

Division 45 – Rural Development

**Project and Stove Design for
Large Scale Cooking in Devel-
oping Countries**

A Guide Book

FWD

GTZ

Foundation for Wood-
stove Dissemination
GmbH

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Abbreviations

<i>FWD</i>	Foundation for Woodstove Dissemination
<i>GO</i>	Governmental Organisation
<i>GTZ</i>	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)
<i>HEP</i>	Household Energy Programme
<i>ILCS</i>	Improved Large Scale Cookstoves
<i>J, kJ</i>	joule, kilojoule unit for energy, heat 1 J = 1 Ws
<i>kg, g</i>	kilogram, gram
<i>LCHS</i>	Lund Centre for Habitat Studies
<i>NGO</i>	Non-Governmental Organisation
<i>PRA</i>	Participatory Rural Appraisal
<i>PTD</i>	Participatory Technology Development
<i>RCA</i>	Rapid Conflict Appraisal
<i>RRA</i>	Rapid Rural Appraisal
<i>SADC</i>	South African Development Countries
<i>W, kW</i>	watt, kilowatt unit for power, (energy released in a given time)
	1 W =1 J/s

1 Foreword

This guide book on institutional cooking represents a joint effort of the Foundation of Woodstove Dissemination (FWD) and the Household Energy Programme (HEP) of GTZ. As such it is an attempt to share the knowledge and experiences of organisations from different geographical areas in the South and the North and we hope, that the outcome justifies the additional coordination input necessary.

As with any handbook on technical assistance, this book intends to sensitise and motivate the reader and provide basic knowledge for systematically verifying, planning, organising and implementing activities for the purpose of improving the conditions in large scale cooking situations in developing countries.

However, motivation to improve a situation and knowledge on how to do it alone is often insufficient to bring about the necessary changes. There is also the ability to apply in practice the knowledge one has acquired, which comes only through experience and cannot easily be gained by reading alone. It is our strong advice, therefore, to use this book to get ideas on what options there are in a particular situation and then to get the additional advice from experienced people on how to implement these options.

It is also important for us to point out, that in order to get optimum results it may not be sufficient to improve on the cooking system alone, but to look at the whole kitchen environment and to develop an advisory package, including cooking, lighting, water heating, ergonomics, sanitation, hygiene, nutrition, etc.

Although some figures on costing have been given at the end, it must always be kept in mind, that the actual costs depend entirely on what the concrete situation is; the figures cited are only meant to give some idea on what might be involved under certain conditions. One thing should be clear, however, the higher the requirements in a given situation are (i.e. if thousands of students have to be fed regularly), the higher the quality of the product and thus the technical expertise needed, and the organisational and management input should be. Otherwise the danger of failure is great.

Finally, we would hope to get some feedback on the usefulness of the guidebook and the constructive criticism, addressed either to FWD or to HEP/GTZ so that in the future we can improve on the content of this type of technical instruction booklet.

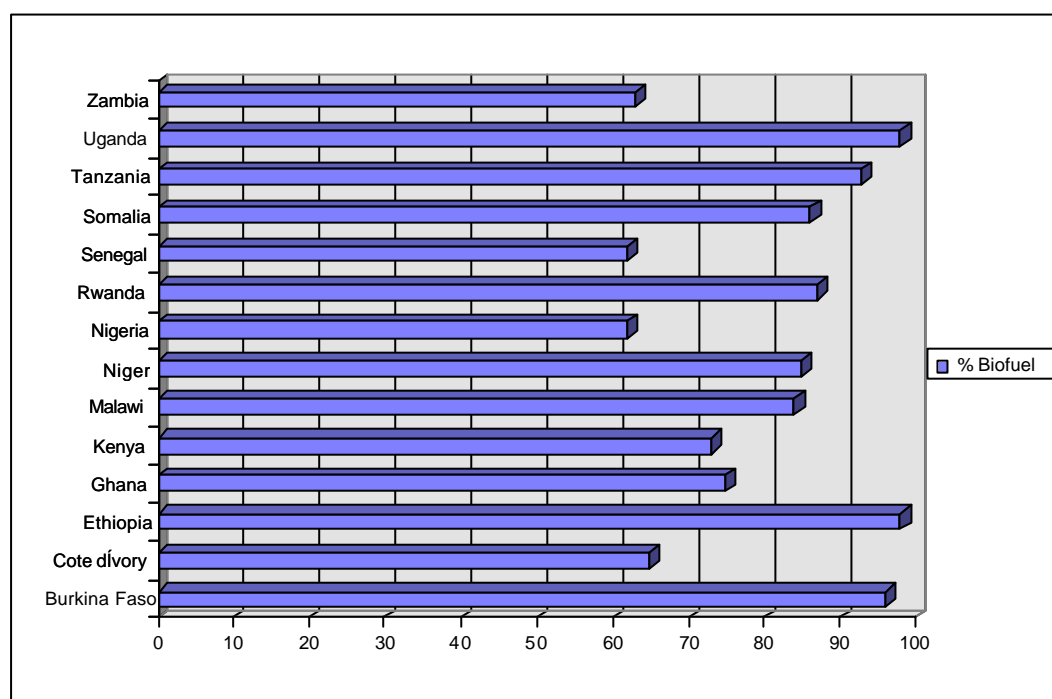
A. Klingshirn
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2 Introduction

