PRACTICAL ACTION
Technology challenging poverty

CHIMNEY STOVES AND SMOKE HOODS

Getting smoke out of the kitchen

Why get rid of smoke?

Nearly half the world cooks on three-stone fires or rudimentary stoves. Indoor air pollution, caused by burning biomass fuels, such as wood and agricultural residues, causes the deaths of more than 1.5 million people each year. The people most vulnerable are young children aged five years and under, particularly infants less than six months old. Where people live a long way from towns or cities and have no choice other than to burn biomass fuels, ways must be found to burn fuels more efficiently, and to get rid of the damaging smoke from their homes. Chimney stoves and smoke hoods are two ways in which this can be done.

Methods of smoke removal

One way to get rid of the smoke is through a flue or chimney, which takes the smoke outside the house. There are basically two ways of doing this – either through a chimney stove, where the flue is an integral part of the stove (Figure 1), or using a smoke hood (Figure 2), where the hood is placed over a traditional fire or a stove, and the cook can access the stove through a front opening, allowing her to cook in a way which is familiar to her. Hot air rises up the flue out of the room.

These two systems are very different, in that the chimney stove is an enclosed system, with only a small opening to insert fuel and to let in limited air, so the smoke has nowhere to go other than out of the room. With a smoke hood, on the other hand, the fire burns largely independently of the surrounding hood – though the smoke is drawn up to some extent by the heat of the flue.

Figure 1: A well-designed chimney stove disseminated by HELPS International in Central America (*photo: HELPS international*)

Chimney stoves

In theory, a chimney stove seems a perfect solution. With nowhere else to go, the smoke vents into the open air outside the house. A well-constructed and maintained chimney stove can get rid of most of the smoke.

Figure 1 shows a stove disseminated by HELPS International that fulfils all the requirements of a good chimney stove and is very popular with the user.

Such stoves can be found particularly in Central and Latin America. The top surface is a sheet of metal called a *plancha* on which tortillas can be cooked. Recesses are sometimes built into the *plancha* into which the pots can fit.

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Clips at the top and the bottom of the flue mean that it can be easily removed for cleaning. The opening for fuel is exactly the right size, and there is a small bar across the opening close to the bottom to ensure that air can pass underneath the fuel so that the fuel burns completely. The material for the stove is based on a lightweight local tile called a *baldosa.*

What makes a good chimney stove? Table 1 indicates some of the features that are vital for a good design and some of the problems if care is not taken in design and manufacture.

Table 1: What makes a good chimney stove?

	Good design	Potential problems
Stove material	The firebox, where the burning takes place, must be made of lightweight insulating material that reflects heat back into the stove. Metal can also be used as a stove material, provided it is strong enough to last.	Despite its widespread use, mud is not a good insulator. It absorbs the heat just like a sponge absorbs water. Whilst this is happening, the fire remains cool and this causes more smoke. Metal stoves have to be protected externally as they do not appear hot, and can cause burns. They emit a lot of heat into the room, and often use a lot of fuel. If the gauge is not thick enough, they will distort and air will leak into them.
Chimney or flue	The chimney or flue must be cleaned every two or three weeks – so it must be easy to dismantle to make this task quick and easy. Training in cleaning of flues is a vital part of successful introduction of chimney stoves.	Flues that are fixed to the stove at the bottom and fastened firmly to the roof at the top require the cook to climb onto the roof to clean the flue. This is such a big nuisance that flues tend to be left, they block up with soot and the smoke blows back all the time into the room.
Flue dimensions	This is highly critical. The correct cross-sectional area and height of flue pipe will provide clean and efficient combustion. It is therefore important that the person making the stove has good design specifications and close tolerances on his / her work.	Too tall a chimney will cause too much suction on the stove and it will burn excessively quickly. The cross-sectional area needs to be sufficient to take up all the smoke, but narrow enough to accelerate the smoke out of the house.
Fuel opening size	Fuel burns best when it is cut into small pieces, and a small opening will ensure that the cook uses the right size fuel for optimum burning.	However, too small an opening may stop the cook from using the stove at all if she finds that it is a nuisance. Too large an opening allows too much air to rush into the system, cooling the fire. It will also allow the cook to use pieces of wood that are much too large.
Pot-holes	Ideally, these should allow the pot to sit down into the stove so that heat can reach the sides of the pot. In some Latin American countries, the hotplate is a flat metal sheet (called a *plancha)* on which food such as tortillas can be cooked directly, as in Figure 1.	Pot-holes will allow smoke out into the room unless the pot fits snugly into them. When the cook removes the pot to stir the food, smoke escapes through the holes. Also, if the stove has two pot-holes, an extra disc to block off the unused pot-hole is required, or smoke will escape. This is an extra operation for the cook.
Distance between fire and cooking pot	As the fire burns, particles of smoke are created and rise up towards the pot. In a well-insulated chamber, these particles will burn creating more heat if there is sufficient distance between the fire and the bottom of the pan.	If there is insufficient distance between the pot and the fire, the particles of smoke will move past the pot and go into the cooler flue before they are burnt. This creates more smoke and reduces efficiency.

