viewed as essential for successful projects. Although networking can be very valuable, there is scepticism about the willingness and ability of people to effectively network. Also, there seems to be the notion that re-inventing organisations and co-ordinating structures would ensure that they function effectively; there is no recognition that it is not the structures that fail but the individuals and organisations in the structures that fail to participate fully and network effectively.

Nevertheless, the Africa discussion group decided to form an umbrella co-ordinating body called "Solar Cookers for Africa". This group initially aims at becoming a web-based resource to support, link and catalogue all solar cooker projects in Africa. The advantages in identifying all the solar cooker projects in Africa and placing them in an easily understandable and accessible format are:

- Technology and knowledge sharing will be easier for solar cooker project planners and leaders inside and outside of Africa
- Work is not duplicated or repeated
- Project leaders will be able to assist each other to overcome challenges faced in each country or region
- It would be easier for the rest of the world to assist solar cooker projects reducing the amount of

time and cost of getting support - communication in Africa is often difficult, expensive and even impossible at times.

The approach to solar cooking popularisation

Solar cookers have sometimes been called a solution looking for a problem. However, solar stoves can: supply free energy, save fuelwood, save trees, save the environment and free women from wood collection. Furthermore, they offer a simple solution to their intended beneficiaries, mainly poor, rural women without adequate energy sources for cooking. The underlying vision of solar stove projects in the 1950's-1960's were simple: many families in Third World countries had limited fuel for cooking and solar stoves could be made to cook without fuel (GTZ & DME, 2002a). During this period solar stoves were crude devices, neither extremely efficient nor produced in great numbers. Also, promoters argued that the stoves should be as cheap as possible, subsidised or better yet, given away for free. A number of projects also focused on teaching people to construct their own solar cookers using inexpensive materials.

During the 1990s a number of solar cooker proponents argued that solar cookers should not be subsidised or given away for free, but sold on a commercial basis, for profit, as any other cooking appliance. This implied that solar cookers should not be viewed as an appropriate technology product, aimed at the poor, but as a consumer product, for sale in an open market where anyone (rich or poor) could buy the product if it appealed to them. A number of further implications flowed from this approach:

- Solar cookers should be sold on a commercial basis, implying that the product should adhere to accepted commercial norms in terms of appearance, quality, product support, packaging, marketing, durability and functionality;
- A commercial approach implies that users pay the full price (cost plus profit) for solar cookers and that no subsidies are available in the product chain;
- If customers are expected to pay the full price for the product, the quality of the product becomes important and promoters cannot expect users to pay a high price for a solar cooker that looks cheap.

The commercial approach to solar cookers was not entirely popular and is still not accepted by all proponents of the technology. They argue that their target groups are too poor to afford a solar cooker and rely on subsidisation. They further argue that the poorest require a basic solar cooker that must work and be as cheap as possible. When the performance of a solar cooker is increased, so does the cost, so in order to keep the cost down, only a basic cooker is required. However, experience from other projects has shown that the most important factor is to offer a variety of quality products and let the user choose what suits his needs and is affordable.

Supporters of the commercial approach argue that the more affluent target groups, such as farmers and environmental enthusiasts, require a sophisticated product, able to compete in performance and appearance with gas and electric cooking devices. If adequate demand can be generated for high quality solar cookers, prices will eventually decrease and the poor will benefit from low-cost, high-quality solar cookers. Proponents of the commercial approach further emphasise that everyone who cooks should own a solar cooker, whether they are living in the northern or southern hemisphere. It is argued that energy efficiency is everybody's business and solar cookers can reduce energy consumption in cooking, regardless of your financial status, and even if used once a week can contribute to reducing fossil fuel demand with concomitant environmental benefits.

From the conference, the divide between the commercial approach and the humanitarian approach seems to be growing. Although both sides agree on the need for quality cookers, the humanitarian approach sees the answer in decentralised, small-scale, local manufacturing while the commercial approach sees the answer in mass production. The attendance of the conference by two industrial designers sponsored by a business organisation was an interesting signal; that a strong, business organisation recognises the potential of the product but it requires fine-tuning in terms of appearance and manufacturing processes.

Figure 2 Homemade solar cooker with foil and clothes pegs (*photo: Marlett Balmer*)

In summary, the approach to solar cooker manufacturing and dissemination evident at the conference seems to divide proponents into 3 groups:

- The advocates of the homemade "make your own cooker" approach; utilising available material, sometimes free of charge, to make your own cooker (Figure 2).
- The advocates of disseminating (not necessarily selling) solar cookers to extremely poor households and those in extreme disaster situations; the poorest of the poor cannot afford to pay for the technology and must therefore be subsidised. The focus is therefore on extremely cheap cookers with the highest possible efficiency.
- The proponents of a highly commercial approach; requiring very high quality products, well made, attractively packaged and sold in a wide range of shops, supported by sophisticated marketing campaigns.

There is clearly a place for all three approaches, and the challenge is how to structure the debate at a conference to ensure maximum benefits for all three groups.

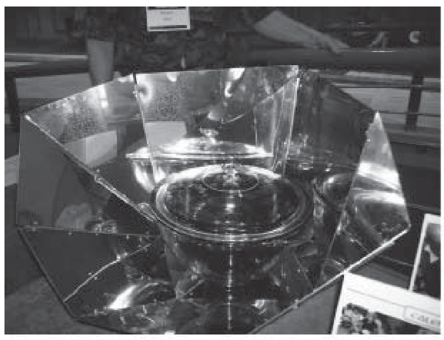

Figure 3 The Mexican HotPot (*photo: Marlett Balmer*)

Theme

The products

The products have also changed and developed in a number of ways. Less prototypes were exhibited and more cookers of which a significant number have been sold, were displayed at the conference. For example, the "Hotpot" from Mexico, seems very promising, a high quality product with reported sales of more than 2500 in a little over

Figure 4 Ulog's camping cooker (*photo: Marlett Balmer*)

Figure 5 The Japanese take on the SK. Note the high quality finishes, legs and pot holder (*photo: Marlett Balmer*)

2 years (Figure 3). The product is also relatively affordable at around $45. It is supplied with a well written recipe book and cooking instructions.

There were also a number of exciting improvements to existing cookers.

At present it seems to be the middle (Figure 4 & 5) of the range products (Sunoven, Sunstove, SK series) that are enjoying the most commercial success (Figure 6).

Figure 6 SK's/Koch cookers/IZola (*photo: Marlett Balmer*)

The Way Forward

The Conference saw the creation of the "Solar Cookers International Association" affiliated with Solar Cookers International. The purpose of the Association is to improve health, economics, societies and environments through collective actions to spread solar cooking, pasteurisation and food processing. The Association will consist of founding members (organisations and individuals who support the purpose and pay annual dues), a steering committee consisting of volunteers to facilitate collective action, co-ordinate communication and allocate and monitor use of funds for collective actions.

Regional networks and regional network leaders were selected in the following regions: Asia/Australia, Ibero-Latin America, Africa and Europe and non-Latin Americas.

Furthermore, collective action groups in the following areas were also formed: education, health, business, humanitarian, advocacy, technology and food processing.

Conclusions and Recommendations

The International Conference on Solar Cooking and Food Processing of 2006 successfully showcased exciting developments, not only in solar cooker design but also in the debate of popularising solar cooking across the globe. The conference recognised that solar cookers have not been made visible and accessible to the millions of people who need them. Urgent problems, both human and environmental continue to accelerate and solar cookers can be among the solutions to alleviate problems, such as indoor air pollution related illnesses, fuel scarcities, smoke and water related illnesses and fuel collection burdens of women. The message was clear: start at home and use a solar cooker as often as possible everyday to aid the spread of this valuable technology.Some specific recommendations are summarised below:

- Integrate solar cookers into other solutions to address fuel and environmental problems;
- Investigate the income generation possibilities of solar cookers;
- Training and demonstration of solar cookers are essential for success;
- Re-deploy existing fuel subsidies to include solar cookers;
- Upscale solar cooker targets;
- Utilise effective marketing strategies;
- Ensure that projects include some form of monitoring and verification to enable impact measurement and results of solar cooker programmes;
- Form regional and local chapters;
- Look at minimum quality standards.