Recent estimates indicate that biomass energy is the fourth most important source of energy in the world. Biomass energy (biofuels¹) is the dominant fuel in many subsaharan African countries. For example, biomass accounts for over 94 % of the national energy supply in Ethiopia (World Bank, 1996) and about 80 % of the total energy supply in the SADCC region. Developing countries can be distinguished from developed countries on the distinctive characteristic of their significant dependence on biomass energy, as shown in Figure 1 (Karekezi, 1994).

figure 1

Biomass energy consumption in sub-saharan Africa percent of final energy consumption (1990)



Demand for biomass in urban areas is increasing, while supplies are diminishing in many rural areas. Increased demand for biomass has resulted in the increase in price of biofuels.

The increase in biofuel prices is felt hardest by large-scale consumers who depend almost exclusively on the purchase of biofuels. These large-scale consumers are made up of two distinctive groups:

- institutions, and
- small scale enterprises

Higher prices place severe financial strains on institutions and small businesses, and saving fuel is one of the very few successful measures introduced to cut production costs.

¹ Biofuel here means processed and unprocessed renewable biomass fuels (wood, manure, agricultural waste, charcoal)

Sustainable efforts have been directed towards the modernisation of fuelwood production and end-use technologies for the last 30 years (Karekezi, 1994). One of the most notable efforts in developing countries has been the creation of environmentally-sound and efficient improved cooking stoves for large-scale food preparation in rural and urban areas. They are mainly used in hospitals, schools, restaurants, hotels and other small businesses for food processing.

This publication concentrates on the subject of improved large scale cookstoves (ILCS's), which are the most widely used devices (others include e.g. baking ovens, kilns, furnaces) in both institutions and small businesses. The high saving potential and the relatively low investment in simple technology (with an underlying complex need for adaptation), ILCS programmes present one of the most cost effective measures in the field of rational energy use.

Biofuel use in institutions

The fuels used in most institutions include wood, electricity, charcoal, kerosene, and LPG. The Beijer Institute study in Kenya (1984) suggested that wood and charcoal met over 50 % of the institutions' energy needs.

Biofuel for institutional cooking in developing countries is consumed by:

- schools, universities, colleges, playschools
- hospitals, recreational institutions
- public kitchens, charity food supplies
- refugee and relief agencies
- canteens in industry and commerce
- military canteens, prisons

In Kenya for example, the total consumption of fuelwood could be in the order of 700,000 tonnes per year and accounts for an estimated 2.6 % of the annual total of fuelwood consumed (Walubengo and Joseph, 1988). However, there is strong evidence to show that, due to both the increased prices of petroleum fuels and their frequent unavailability, more institutions are switching back from petroleum products to wood and charcoal. In many African countries, it is probable that more institutions will continue to switch to fuelwood as the price of charcoal continues to escalate at a faster rate than that of wood (Walubengo and Joseph, 1988). Institutions' fuelwood consumption varies from 10 to 60 tonnes per month with an average of 50-60 kg per person per month. An institution using 30 tonnes of wood per month could clear about three hectares of forest cover per year, and if this forest cover is not replaced, the impact on the local environment could be devastating (Walubengo and Joseph, 1988).