There are many designs of chimney stove that do not work well, that create a lot more smoke than

an open fire, and that burn more fuel than an open fire. As a result, large numbers of chimney stoves have been abandoned and their components used for other purposes, or they have not been replaced once worn out.

Successful chimney stoves require good design, good maintenance and good instructions on how to clean the stove very regularly. In the right place, well-designed chimney stoves can have a major impact on smoke reduction.

Smoke hoods

In some situations chimney stoves may not be appropriate.

- Where people like a traditional fire and are unused to cleaning chimneys, a chimney stove may be too different to be well accepted.
- Where people have very little money and no chance of a subsidy, chimney stoves can be too expensive
- A high level of skill is needed to reproduce the exact dimensions of the stove – mass production is ideal. This may not be feasible in some communities
- If people want space heating, a chimney stove does not work well because it insulates the fire so little heat escapes. In such a situation, people may be tempted to light an additional fire in the room in order to keep warm.

Smoke hoods are work in a similar way to open fireplaces used for heating in many countries worldwide. They alleviate smoke by venting it out of the kitchen once it has left the fire or stove on which the food is cooking. Practical Action has been promoting smoke hoods for several years.

Technically, the most important factor is the ratio of the area of opening to the flue cross-sectional area – ideally a ratio between 1:10 and 1:7 – the larger the better within these ratios. The flue must be tall enough to prevent 'blow back' into the room, and to keep the hot gases away from any inflammable roofing materials.

Figure 2: Woman sitting beside smoke hood, Kenya
Photo credit: Practical Action East Africa

Figure 3 Woman sitting beside smoke hood, Nepal. Photo credit: Practical Action Nepal

In Kenya, a well-known low-cost *upesi* stove is built under the hood in place of the open fire, as in Figure 2. The *upesi* is a well accepted ceramic stove which can be built into a base, with the hood set over the top to provide a neat safe environment – reducing the risk of burns and reducing the fuel costs. Currently, another type of stove, built on a principle called a 'rocket' stove, is being researched. If this research proves successful, the stove will reduce emissions and fuel costs, and the smoke hood can still be used for venting any residual smoke up the smoke hood. The smoke hood is sufficiently versatile to allow these changes to happen.

A key issue with any new technology is that people must like the finished product, and be able to afford it, or it will not be of any use, so the design must be adapted to meet local requirements. In Nepal, for example (Figure 3), the hood is somewhat larger and higher as brewing liquor is part of the weekly tasks, so the smoke hood must accommodate this weekly task.

This design has been developed with the community, and it is both acceptable to the user and removes a substantial percentage of the smoke. The side walls of the hood are hinged as people want to sit around the stove when the weather is very cold. Once the fire is burning brightly, it emits much less smoke and this is a good compromise – much better than people lighting a second fire in another part of the room.

Because people store grain in the roof space, a small vent, complete with cowl, allows some smoke to escape within the roof void, safely away from the house occupants (Figure 6).

Smoke hoods will not, however, reduce the amount of fuel people need to use – but they do provide a good opportunity to make other changes that will help people burn less fuel.