The recognition of the high social and environmental costs attributed to the use of certain energy sources is becoming increasingly recognised, for example the South African Government has initiated the development of a strategy to optimize the use of household fuels. These and other positive policy-related developments, coupled with progressive developments in the solar cooker field may push solar cookers from the fringe into the mainstream of clean household cooking technologies.

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Profile of the author

Marlett Balmer holds a Masters degree in Development Studies, a B.Comm Honors (Energy Studies) and a B.A Honors degree from the University of Johannesburg and is currently registered as a PhD student in the Institute for Technological Innovation, University of Pretoria. Marlett has been working in the energy field for more 15 years and has completed more than 60 energy and development related research projects. She received the Eskom eta award as Woman in Energy 2003 for her contribution towards the energy sector in South Africa. For more information please see www.pdc1.co.za.

Getting Technologies to the market – the case of the Rocket Stove in Malawi

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Wasteful baseline technology

A survey conducted in 2003 in Malawi revealed that the majority of institutional cooking was done with firewood using inefficient technologies, including open fires (Figures 1 & 2). The Bellerive-type, which is an excellent, but expensive stove, was only found in a few places, as its selling price in Malawi is beyond the reach of most customers.

Figure 1 Inefficient firewood cooking at Maula prison (*photo: Christa Roth*)

Figure 2 Inefficient firewood cooking lauderdale tea factory in Mulanje district (*photo: Christa Roth*)

New technology that works better

In order to create an improved and more affordable technology, GTZ-ProBEC asked Peter Scott in 2004, from Aprovecho Institute, to apply the rocket stove principle to stoves, in Malawi, for 50 – 300 litre pots. The first prototypes were developed in 2004 in Mulanje and designed with a square combustion chamber.

Much has been written in this magazine previously about rocket stove technology, and so we present only a very brief summary here, taken from a presentation by Peter Scott (Figure 3). The rocket stove principle combines improved combustion efficiency, whilst reducing smoke output, with optimised heat transfer efficiency. More details and a video can be found at: www.aprovecho.org/web-content/media/ashden.htm

The rocket stove principles are optimally suited for institutional stoves:

Firstly, more energy is wasted from an open fire as pot size increases, therefore the potential savings are greater for larger pot sizes. In the first tests at the kitchen of Lauderdale Tea Factory in Mulanje, it took 170 kg of wood to cook 100 litres of the staple food nsima (maize meal) on the open fire, whereas the first rocket stove built by Peter Scott required less than 17 kg of wood.

Secondly, the rocket principle relies on optimised gaps between pot and stove to deliver the best results. This is easier to achieve in institutional cooking, as normally the variety of food cooked and pot sizes are limited, unlike in households. In Malawi a stainless steel pot is cheaper than a rocket stove by a factor of two, so it is economic sense to keep the existing pot which institutions already use to prepare food. The rocket stove is then tailor-made to fit the existing pot, reducing the overall investment costs for a new stove. This not only makes the technology switch considerably cheaper but increases willingness to do so.

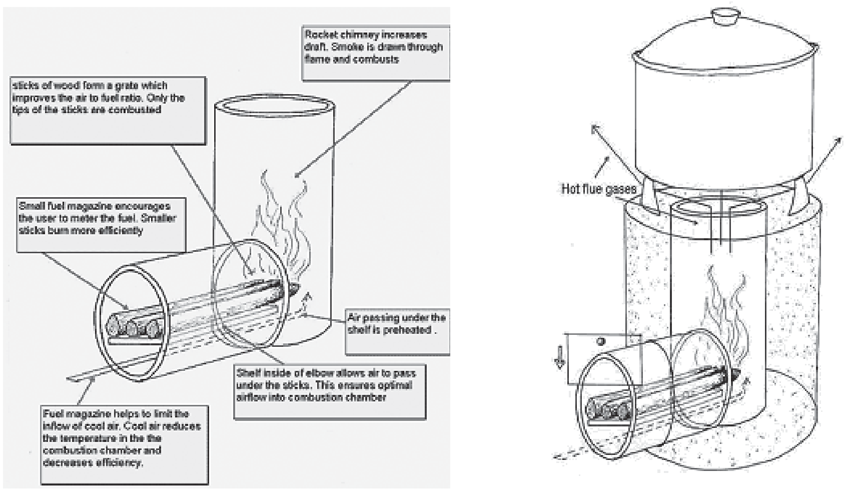

Figure 3 Diagrams showing the principles behind the fuel efficiency in rocket stoves (*diagram: Peter Scott*)

Why is it better than what was there before?

Due to better combustion and heat transfer efficiencies, rocket stoves give the following benefits:

To the user:

Reduced health risks

- Reduced smoke emissions: shorter-term benefits included less coughing and burning eyes whilst longer-term benefits include a reduction of respiratory and eye infections for the cooks.

Theme

Figure 4 In this school in Tanzania, this sight of a Bellerive-type stove, right, being used with long uncut pieces of wood and the door left open is not uncommon. However, it is still an efficient stove compared to the 3 stone fire, even when the door is open. Its high cost has prevented further dissemination (*photo: Christa Roth*)

- Less exposure to heat: the fire/ flames are contained within the combustion chamber and the hot flue gases are shielded by a skirt (enhancing heat-transfer to the pot). The exhaust gases leaving the gap between the skirt and the pot normally don't exceed 190°C.
- Reduced danger to the cook from burning, as the cook is not exposed to an open flame.

Convenience

Convenience is a factor that should not be underestimated when discussing stove design and efficiency. Cooks will always find the most convenient way to use a stove, which often does not favour efficiency, or they will not use an inconvenient stove at all (Figure 4). This means that even the most efficient stove-design will then have zero impact! For example, the Bellerive stove is a very efficient stove (Figure 4), but the draft system is designed to work with a closed door to function efficiently. This requires firewood not only to be split, but cut into 20cm long pieces to fit into the fire chamber. Reality often shows a different picture: normally it is the cook's duty to prepare the firewood. Unless the economic savings achieved by this extra work are shared out to the cook, there is no incentive to use the stove properly.

Cooks from the kitchen shown in Figure 4 preferred the rocket stove because:

- Less time and effort needed to prepare wood: the rocket stove can take any length of firewood, therefore there is no need to cut wood. The only requirement is to split the wood lengthwise into pieces ideally around 3-6 cm thickness, which is not as strenuous as cutting. Also, less wood needs to be prepared due to the economy of the stove on firewood use (Figure 5).
- Less smoke even without a chimney.
- No chimney to sweep, therefore less maintenance work.
- Reduced cooking times compared with an open fire.

Figure 5 Less wood is needed to cook the equivalent amount of food with a rocket stove (*photo: Christa Roth*)

Figure 6 Caked food from traditional fire, left, and from rocket stove, right, with same maize flour used (*photo: Christa Roth*)

The usual feedback from rocket stove users is similar to that from Emmanuel Teacher Training College in Blantyre: the three cooks really treasure the stove and look after it, and do not wish to return to using the open fire, when they had to take turns of less than ten minutes in the kitchen filled with biting smoke in order not to choke. They attribute health improvements to the rocket stove. Athough they mention that the rocket stove needs more frequent attention to push the firewood in at the right pace than the open fire, but that it is outweighed by shorter overall cooking times.