A survey of a number of institutions in Tanzania by the Lund Centre for Habitat Studies (LCHS) in 1992 revealed that most of the electric and gas cooking equipment was lying idle:

"because there is no power or fuel; there have been mechanical breakdowns; or because the equipment is not appropriate for the kind of food prepared in the country. Kitchen staff rarely know how to operate, clean and maintain such equipment; repairs cannot be done due to lack of spare parts, lack of maintenance budget or lack of service technicians."

Thus due to the technical complications of electric and gas cooking equipment, there is a genuine need for institutions to acquire more efficient woodfuel devices. This is supported by the results of a Kenyan market survey carried out in 1987 (Walubengo and Joseph, 1988). Woodfuel stoves rather than electric and gas devices, can sometimes be more suitable in fulfilling the needs of institutions. One of the distinctive features of institutional stoves is their appropriateness for preparing food for a large number of people at relatively low cost.

The need to improve energy use efficiency in institutions is due to the increasingly unsustainable commercialised extraction of woodfuel. Trees are cut down to satisfy the energy needs of institutions whereas in households the fuelwood used is often a mix of dead wood, assorted branches and agricultural residues. As a result, the impact of institutional use of wood energy on deforestation is more significant than was originally envisaged .

Biofuel use in small businesses

Biofuel use in small businesses is very difficult to assess, because in principle there is little distinction between household energy use and biofuel use for small scale production.

It is estimated that out of the total of the world's traditional energy, 10-30 % is consumed by small businesses. Another estimate suggests, that half of the urban and 20 % of the rural population in developing countries either directly or indirectly rely on the informal sector for their income (ILO, 1986).

Although up to the present day an estimated one billion US Dollar (World Bank, 1992) has been spent on the improvement of traditional energy systems, only a very small percentage has been directed to the improvement of energy use in informal sector businesses.

In Nepal, for example, the informal sector does not even appear in the traditional energy statistics of the World Bank and is summarised under domestic. According to the World Bank 97 % of biofuel is consumed in the domestic sector and only 3 % in the industrial sector. A closer look at the domestic sector reveals a slightly different picture, where 25 % of the domestic biofuel consumption is actually used for income generating activities (FAO, 1985). 54 % of this is used for activities such as food vending, hotel/restaurant/tea shops and ceremonies, and an additional 25 % in food processing (building 2.8 %, agro processing 4.3 % smithery 10.2 %, pottery 1.1 %). This shows that almost 80 % of biofuels used in small businesses are actually for larger-scale cooking.

In Machakos, a rural district of Kenya, 64 business premises were surveyed for fuel use. It was revealed that the highest fuel consumption was by "pombee" (beer) clubs where beer is kept warm in large-scale cookstoves throughout the night and during the day in rainy seasons, as shown in table 1. Restaurants where cooking, heating water and warming food is carried out, registered the second highest woodfuel consumption.

Table 1

Average annual fuelwood consumption (in kilograms) by business type, Machakos District, Kenya

Type of Business	Vegetation zone*			Average
	I	II	III	
Pombee clubs	20,904	18,192	634	15,046
Restaurants	11,621	9,231	19,613	14,262
Butchers	9,746	9,654	9,419	9,566
Others		1,534	18,031	7,826
Shops	2,864	-	-	1,518
Average	10,826	10,158	10,647	10,604

* "Vegetation zone" refers to a subjective division made by the investigator into good (I), medium (II), and poor (III) areas by quantity of vegetation cover.

Informal businesses show very little flexibility in their cost structure and their marginalised economic activities. Investigations in breweries and other food processing enterprises in rural Ghana revealed that the expenditure on biofuels were twice or three times higher than the amount of income generated. Significant fuel savings are therefore very effective in raising the income and investment power of those businesses (Usinger, 1993).

2.1 Problems and effects of large-scale cookstoves

Similar to household use of biofuels, the use of large-scale cookstoves with traditional fuels is related to a number of other problems, such as local available resources and needs in terms of hygiene, health and economy.