Figure 4: Maasai woman standing beside her smoke hood, Tanzania. Photo credit: Practical Action East Africa

In Nepal, the traditional stove is a three-legged tripod with a circular metal ring on the top where the pots can sit. By building around the back of the stove, more heat is directed at the pot, increasing efficiency, whilst those sitting around the stove can still see the flames (Figure 3). The dry-stone walls of the houses have been insulated as part of the project, as shown around the smoke hood in Figure 3. This means that less heat goes out through the walls, compensating for the heat lost through the chimney in the vented smoke.

A successful initiative in Tanzania and Uganda also involves the use of smoke hoods, combined with the installation of *upesi* stoves (Figure 4).

Some structural changes have included the removal of a wall across the door opening, and the addition of two small windows. The result is that the Maasai homes in this district have been transformed from enclosed smoke-filled kitchens to clean bright open houses.

The very low level of emissions now evident in the households is partly to do with the technology, but also perhaps because of the extreme fuel shortage. Women in this region walk for several hours twice or three times per week to gather fuel.

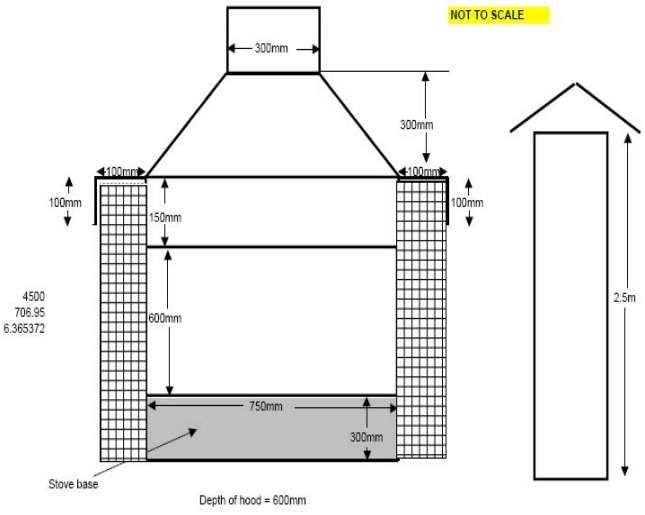

Figure 5: Stove dimensions used in the Tanzania smoke hood.

The *upesi* stove works best when thin pieces of very dry wood are regularly added to the stove. Where people are very short of fuel, they will conserve it carefully by burning it in this careful way. The dimensions of the smoke hood used in Tanzania are shown in Figure 5.

Smoke hood manufacture

Smoke hoods need to be made within certain tolerances, but these are not so critical as for successful chimney stoves. The hoods can be made by local artisans, thus providing new employment opportunities and keeping the money 'in the community'.

An additional benefit is that when things go wrong, they can be easily fixed as the manufacturer lives close by.

Figure 5 shows the dimensions of the smoke hood used in Tanzania – the Kenya model is similar but has metal side walls.

Figure 6 shows the dimensions for the Nepali smoke hood made by a local Tamang entrepreneur, whose story is given in case study 1.

Case study 1: A story of a local smoke hood entrepreneur ***(report by Min Bikram Malla)***

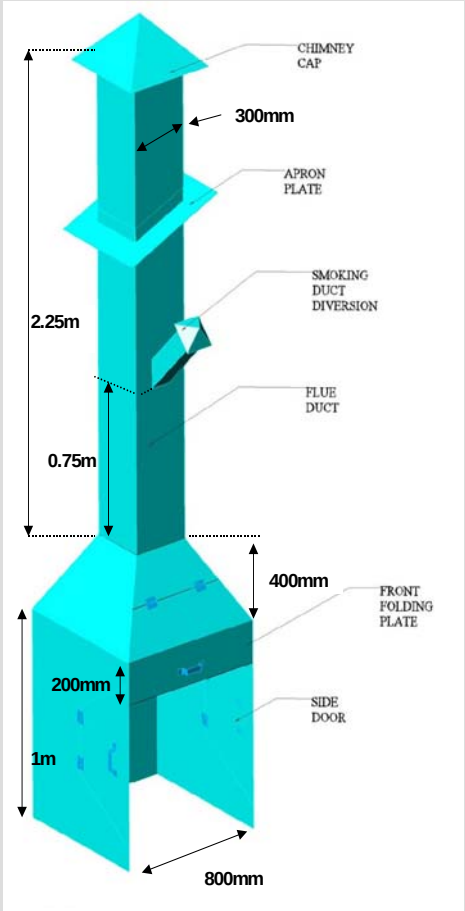

Figure 6: Nepal smoke hood.