To the owner (buyer, head of the institution):

Economic

- Cheaper to buy than other available improved technologies, such as the Bellerive-type stove.
- Considerable savings in firewood, ranging between 50 to 95 %, depending on the inefficiency of baseline technology.
- Reduced transport costs for firewood (e.g. Maula prison: 4 truckloads of firewood per week without Rocket Stove, 1 truck load fire wood per week with Rocket Stove).
- Less burning and waste of food.
- Better quality of food prepared in the rocket stove as compared to the open fire, as more equal heat distribution and faster cooking (Figure 6).
- No chimney to be passed through the wall or the roof (no leakages).

To society:

Environmental

- Reduced deforestation as result of reduced wood consumption.
- Less wood transport on the roads, therefore a reduction in CO_2 emissions from trucks.

How does the technology become a 'product' and find its way to the user?

We need to look at two aspects:

1. Who is involved in turning the raw materials into a sellable product?

2. Who is involved in causing the product to reach the user?

Input supply of raw materials

Metal for the structure, insulative bricks and high temperature mortar for the lining of the firechamber, are the major materials needed for a rocket stove. All metal ingredients are available from regular steel suppliers in the larger centres of the country. Manufacturing the insulation material was a challenge, as no natural material like pumice or processed vermiculite was available. Together with the clay expert Chris Stevens from Dedza pottery, insulation material was developed out of white refractory clay and sawdust, fired at 1250°C. The bricks in a 100 litre stove cost about $15, which is less than 8 % of the total cost of the stove. Dedza pottery now tailor-makes sets of insulating bricks for the three most common fire chamber sizes. For other sizes the bricks are cut with a hacksaw blade.

ProBEC negotiated for minimum stocks to be kept, as manufacturing times for insulative bricks can exceed 6 weeks, due to the slow drying of the moisture-absorbing sawdust. The density of the fired bricks is about 0.8 g/cbcm. This makes them physically vulnerable, especially at sites where the firewood is 'rammed' in. Our hardest challenge was in a prison in the capital Lilongwe: cooking is done by the inmates, who are capable of destroying a stove in less than 6 months. Under normal circumstances the lifespan should exceed 3 years. This prison has become a valuable testing ground: anything surviving the 'stove abuse' there is fit for normal use. Dedza pottery developed hard, high-density tiles about 1 cm thick, made out of the same white clay mentioned previously, resistant against physical shock and abrasion. They are interlocking and fitted on the lower part of the fire chamber to protect the area in direct contact with the firewood. It is always a challenge to balance the durability versus the insulative properties of a stove. So far the tiles used since October 2006 have not reduced the efficiency of the institutional stoves as the heat loss through the tiles is compensated by the longer cooking times in the institutions. The tiles have enticed some producers to increase the warranty for the stoves from 6 to 12 months. ProBEC constantly monitors the performance of the stove components and adjusts materials and designs as the need arises.

Figure 7 WFP type of stove: lower skirt, less L-shape at the entrance to cut costs, designed for half-220l gallon oil drum (*photo: Christa Roth*)

Figure 8 Stoves waiting to be loaded at Ken Steel Engineering in Mulanje (*photo: Christa Roth*)

Who turns the raw materials into stoves?

Ken Chilewe from Ken Steel Engineering in Mulanje was the first producer to be trained in 2004 (Figure 7 & 8). Since then, he has successfully sold over 1,500 institutional rocket stoves (see as well Ashden Awards video).

In 2005, a further four entrepreneurs were selected for training according to the criteria that they were already in business, had an equipped workshop and at least one successful product on the market. Even though there were promising orders available, only 3 took up stove production. A fourth was later trained and now 4 producers cover the 3 major regions of Malawi.

Who is involved to make the product reach the user?

This will be further elaborated in a next issue of Boiling Point.

Profile of the authors

Christa Roth is a technical advisor to ProBEC with over 6 years experience in building capacity especially in rural communities.

Andreas Michel holds a MSc in Renewable Energy (University of Oldenburg) and is a technical advisor to ProBEC since 2005, his first degree is in mechanical engineering. His focus is on rocket stove-based technologies.

Dr. Christoph Messinger, a geographer by profession, is the Regional Coordinator for ProBEC Malawi, Tanzania and Zambia.

SODIS – Solar Water Disinfection: Water Quality Improvement at Household Level with Solar energy.

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Introduction

The lack of clean drinking water for some 1.1 billion people in this world has dramatic consequences: approximately 4 billion cases of diarrhoea are reported annually, of which 2.5 million end in death. Every day around 6000 children die due to the lack of safe drinking water. Criteria for improving water supplies only consider water availability and its accessibility. However, since the drinking water quality is not taken into account, the situation is far worse as more than 1.1 billion people are exposed to unsafe drinking water.

In order to make water safe to drink, further treatment is necessary. The most recognized and established treatment is to boil the water to kill the micro-organisms, such as bacteria and viruses, in the water. In developing countries most people in the urban and peri-urban areas use kerosene or gas for cooking and boiling water, while in the rural areas people commonly use wood or other biomass as fuel. As fuel is getting scarcer or too costly, the water often is no longer boiled leading to an increase in infections

SODIS

SODIS, which stands for Solar Water disinfection, is a simple method that utilizes the synergy of the UV-A (radiation effect) and infrared light (thermal effect) to kill the bacteria and viruses in the water (Figure 1 & 2). The system

Figure 1 The three types of solar radiation (*diagram: Yayasan Dian Desa, Yogyakarta, Indonesia*)

uses PET (Polyethelyne) transparent plastic bottles that are exposed to the sunshine for several hours (Figure 3). These are ordinary plastic drink bottles of the kind used for soft drinks and bottles water- they do need to be clear and transparent. The plastic bottles have proven to be an adequate and safe container for the treatment.

SODIS was first initiated through experiments performed by Prof. Aftim Acra at the American University of Beirut. It was further researched with extensive laboratory and field tests carried out by EAWAG-SANDEC, a Swiss Research Center for Water and Sanitation for Developing Countries, based in Switzerland. The field tests of SODIS, completed in several developing countries, have shown it to be an efficient and effective drinking water treatment method, as well as a simple and low cost technology.

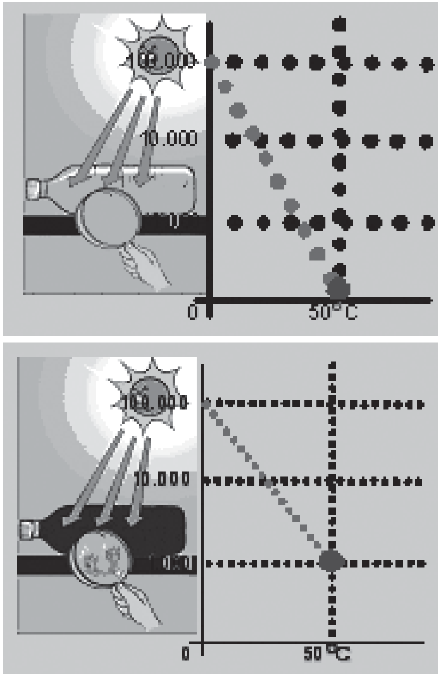

Figure 2 All faecal bacteria in the transparent bottles where there is synergy between the UV-A radiation and heat is inactivated when the temperatures reaches 50°C, top picture, but not in the dark bottle that only gets the heat from the sunshine, bottom picture (*diagram: Yayasan Dian Desa, Yogyakarta, Indonesia*)

SODIS in Indonesia

Indonesia is a developing country that still faces problems with the availability and accessibility of safe drinking water, especially for those living in rural areas. In many areas people still drink untreated water, to save fuel or because of a taste preference, and neglect the possible negative health consequences.