Problem area		Potential problems encountered
Resources	Fuel	limited availability, no alternatives, poor harvesting, no transport, high humidity, low heating value, poor processing possibilities, high expenditures
	Food	energy intensive food preparation, no alternative food, limited food availability, cooking process
Technology	Stove	poor combustion, low heat transfer, poor maintenance, inappropriate design, poor materials and durability, high investment costs, poor reliability
	Chimney	poor function/maintenance, inefficient design
Kitchen architecture	Location	poor hygienic conditions, safety precautions lacking, air movement, humidity, cultural practices
	Ventilation	high exposure to airborne pollutants and heat,
	Construction	labour intensive, poor ergonomic design, uncomfortable
Cooks	Habits	energy- and time intensive cooking, low attendance, no proper fuel and stove handling
	Skills	poor skills in constructing and maintaining stoves or process fuels and food
Institution	Economy	lack of investment power, limited diet
	Structure	managerial short comings, no interest in cooks' problems, cooking needs to meet tight organisational time frame, availability of cheap fuelwood
Producers	Skills	no experience in designing efficient stoves and chimneys
	Materials	limited availability or use of important construction materials, low quality of materials

The above overview illustrates only a small selection of possible problems which have been encountered in institutional cooking.

There are a number of frequently occurring negative effects associated with traditional large scale cooking in the following fields:

Working Place Standards of Cooks

Inefficient stove and fuel use results in:

- more processing and storing work of biofuels
- more working time needed for biofuel collection
- more time needed for cooking thus higher levels of energy consumption
- larger quantities of emissions are produced, therefore higher risk of respiratory diseases
- more hazards/accidents may potentially result
- less time for other productive activities

In combination with unsatisfactory and inadequate kitchen design, cooks suffer from:

- high exposure to pollutants
- unnecessarily heavy workloads
- time consuming activities
- hygiene problems due to unsatisfactory methods of food preparation and low-quality cooking
- health problems because of generally poor working conditions
- economical disadvantages to cope with the effects of their work
- low safety standards and thus high risks of accidents

Effects on Institutions and Small Business Holders

- fuel expenditure reduces budgets/income (reduced profits)
- reliability of food supply (in terms of cooking time and quality) is critical
- low nutritional value if food is overcooked
- reduced comfort for customers (restaurants)

Effects on Environment

- deforestation, erosion
- air pollution
- employment

Indoor air pollution in institutional/commercial kitchens.

Unfortunately there is little information on indoor air pollution in institutional and commercial kitchens. Some measurements in Ethiopia (Usinger, 1994) and in Ghana (Usinger, 1992) confirm the expectations that concentrations in institutional kitchens are sometimes at an alarmingly high level. Especially if kitchens are indoors, carcinogenic particulate levels are often a hundred times higher than the maximum level considered acceptable in the working place (e.g. WHO recommends 150 µg/m³, whereas concentrations in the field range sometimes between 10,000 to 20,000 µg/m³). The problem here is in fact more serious than in households, because in large-scale kitchens the amount of fuel burnt and the emissions created are many times higher. Cooks are exposed to much higher concentrations of particulates, and also CO, which is of less concern in households. Also the exposure time is longer compared to that of households. Not only cooks, but all other staff working in kitchens are exposed to heavily polluted air. The following table shows average concentrations found in Chinese kitchens.