Figure 7: Mr L. with a team of smoke hood manufacturers whom he now employs.

Mr. L. (26 yrs) lives in Rasuwa district, Nepal, where the DFID-funded Practical Action smoke project has been running (2001-2007). He belongs to a poor Tamang family with 11 family members to support, and although he dreamed of serving his community as a doctor, poverty compelled to undertake daily waged work as a house builder.

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From February 2006, Mr. L. started his business (Figure 7). Over 11 months, his team has been able to install 232 smoke hoods. His schedule is tight, with enough demand for the coming 6 months. Currently, his daily income is about Rs.500.00 (£4.00), which is a good income in the rural village. He has been able to send his brothers and sisters to a good school and hopes to fulfil his dream of higher education through his brothers and sisters. Likewise, he gets great satisfaction when his neighbours thank him for making their kitchens smoke-free. They are particularly glad that their children can do homework under supervision indoors. Where a smoke hood has been installed in a local café in the marketplace, the number of people coming to restaurant increased significantly contributing to an increased income for the owners, who previously earned very little.

In a district level workshop, the Superintendent of the district hospital, Rasuwa, mentioned that there is significant reduction in patients with respiratory problems after the introduction of smoke hoods in Rasuwa. The Chief District Officer, Local Development Officer and leaders of main political parties expressed their commitment to support this initiative and praised the contribution of local entrepreneurs. According to Mr. L., he never thought to receive such big honour. Such experiences have given him greater confidence and enthusiasm in his initiative.

Can people afford chimney stoves and smoke hoods?

Both chimney stoves and smoke hoods are quite expensive if you are on a very low income. However, the major problem is finding all the money at once – the *up-front* or *capital costs*. Once installed, the technologies often save fuel costs for reasons described above. One way to enable purchase of hoods and stoves is to create *revolving funds.* These funds are based on *seed capital* – an amount of money that starts off the process. A few households belonging to a community group, will buy the appliance in instalments; sometimes paying a low additional interest rate to provide a small income for the person running the fund. Once they have paid back some of the money, this provides enough funds for a few more people to get appliances. The larger the seed capital, the sooner everyone gets a chance to reduce smoke in their kitchen.

Choosing the right technology

Practical Action believes that people should have the right to choose what is best for them, and the organisation will strive to make it possible for them to purchase whatever they choose. The most important people in any development work are thus the people in the community with whom the organisation works.

Good chimney stoves that are well-designed and constructed will be appreciated, and therefore are more likely to be well-maintained by cooks who are keen to use them. If they are an imposed solution, they are likely to fall into disrepair.

Smoke hoods are an excellent solution if they are affordable and if people want to maintain their traditional cooking practices. They are also useful in that they allow people to sit in front of them when the weather is cold. The social aspects of sitting around a cosy fire should not be underestimated. All manner of stoves can be built underneath them.

Ultimately, the choice is going to be decided by the user, and by what they can afford.

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References and further reading

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- *Smoke, Health and Household Energy Volume 1: Participatory Methods for Design, Installation, monitoring and assessment of smoke alleviation technologies*. Bates. E. et. Al. Practical Action May 2005
- Good website for looking at efficient and effective stoves: http://www.crest.org/discussiongroups/resources/stoves/
- HELPS International: http://www.helpsintl.org/programs/stove.php
- *How to Build The Improved Household Stove: A Construction Manual for the Rocket – Lorena and Shielded Fire Stove*, Ministry of Energy and Mineral Development, Uganda. http://www.energyandminerals.go.ug/DOCS/HOUSEHOLD%20Stoves%20Construction%20Manual.pdf

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