SODIS was first field tested in Indo-

Figure 3 How is SODIS used? Clean bottles are filled with water and placed on the roof. The bottles must be exposed to the sun from the morning until the evening, at least six hours, before they are ready for consumption (*photos: Yayasan Dian Desa, Yogyakarta, Indonesia*)

nesia in 1997 by Yayasan Dian Desa, an Indonesian NGO based in Yogyakarta, Indonesia, and more recently there has also been collaborative work with EAWAG-SANDEC, who also provide technical back up. Support has been provided by UNICEF, SIMAVI and from some private sector companies such as the Coca Cola Company and Georg Fischer.

The two main areas of SODIS dissemination in Indonesia are in two islands, East Lombok District in Lombok Island and Sikka District in Flores Island. Between these two islands there are more than 150,000 beneficiaries in more than 40 villages (Figure 4 & 5). The benefits of adopting and applying SODIS, as reported by the communities, are a saving on fuel and an improvement in health, especially reduction of stomach problem or diarrhea. The local health department has also recognized the positive health impacts of SODIS application by a community (Figure 6). The following graph shows the reduction of diarrhoea incidence in the villages on Lombok Island, Indonesia, where SODIS is used by the community (Figure 7).

Conclusion

Figure 4 The water bottles can also be placed on a corrugated iron sheet (*photo: Yayasan Dian Desa, Yogyakarta, Indonesia*)

Figure 5 Some 130,000 people in East Lombok use SODIS (*photo: Yayasan Dian Desa, Yogyakarta, Indonesia*)

Impact of SODIS on Diarhoea Incidence

Cases of Diarhoea in the Years '02, '03, '04 (until May '04)

	Av.Cases Diarhoea '02 (before SODIS)	Av.Cases Diarhoea '03	Av.Cases Diarhoea '04	Reduction in '04 compared to Av.of '02 and '03
Paneda Gandor Vill.	15	16	1	90 %
Ketannga Vill.	12	12	1	87 %
Sel. Ketangga Vill.	41	41	31	23 %
Pringgabaya Vill.	30	38	15	57 %
Jerowaru Vill.	60	28	14	68 %
Pengadangan Vill.	19	6	2	86 %
Gelanggang Vill.	48	28	0	100 %
Sukamulia Vill.	10	9	2	84 %
Jenggik Vill.	11	14	3	78 %
Tebaban Vill.	12	8	4	54 %
			Average Reduction of Diarhoea	73 %

Figure 6 Number of cases of diarrhoea in ten villages in East Lombok from 2002 until May 2004 and the percentage reduction in diarrhoea incidence after SODIS was introduced.

The case study in Indonesia has shown that SODIS is a simple and cost-effective alternative in providing access to safe water. All that is required is a 1.5 litre or smaller PET plastic bottle and sunshine. Plastic bottles are low in cost, approximately USD 0.15 to 0.20 (Rp. 1,000 – Rp. 1,500), and can last for three to four months if used on a daily basis.

Limitations

However, there are several limitations to the further application of SODIS technology:

- SODIS is unable to be used with larger containers. The best size of PET plastic bottles to be used for SODIS is 1.5 litres and maximum size is 2 litres.
- SODIS application is dependent on the climate.
- SODIS cannot be applied to muddy water. Therefore, if the water is muddy, the water must be pre-treated in order to clarify it.

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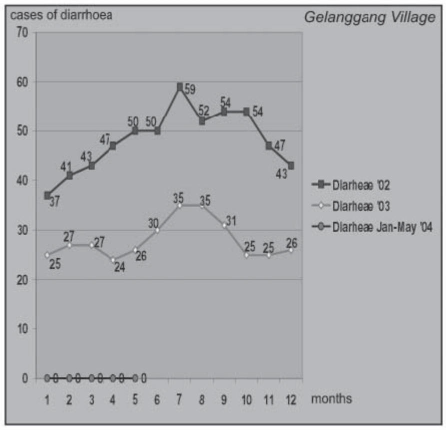

Figure 7 The incidence of diarrhoea in Gelanggang village was impressively reduced after the introduction of SODIS

Profile of the author

Christina Aristanti has been involved with Yayasan Dian Desa, an Indonesian NGO working on appropriate technology for community development, since 1980. She is primarily interested in the issues associated with household water treatment and sanitation and previously worked as an assistant to the Director of Yayasan Dian Desa. She became more greatly involved in household energy, and specifically improved cookstoves, in 1989 when Yayasan Dian Desa was a focal point of Foundation for Woodstove Dissemination and to an even greater extent when the Asia Regional Cookstove Program (ARECOP) started in 1990. She has been the manager of ARECOP from 1992 to present. More information on the work and future activities of ARECOP can be found at www.arecop.org.

A story of improving cooking stoves in a Dogon village, Mali, West Africa

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Theme

The meeting had lasted for some time. The representatives from the invited NGO had spoken and explained the reasons behind their presence, and the village chief had gone through his formal invitation and had given his blessings. But not a single woman for whom the meeting was organised in the first place had uttered a word. It was finally asked, “Is any woman going to talk?”

The meeting was in the Dogon village of Beignematou. It is a small village of 350 inhabitants situated on the edge of the “Cliffs of Bandiagara”, a World Heritage Site in the West African republic of Mali. Also known as the “Land of the Dogons” this region lies south of the Sahara Desert, in a semi-arid region called the Sahel, where the sands of the Sahara is never very far away.

The meeting had been organised as part of a project that had originally started in 2002 as a participative school project which included the designing and building of the village school. However, in 2005, it was broadened to cover wider environmental aspects as the project implementers realised that the major livelihood threats were insistent desertification, environmental degradation, poverty, malnutrition and migration, amongst others.

One idea to compensate for the wood used in the construction of the school was to encourage villagers to plant saplings of the affected species. The villagers, however, did not think those species would be able to grow, so it was agreed to either abandon the tree planting idea or look for a new approach. Research carried out by the Woodless Construction Project in Niger showed that building activity in the Sahel was responsible for 7% of destruction of the vegetal cover. A major part of this destruction was a result of firewood needs for domestic cooking, so the idea of an Improved Cooking Stoves programme was suggested.

Women in Beignematou cooked on traditional three stone fires, which coupled with strong winds, meant that cooking used a lot of firewood. With prolonged famines and greater human and domestic animal pressure, firewood was becoming exceedingly difficult for the women to find (Figure 1 & 2).

Commercial cooking requirements were also assessed; local restaurants in Bandiagara (equivalent of the district headquarters) used improved cooking stoves made of metal sheet that could be used for both wood and charcoal. The stove also recuperated the charcoal formed during the firewood burning. Fabricated by the local metal workers, the design had been integrated into the local economy.

However, this was not a feasible option for the village of Beignematou, 40 km of rough roads (suitable only for all terrain vehicles) away from Bandiagara. Further inquiries led to the office of a local NGO, “Ya G Tu”. They had prototypes of simple earthen stoves in their office courtyard. Ya G Tu, a woman-centred group, carried out demonstration and training programmes in improved cooking stoves in remote villages. And were keen to discus a possible intervention with Beignematou village.

Figure 1 Women spend long hours searching for firewood and then walk long distances in an arid environment to reach their villages. (*photo: Peeyush Sekhsaria*)

Figure 2 Urban areas continue to depend on firewood and wood based charcoal for cooking needs, putting immense pressure on already stressed rural environments. A firewood depot in the capital, Bamako. (*photo: Peeyush Sekhsaria*)

A village meeting with Ya G Tu was organised. All the women and several men of the village attended. This was the first time that the women of Beignematou had participated in a meeting with an outside NGO. Naturally, they were hesitant and therefore had not spoken a word. Dicoré, from Ya G Tu was aware of this fact and took a gentle approach knowing that patience was key. Soon the older women started to participate and by the end of the meeting everyone was interested and co-operating in the Improved Cooking Stoves project. Six women, two each from the three areas that make up Beignematou were chosen for training (Figure 11).