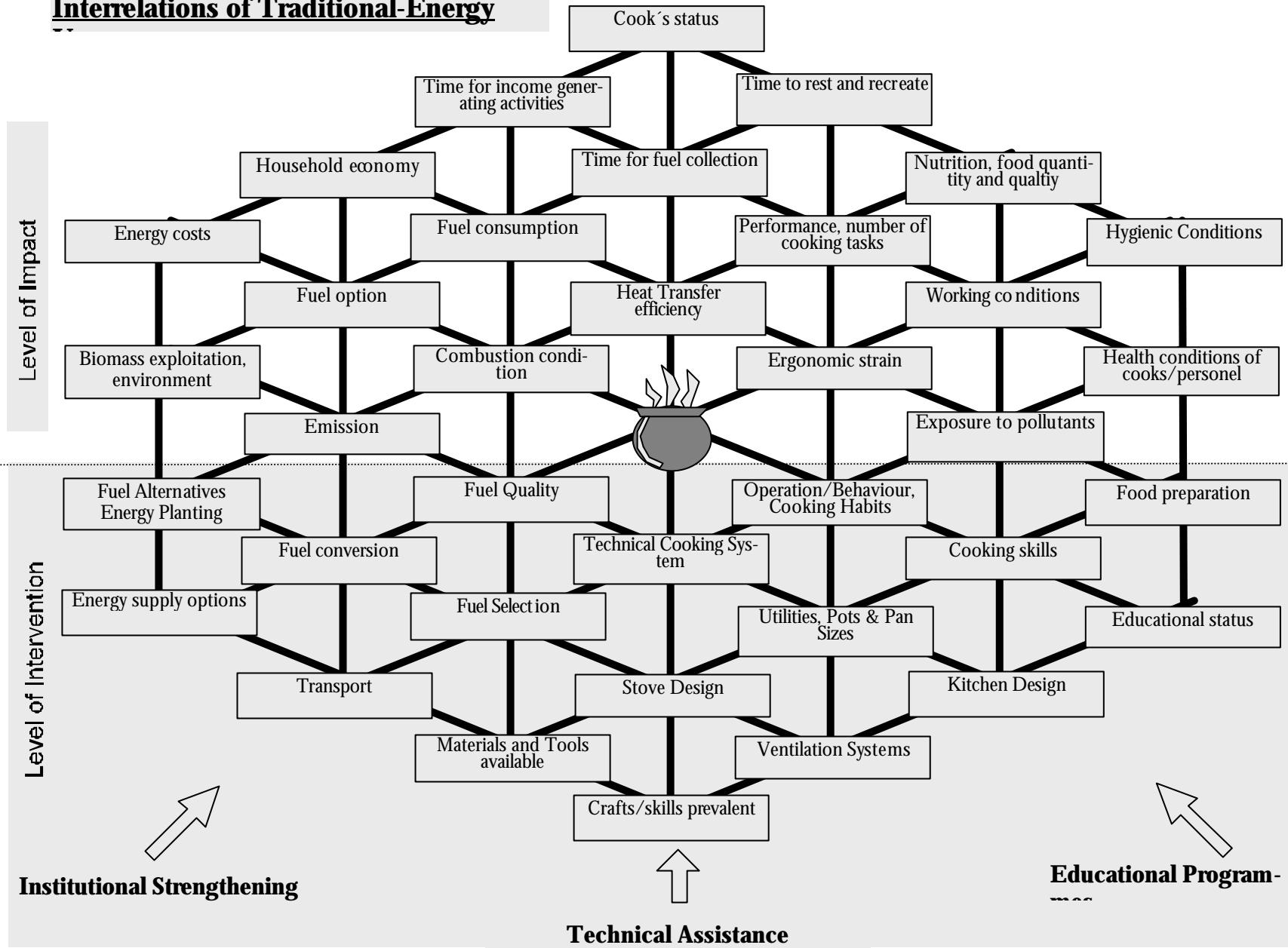
Heat exposure is another very serious effect of institutional cooking. The ambient temperature in front of large-scale cooking stoves is often around 50° C and higher. This puts tremendous physical stress on cooks. A considerable amount of time and money has been spent investigating industrial work places. However, there has been virtually no interest shown in institutional/commercial cooking, even though it is usually one of the largest employers in many developing countries (in many it is in fact the largest employer in second place only to agriculturally-related employment).

Pollutant	Fuelwood	Coal Briquette	Liquified Petroleum Gas	Biogas
Total suspended particulates (µg TSP/m ³)	790	490	190	180
Carbon monoxide (mg/m ³)	24	22	24	7
Nitrogen dioxide (mg/m ³)	0.024	0.024	0.026	0.013

Source: K.Smith, 1987

The following graph attempts to illustrate the main interrelations found in the field of traditional energy use:

Interrelations of Traditional-Energy



3 The Response Option - Practical Experiences with Improved Large Scale Cookstove Programmes

Several models of institutional stoves have been developed during the last ten years. Some of these experiences are summarised here.

In general, all these programmes aim to improve one or more of the following:

- reduction in the rate of deforestation and land degradation
- secure supply of energy through the decreased use of imported oils
- reductions in institutional expenditure on fuel
- reduction in time required for fuelwood collection
- reduction of indoor air pollution and related respiratory diseases through smoke removal
- reduction of time required for cooking
- enhanced kitchen safety and a cleaner cooking environment
- income and employment generation through the manufacture and installation of improved stoves
- promotion of community and technology development programmes (Karekezi 1994; Joseph et al, 1985)
- increased productivity by undertaking other useful activities

Survey results reveal that to cook the same type of food, a traditional institutional stove consumes 528 kg of firewood, whereas the improved stove requires only 92 kg of wood (Wickramagamage, 1992). The Bellerive institutional stove, when properly operated, reduces the cooking costs by 75 % or more for a traditional kitchen, and up to 55 % in most other cooking systems. The Kenya Community Stove (Micuta) can potentially reduce cooking time from four to five hours to 15 to 30 minutes and cut down fuel consumption from 50 kg per institutional meal to six kg for the same meal. The Argentinean community stove reduces consumption of fuelwood by 50 % to 70 % and reduces cooking time by 50 % in comparison to an open fire. One of the stoves developed by the Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) in Tanzania has a fuel saving range of 70 to 85 %. The Duma stove, also from Tanzania, provides fuel savings of 40 % compared to the traditional metal stoves, have a life span of between six and nine years and a pay back period of about one and a half year (Otit, 1991). A hospital in Sri Lanka that serves between 90 and 250 students per day spent more than 7,500 US Dollar on fuelwood in 1987. After the installation of improved stoves, the overall saving is 38 % plus an appreciable amount of saving in boiling time.

The solution level, however, has not been absolute. Institutional stoves have not proved to be a panacea to the energy problems facing institutions. Their promotion and distribution has also been hampered by technical, social, economic and political factors. Uganda for instance, which has many boarding schools, hospitals, prisons, restaurants and eating houses mostly relying on fuelwood for cooking, had less than 2,000 institutional stoves disseminated in a six year period (Turyareeba, 1992). In most cases the institutions cannot afford the stoves (Walubengo, 1986).

In Burundi institutions were able to switch from wood to peat (Adam, 1986) with the help of improved stoves, which can be extended with an adapter to allow the use of kerosene or gas.

Problems of improved stove programmes

In Uganda the following problems and conflicts were encountered in initially introducing institutional stoves:

- kitchen staff and domestic bursars who are responsible for the preparation of meals and the purchase of fuelwood resisted the change from open fire techniques to improved stoves, because they felt that cutting fuelwood into small pieces and drying it before use, was too time consuming and labour intensive;
- producers faced a short supply of raw materials particularly sheet metal and scrap metal;
- potential customers lacked the investment power. There was the difficulty of obtaining bank loans which required a well prepared feasibility study, a land title to secure them and the payment of high interest rates of between 38 % and 42 %;
- the rare demand for stoves and the need for producers to rent the stoves held back the production of additional other stoves (Turyareeba, 1992).

Unfortunately there is little information about the more underlying reasons, but clearly the applied stove concept was inappropriate to the needs and frame conditions.

In another case study carried out in a large hospital near Nairobi in Kenya food was prepared for about 950 patients daily using gas stoves and a switch from gas to wood in order to reduce energy costs was not supported by the kitchen personnel. They objected to the smoke in the kitchen, blocked chimney pipes and the leaking roofs destroyed the stoves. Because the stoves were constructed far away from the dining area, cooks complained about the extra work. All these factors contributed to the woodstoves negative image (Schneiders, 1985).

This experience underlines the fact that improved stoves are not only simple to develop and disseminate, but need to be embedded in a more integrated approach as already illustrated in chapter 5.

There are a number of technical and non-technical factors influencing the relative success of stove programmes reported from other projects, e.g.