The demonstration started with the stove mixture consisting of:

- Three head loads of clay soil, the same as used for making adobe bricks
- One head load of donkey dung
- One head load of millet chaff
- Three buckets of water.

The ingredients were mixed thoroughly, covered for protection from the sun and watered daily. The mix would be ready in a week’s time (Figure 3).

The Ya G Tu team returned in a week’s time for the fabrication of the stove, assisted by the chosen group of six women. All interested households had to prepare the stove mixture for fabrication for the improved stoves before the next visit.

Three representatives from Ya G Tu arrived at the fixed date. Assisted by the group of six women and a few young men they fabricated stoves for 19 households out of the total of 37 households over a period of two days (Figures 4 to 9). The following observations were made:

Figure 3 After one week the mix is ready to be used for the fabrication of the stove. (*photo: Peeyush Sekhsaria*)

Figure 4 Each stove is custom made. Measurements of the vessel are taken based on the diameter of the cooking vessel. (*photo: Peeyush Sekhsaria*)

Figure 5 The vessel is placed on three stones, now organised as per the vessel measurements and the stove fabrication begins. (*photo: Peeyush Sekhsaria*)

- Many people were waiting to see the outcomes out of this project before involving themselves.
- Good soil was only available at a distance and fairly large amounts were needed. This made the task of transport difficult for women.
- As the quantities of mix prepared had been small, stoves for smaller size vessels[1] had been fabricated.
- People were very keen that the project continued.

Ya G Tu also evaluated the impact of the stoves fabricated in the first phase.

In the second phase, a team of two young men from the village were to organise the supply of earth with the help of donkeys and also assist the women in stove fabrication. The objective was to replace all stoves in the village with Improved Cooking stoves.

The result was that the village team fabricated stoves for the rest of the 18 households bringing the total stoves to 48, spread over 37 households.

In their evaluation concerning the first 19 beneficiary households Ya G Tu noted, “With the improved stoves, 1 fagot[2] of firewood that was previously used for 1 day is now used for 3 days.”

The women had become more proactive, asking for meetings, participating and actively discussing issues and ideas.

One interesting fact was that now all households had improved stoves, but one of the commercial ventures in the village is the making of millet beer and millet beer making stoves still remained in 18 households. Millet beer is an important source of income to the women, being sold in the village and the neighbouring villages during weekly markets. Millet beer preparation used the largest vessels and consumed large quantities of firewood. The fabrication of Improved Stoves for millet beer making was, due to their large sizes, considered more difficult. However due to the success of the household Improved Cooking Stoves, the village team was confident and enthusiastic. The village successfully fabricated improved stoves for all the eighteen millet beer preparing households, without the support of the Ya G Tu team.

Firewood that was used up in two days now lasted 5-7 days. Food cooked faster and the wind was no longer a problem. The stove remained warm long after the fire was put out and was used for heating water.

In one month, after three visits by the representatives of Ya G Tu, the training of 6 women and 2 young men, and the involvement of a small team for transporting the earth, Beignematou villagers were all using Improved Cooking Stoves (Figure 10). Their savings in precious firewood and corresponding hardships were 300 %.

A follow up meeting was called by the six woman trainers, as neighbouring villages were asking them about the fabrication of stoves. The trainers wanted to know: “Could they fabricate stoves for others?” They were worried as they had never gone to other villages to fabricate stoves in the past, the people would not pay and importantly who would cook for their family when they were away? All these concerns were discussed as well as ways of overcoming them in such as way as to ‘scale-up’ the work.

Figure 6 The stove is hand moulded around the stones and the vessel. The surface is smoothened and a uniform shape is assured. (*photo: Peeyush Sekhsaria*)

Figure 7 Rotating and lifting it at the same time the embedded cooking vessel is carefully removed.(*photo: Peeyush Sekhsaria*)

The scaling up of the work has still to be achieved and is proving difficult. In Beignematou itself, new stoves had been fabricated, some of those that have been damaged had been repaired and even replaced, but there needs to be more institutional and financial support for the Beignematou women to be able to go to neighbouring villages and fabricate stoves, although there is a de-

Theme

Figure 8 Final touches are given, the inside of the stove is smoothened and cleaned. (*photo: Peeyush Sekhsaria*)

Figure 9 The opening for firewood is marked in the moist earth. The opening will be removed after a day. (*photo: Peeyush Sekhsaria*)

mand and need for them to do so.

As Michel, a dynamic father of four children had put it very simply, “Earlier we had never even thought that such an idea exists. For us they are very, very good.”

Summary

In summary two interesting issues have emerged from this project:

- Although it was a women-centred programme and the NGO ‘Ya G Tu’ had a wide experience in this kind of community work, it was found that the participation of men played a key role in the success of the project. Men can use donkeys to transport large quantities of earth for stove building; women do not use donkeys and have to transport mud in baskets from long distances. Men are used to earthwork as a result of farming and the use of mud in making adobe bricks, mortars and plasters in construction. They are therefore better placed to identify the best earth and their location. The conclusion was that women and men have different roles to play in the stove making process but both should be involved in a participatory and planned process.
- In terms of knowledge transfer, the social distances seemed to play a more important role than the physical distances. The women of Beignematou were ready to fabricate stoves for villages that were up to four hours walking distance that were related either through marriage or through migration, than in the neighbouring village that belonged to a different clan. This is an important cultural issue that needs to be taken into account when designing ‘scaling up’ programmes.

[1] Vessels of different sizes are used depending on the family size and the specific preparation being made. Most families have two or even three stoves of different sizes depending on the size of the vessel being used.

[2] Two Fagots roughly make up one headload of firewood.

Profile of the author

Peeyush Sekhsaria, an Architect – Geographer specialised in Earthen Architecture and Sustainable Development. He has an M. Phil in Geography from the Sorbonne. He is interested in questions of sustainability and participation. He is interested in taking this project to a larger scale in the same region and can be contacted on psekhsaria@yahoo.co.uk

Figure 10 One of the first stoves being used. (*photo: Peeyush Sekhsaria*)

This project was realised as part of a school project with the participation of CRATerre-France, Cultural Mission of Bandiagara, Misereor-Germany, Association Mali Initiatives.

Anybody at the individual or organisation level can get in touch with Ya-G-Tu, please keep in mind that their English is very limited, but they need all sorts of help to take their programmes forward

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Madam Dikore Nantoume, Animator

Figure 11 The team of six village women responsible for the Improved Stove Programme in the village. (*photo: Peeyush Sekhsaria*)

Micro-Gasification: What it is and why it works

Paul S. Anderson[1], Thomas B. Reed[2] and Paul W. Wever[2]
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Preface

Every successful cookstove project must address the four essential components: fuels for the heat, combustion to obtain the heat, applications of the heat, and human factors such as costs, cooking preferences/traditions, and user-friendliness. Failure in any of these four will lead to failure in the project. With regard to applications (such as single-pot direct heat or plancha griddle tops or baking), these are mainly issues of stove structure with a focus on the transfer of heat to the pot, and the applications are defined locally and solved locally. The human factors are much more personal and cultural, have less to do with the actual physical stove, but often require the greatest efforts and investments of time and money. Many cookstove projects are outstanding in the components of applications and human factors.

In contrast, the issues of fuels and combustion are often simplified to be "making sticks of wood burn," especially in the most simple stoves. But when additional fuel types are considered, and when issues of complete combustion and emissions are considered, fuels and combustion become more technical, scientific, and challenging. Clearly, the success of the Rocket stoves is linked to its superior combustion of stick-wood, which in turn justifies the truly significant efforts for applications and the human factors. In the case of gasification, there are yet to be any main success stories that include applications and human factors. But concerning fuels and combustion for cookstoves, this article will show that "micro-gasification is a technology that works."