- users inability to demonstrate to cooks that fuel/smoke/cooking time are problems
- poor assessment beforehand
- insufficient technical support initially
- poor training on stove maintenance
- insufficient user understanding of health problems associated with smoke and gaseous residues (Joseph et al, 1985)
- unattractiveness of the stove after use
- inability to effectively burn the range of fuels commonly used
- inability to easily cook all types of food normally prepared during the year
- emission of too much smoke
- negligible reduction in fuel use
- prolonged cooking time
- high investment costs for initial purchasing and maintenance
- users unwillingness to clean the chimney (Joseph et al, 1985)

Some of the technical aspects affecting the use of institutional stoves can be greatly facilitated through proper training in fuelwood and stove management. In the case of Kenya, a survey identified the following unsatisfactory cooking techniques:

- not letting the food simmer once it had boiled

- no application of efficient food preparation techniques, for example soaking maize, beans before cooking, etc.
- feeding the stove with excessive amounts of fuel and making the food boil more violently

- not placing lids on the pots while cooking (even when lids were available)
- prolonging the cooking time by improperly tending the fire
- chimneys were never cleaned
- ash boxes were never emptied and
- oversized pieces of wood were fed into the firebox (Walubengo and Joseph, 1988)

3.1 Summary

The major problems and effects found with institutional/commercial cooking in developing countries are:

- high fuel consumption and high expenditure
- high exposure of cooks in terms of heat and airborne pollutants
- hygienic and nutritional problems, because of insufficient/inadequate cooking
- increased deforestation and erosion
- reduced time for other productive activities

Programmes in improved institutional and commercial cooking can provide important solutions and the following impacts:

- fuel savings of up to 80 % can realistically be achieved
- exposure levels reduced to acceptable levels
- improved general working conditions
- reliable good quality cooking (improved nutrition)
- reduced demand for biofuels
- employment creation
- reduction in number of kitchen accidents

Experiences with unsuccessful programmes show that programmes fail, if they

- lack a proper needs assessment beforehand
- are too technology focused
- fail to illustrate the benefits to all the involved target groups
- fail to give enough customer support when the project is initiated
- fail to consider existing socio-economic and cultural frame conditions
- are not sufficiently adapted to user needs
- do not make use of locally available materials