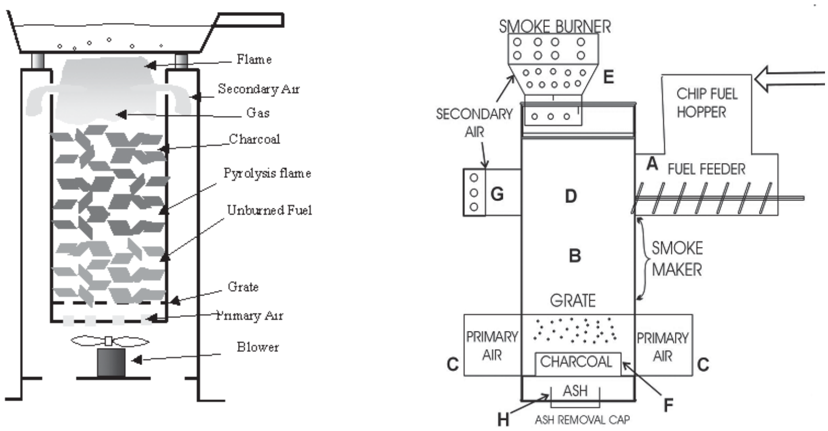

Figure 1 Diagrams of a forced-air TLUD, left, and an AVUD micro-gasifier, right. (*diagram: Tom Reed, left, and Chip Energy, right.*)

Introduction to micro-gasification

When burning any biomass, various gases and vapors called "smoke" must be driven from the solid fuel and then the smoke is burned. For over a hundred years scientists and engineers have known that combustion of biomass is cleaner when the air is well mixed with only combustible gases, instead of having the combustion occur in zones where solid fuel is still present. The creation of combustible gases that are separate from the combustion of those gases is a clearly distinguishing characteristic of a true "gasifier." Practical gasification in small devices (i.e., micro-gasification) was not achieved until 1985 when Dr. Thomas B. Reed conceptualized and accomplished what is now called "Top-Lit UpDraft" (TLUD) gasification with batches of biomass fuel. In 2004 Dr. Paul S. Anderson created a variation of traditional updraft micro-gasification with continuous-operation, being called AVUD for "Another Variation UpDraft" to distinguish it from conventional updraft gasifiers. To achieve these advances, Drs. Reed and Anderson mainly do practical experimentation based on combustion theory and principles*.

Both TLUD and AVUD micro-gasifiers can be constructed in several different ways. Figure 1 shows one diagram for each type. The distinguishing characteristic of these and any other true gasifiers is that the creation of the gases ("smoke") is separate from where the gases are combusted. Of crucial importance in these (and in any stoves) are the flows of primary and secondary air. In the gasifiers, the flows are separate. In most regular stoves, they are mixed. There are cases where the air flows are partially mixed together in the quasi-gasifiers (semi-gasifiers or partial gasifiers) that include several designs in China, the Vesto stove, and the air-jet fan-stoves of Philips and typical pellet stoves. Control of air flow leads to clean combustion, and control also helps prevent too much air entering and diluting the heat.

Micro-gasification in cookstoves

The TLUD gasifier stoves fall into two main categories based on having forced air or natural draft. Two with forced air are pictured in Figure 2. TLUD gasifiers operate with batches of fuel that are pyrolyzed, so they must be emptied and refilled. Therefore, a second fuel canister permits sequentially continual cooking.

The natural draft TLUD gasifiers utilize the principles of Anderson's

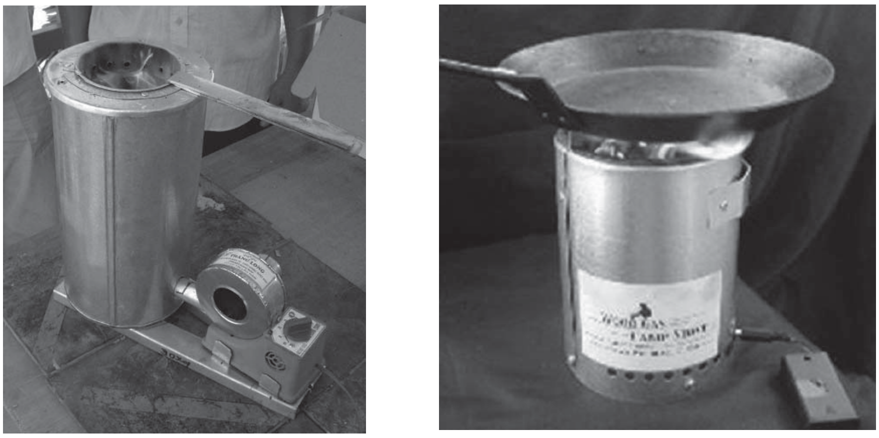

Figure 2 Reed's Woodgas Campstove (left) for sale on the Internet (US$55) and Anderson's Juntos B+ TLUD gasifier (with removable fuel canister) hand-made in Cambodia with GERES (estimated cost under US$20). For cooking, the pot can be placed on top of the unit or (better) be positioned on a simple pot support structure of any size so that the gasifier can be moved for refilling without disturbing the pot. (*photos: Tom Reed, left, Paul Anderson, right*)

"Champion" stove that won the "Kirk Smith Cat Pee Award" for clean combustion at ETHOS Stove Camp 2005. A 15 inch (38 cm) riser or "pre-pot internal chimney" is needed to achieve the natural draft, but additional chimney height is needed at elevations above 3000 feet (1000 meters). This design is maintained in Andreatta's TLUD testing unit, seen in Figure 3.

The AVUD micro-gasifiers are larger than the TLUDs and operate continually as a gasifier with feeding of additional fuel in from the side (Figure 4 and Figure 1). Both natural draft and forced-air versions are possible.

Results and experiences

The leading international advocate of TLUD and AVUD gasifiers (Dr. Anderson) has worked directly with tinsmiths in Mozambique, Brazil, India, Bolivia, and Cambodia to create locally-available TLUD cookstoves. Each experience was different, resulted in additional enhancements, and taught valuable lessons, including patience. Interest by users was always evident, but resources and determination to continue the projects have been limited. Only the December 2006 effort in Cambodia currently has an active agenda, and that Juntos B+ TLUD utilizes the advantages of forced-air from a US$2 blower from Vietnam (Figure 2 right). The original Juntos B has been fully described since 2004 in the Anderson and Reed (2004) presentation, and would be a good place for serious individuals to get a start on making a TLUD cookstove. Anyone interested in any of the TLUD or AVUD micro-gasifiers is encouraged to contact Dr. Anderson via e-mail. He is also posting information about these gasifiers at the Chip Energy website: www.chipenergy.com, but it is extremely difficult to cover the human factors of usage of a new stove technology without hands-on personal contacts.

Fuels

TLUD and AVUD micro-gasifiers excel in the variety of fuels that they can use. The fuel requirements are dry biomass that is the size of chips or small chunks through which the upward primary air can pass, but not blow freely in channels. Pellets and chunky briquettes are excellent, as are cherry pits and many other reasonable-sized seeds. Woody stems, twigs, stalks, and chipped and shredded wood are favorite fuels. TLUDS with forced-air can very successfully burn loose rice husks, but the duration of combustion is rather short (about 8 minutes for a 10 inch (25 cm) tall fuel canister). Stove developers and users who have a "large-wood-mentality" often express resistance about the efforts needed to make large wood into chip wood but actually collection of small wood (twigs and branches) should be encouraged, along with use of agro-wastes that are more easily cut apart or compacted together into appropriate sizes.

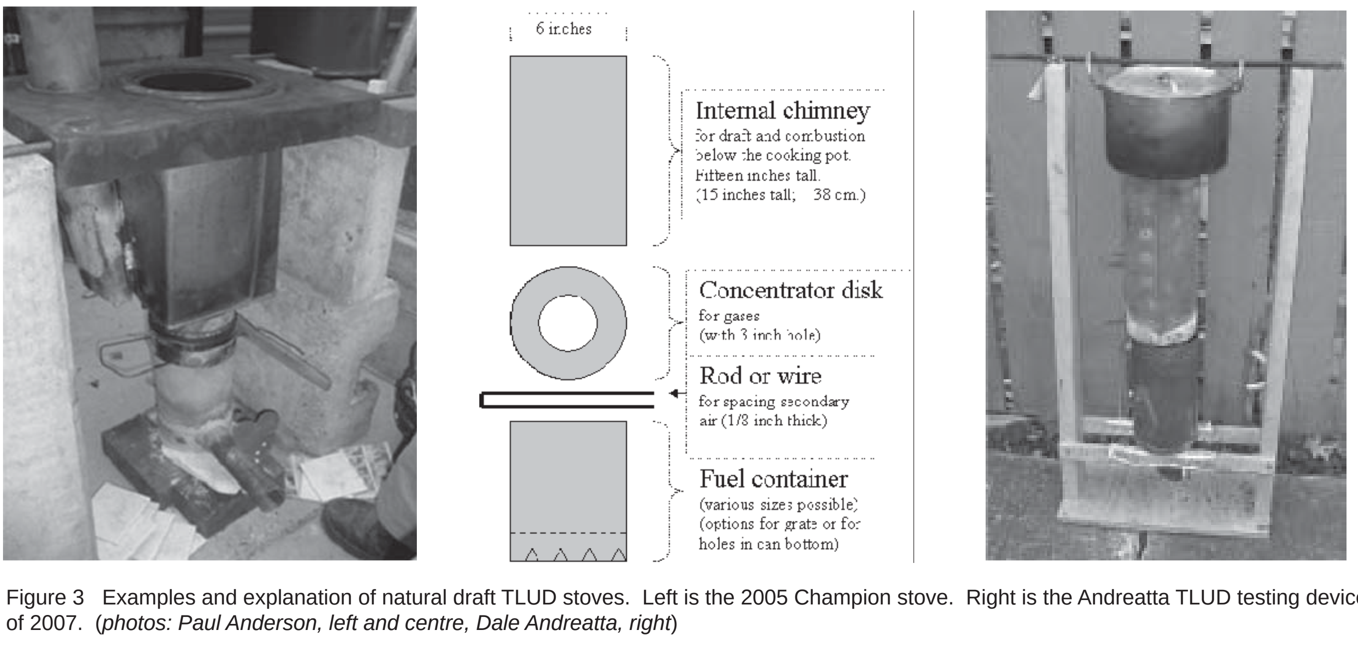

Figure 3 Examples and explanation of natural draft TLUD stoves. Left is the 2005 Champion stove. Right is the Andreatta TLUD testing device of 2007. (*photos: Paul Anderson, left and centre, Dale Andreatta, right*)

Conclusion

Micro-gasification TLUDs and AVUDs are exceptional in terms of fuel varieties and combustion that is very clean and can be quite easily controlled. With regard to heat applications, individual micro-gasifiers have been made for a wide variety of stove bodies, including plancha tops and single-pots both with and without chimneys. Units have been made in Mozambique, Brazil, Bolivia, India, Cambodia and the USA to show appropriate uses and sustainable costs, but there are not any projects with significant numbers of installed gasifier cookstoves. Although there are not many projects with micro gasification at the moment, the evidence above shows that "micro-gasification is a technology that works."

*The authors acknowledge the valuable assistance of Mr. Agua Das and also note the efforts with TLUD-related gasifiers by Dr. Mukunda of India, by Professor Belonio in the Philippines, by Dr. Dale Andreatta in the USA, and by GERES in Cambodia.

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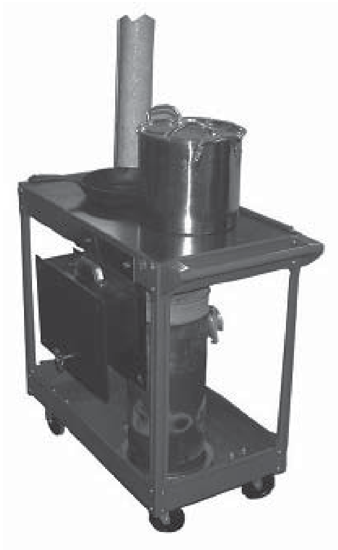

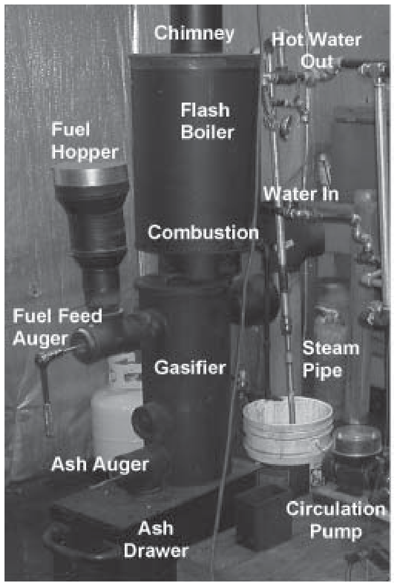

Figure 4 The AVUD gasifier is the lower vertical cylinder with its openings for fuel entry, ash removal, and air flows. Left is the open-cart version of the Chip Energy Biomass Grill (US$150) with the combustor in the tray under the plancha griddle top, plus the chimney. The cart is essentially "stove structure" that could be adobe blocks or stainless steel walls. Right is the Chip Energy Furnace for process heat (200,000 BTU = 211 megaJoules = 50,400 kcal) with combustion at the center of the picture and a flash boiler application in the upper cylinder. Other applications of process heat are easily adapted. (*photos: Chip Energy*)

If you require further technical information regarding the content of this article please contact the authors directly.

Profile of the authors

Paul S. Anderson has extensive international experience from his universityteaching career (Geography) and he has worked on micro-gasification since 2001 when he met Dr. Reed. since 2001 when he met Dr. Reed. He heads the international and improved cookstove (ICS) activities of Chip Energy with hands-on assistance to NGOs interested in the advantages of micro-gasifiers. For information on his ongoing work, see http://www.chipenergy.com/3rdworld.htm.

Thomas B. Reed is one of America's most respected experts on all forms of gasification and other biomass energy issues. He held positions at MIT, Colorado School of Mines, and NREL (National Renewable Energy Laboratory). His activities continue at the Biomass Energy Foundation (BEF) (www.biomassenergyfoundation.org).

Paul W. Wever manufactures heavy steel attachments for constructino equipment (see www.pwce.com), includeing cutting/moving large biomass. Since 2006 he and Dr. Anderson have created Chip Energy's designs and commerical products for biomass micro-gasification at scales for residences and cottage/small industry.

What's happening in household energy?

HEDON Household Energy Network www.hedon.info

HEDON

Leading Issues on the HEDON website

This is the first edition of Boiling Point since it formally became part of the HEDON Household Energy Network. In view of this exciting union, HEDON has been developing the website over the last few months. The aim is to expand the website into an interactive knowledge base for all those that are interested in household energy.

There has been the creation of a comprehensive database of information and resources on a number of leading issues in the Household Energy Sector. These include:

- Climate Change
- Forestry
- Health
- Gender
- Market creation
- Policy
- Monitoring and Evaluation

The pages can be found at www.hedon.info/goto.php/LeadingIssues.

If you would like to contribute on any of the topics listed please don't hesitate to contact: fran@ecoharmony.com.

Getting involved in the HEDON Household Energy Network

Would you like to become an active member of this fascinating network? HEDON has now created a 'volunteer' page with ideas of how you can get involved. Volunteers of all levels of experience can help, there are tasks designed for everyone who has an interest in household energy issues.

HEDON is addressing the issues associated with household energy 'head on' and needs volunteers with all sorts of skills to help build, maintain and get the most out of our site and services. The work you do can make a real impact for those living in poverty and help to improve life for those whose homes are made dangerous and unwelcoming due to smoke. Energy technologies need to be improved, not just to reduce smoke, but to make stoves more efficient, thus reducing deforestation, giving women improved choice, learning about other fuels such as biofuels, which can be faster and cleaner - there is so much to do.

HEDON needs volunteers of all experiences to help to build this "exciting-and-full-of-useful-people-and-information" network, just visit the volunteer page on HEDON (www.hedon.info/goto.php/Volunteer). By dedicating some of your valuable time and effort you can join a team of people whose focus is on two of the most vulnerable groups – women and children.

For those who are not experts but would like to help there a range of possible activities that take from less than half an hour to as long as you want! For example, you can comment on various topics in the knowledge base, join HEDON yourself, help us to prepare the monthly HEDON newsletter by providing us with interesting events and news, adopt a page in the knowledge base, help update funding profiles, or help us translate the website topics into French and Spanish.

For those that have greater experience in the household energy sector there are also a wide range of activities to get involved in. For example, identify and contact community groups from our HEDON Groups, write a Knowledge Base article on policy frameworks, prepare and improve materials related to household energy for use by educational institutes, help us to update the articles on traditional cooking devices, ethanol, grid electricity or create articles on renewable energy technologies in the knowledge base.

HEDON Associate Programme created

In order to build the capacity of young professionals to develop effective household energy projects, and increase regional participation, the HEDON Household Energy Network has launched the HEDON Associate Programme. For more information please visit the HEDON knowledge bank at www.hedon.info for details of programme benefits, requirements, duties and the application procedure.

Profiles of current HEDON Associates

Jose Edgar Villalobos-Enciso

Jose Edgar Villalobos-Enciso is a Ph. D. Candidate for Louisiana State University, USA, researching "Web-Based, GIS/Remote Sensing Watershed Modeling for Mesoamerica", which aims to predict floods in near real time. After graduating as a Civil Engineer in 1983 he worked at the International Boundary and Waters Commission between Mexico and Guatemala for 12 years. After completing an M. Sc. at the IHE Delft in 1996-8, he joined the Civil Engineering School at the Universidad Autonoma de Chiapas in Mexico, where he has developed projects and workshops regarding: cookstoves; dry latrines; fog collection; flux materials analysis, and river basin management.

Dr. Karabi Dutta

Karabi Dutta is the Project Coordinator at Appropriate Rural Technology Institute (ARTI),Pune,India. She primarily works on household energy and health projects, with a special interest in Indoor Air Pollution. She was introduced to this subject about 7 years ago, and since then it has developed into a passion and a mission to spread the awareness about Indoor Air Pollution and Health.

Mamadou Fall

Mamadou Fall has academic qualifications in rural development, energy, sanitation, MSW and wastewater management and treatment. He has more than ten years experience in household energy issues with an informed understanding of Sahelian area sustainable energy policy, working for SEMIS (Service de l'Energie en Milieu Sahélien) in decentralised rural electrification for household and ru-

ral infrastructure and leading projects at the water, sanitation and environmental consultants 'H2O Engineering'.

HEDON Launches CleanAirSIG: the special interest group on Clean Indoor Air

Special Interest Groups or SIGs are thematic groupings of HEDON members, and are new initiatives being introduced to the HEDON community. SIGs aim to:

- Connect people with other people for mutual benefit.
- Promote increased and more effective cooperation between people working in key household energy sectors.
- Leverage financial and other resources by building innovative partnerships.
- Act as a premier source of knowledge and voice.

Activities

- CleanAirSIG connects members from around the world through an email discussion list. Members have access to the list archives and other member resources.
- CleanAirSIG will organise regular online conferences and discussions to share knowledge and build capacities.

Join CleanAirSIG

If you would like to join CleanAirSIG please visit the community pages at www.hedon.info.

CleanAirSIG is kindly sponsored by Shell Foundation.

Bolivia launches national campaign for clean cooking energy

Within the next three years 100, 000 households in Bolivia will cook smoke-free. This is the aim of the ambitous campaign "Cocinas para una vida mejor" recently launched by the Bolivian Minister of Public Works and the German and Dutch Embassies.

Around 9.5 million people live in Bolivia, more than half of them in rural areas. 75% of the rural population use wood as cooking fuel for their daily meals. To reach a wide range of households with different socio-economic backgrounds different technologies, such as Rocket stoves, improved Lorena stoves (named Malena), solar cookers and gas stoves will be promoted. The total cost of the campaign will be about US$ 7.5 million.

For more information visit:

http://www.hedon.info/goto.php/871/news.htm

The latest PCIA Bulletin is available for download: Issue 11 April 2007

In this issue, you will hear from NGOs and international agencies about their commitments to bring cleaner fuels and technologies to people living in the most extreme circumstances - refugees, internally displaced persons (IDPs), and other populations in need of humanitarian assistance. Ensuring that refugees and IDPs not only have food to survive but the means to prepare it has long been a challenge in need of workable solutions. The circumstances of refugee settings are particularly challenging: fuelwood and other biomass resources are scarce to nonexistent, gender-based violence is rampant, and the sheer number of families in need is daunting. Solutions for these settings must be large in scale and require strong coordination among aid agencies.

To download the PCIA Bulletin go to:

http://www.hedon.info/goto.php/886/news.htm

Indoor Air Pollution and Health gets boost at preparatory meeting for Commission for Sustainable Development 15

Energy for sustainable development is the main theme of CSD 14 (review session) and CSD 15 (policy session). The Intergovernmental Preparatory Meeting (IPM) took place at a technical level in New York from 26 February to 2 March 2007, deciding on policy recommendations for negotiations during CSD-15. WHO, GTZ, Practical Action, the US Environmental Protection Agency and the Partnership for Clean Indoor Air held a side-event "Healthy and affordable household energy - let's scale up what works!" at the German House in New York. The side-event was attended by approximately 40 participants almost all of whom engaged in the subsequent discussions.

For more information visit:

http://www.hedon.info/goto.php/857/news.htm

The latest Asia Regional Cookstove Program, (ARECOP), proceedings are now available online

The proceedings of the ARECOP second phase III Planning Technical Advisory meeting 2007 (January 22-25 January, 2007, Chiang Mai, Thailand) are available to download. Find out more at:

http://www.hedon.info/goto.php/887/news.htm

Asia Regional Workshop on Solar Cooking and Food Processing

The Centre for Rural Technology, Nepal (CRT/N), Alternative Energy Promotion Centre (AEPC), Foundation for Sustainable Technologies (FoST) and International Solar Cookers Association (ISCA) organised the Asia Regional Workshop in Nepal in April 2007.

The main objective of the workshop is to promote the solar cooking and food processing in Asia region as well as share best practices on solar cooking and food processing from the international, regional and national community. Besides this, the workshop will also provide a forum for sharing of experiences and expertise on various solar cooking and food processing technologies among the participants, experts and business enterprises.

Further information will be available at: www.hedon.info.

"Where Energy Is Women's Business", a new book from ENERGIA

National and Regional Reports from Africa, Asia, Latin America and the Pacific.

Find out more at:

http://www.hedon.info/goto.php/890/news.htm

Boiling Point is a technical journal for those working with stoves and household energy. It deals with technical, social, financial and environmental issues and aims to improve the quality of life for poor communities living in the developing world.

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The HEDON Household Energy Network is an international forum dedicated to improving social, economic, and environmental conditions in the South, through promotion of local, national, regional and international initiatives in the household energy sector.

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