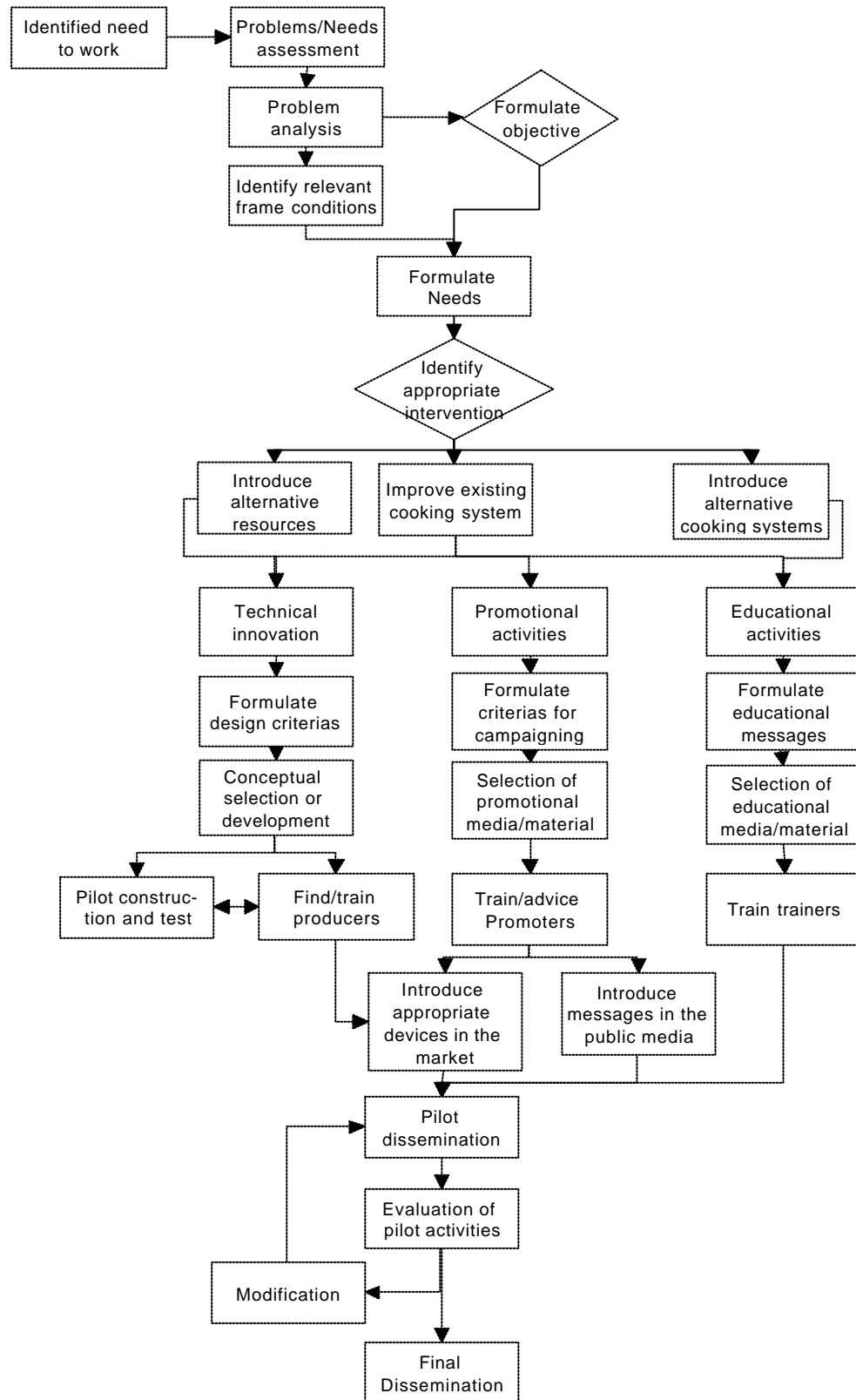
Institutional cooking in particular reveals quite a number of possible conflicts between the participating target groups (cooks-managers-fuel suppliers).

The realistic assessment of conflicts and their analysis seems to be the key issue in the preparation and planning of institutional cooking programmes.

There is no perfect recipe for successful programmes, but a number of successfully applied principals which should be considered are described in the following chapter.

4 Design of Improved Institutional/Commercial Cooking Programmes

4.1 Process flow of programme design



4.2 Problem identification and needs assessment

The problem identification and needs assessment are the solid foundations of a successful programme.

There are various approaches to identifying needs and generating action:

RRA *Rapid Rural Appraisal*
PTD *Participatory Technology Development*
PRA *Participatory Rural Appraisal*

PRA is probably the most appropriate method to use, but there are no major objections to using other methods as well. There is an enormous amount of informative material available on these methods (see bibliography) and for this reason it is not dealt with in depth in this chapter. Whichever approach is adopted, it should include the following assessment elements:

- on the social level, structural frame conditions (interviews and secondary data)
 - structural frame conditions, which refer to the socio-economic, cultural, political, institutional and infrastructural situation
- on the individual level (target groups), concerned peoples' participation and perceptions (interviews)
 - existing knowledge/skills (e.g. on improved stove technology)
 - motivation to participate, support, ignore, or object
- on the resource or physical level, state of the art (measurable/observable)
 - current kitchen and stove designs
 - fuel qualities and quantities
 - physical geographic conditions, climate, etc.

Figure 7 illustrates the various levels, stages of problem and needs assessment.

Technical assistance for sustainable development will not work without the people. Even though many problems seem to be purely technical (excess fuel consumption, high emissions), it is only through people that improved technologies can work, be produced, marketed, maintained and further developed. Therefore the people running programmes have to fulfil three preconditions, they require:

- the technical background in the field to verify and differentiate between technical and habitual problems and the potential of traditional technologies and provide people with a vision of *what it should be*.
- the socio-cultural background to understand the level at which programmes can effectively educate, promote and motivate people to create new technological standards/systems, solve conflicts, and identify *who is going to make it happen*.
- the pedagogic and organisational background on how to design and implement effective educational and motivational instruments and *how to generate support for it* within the existing structures.

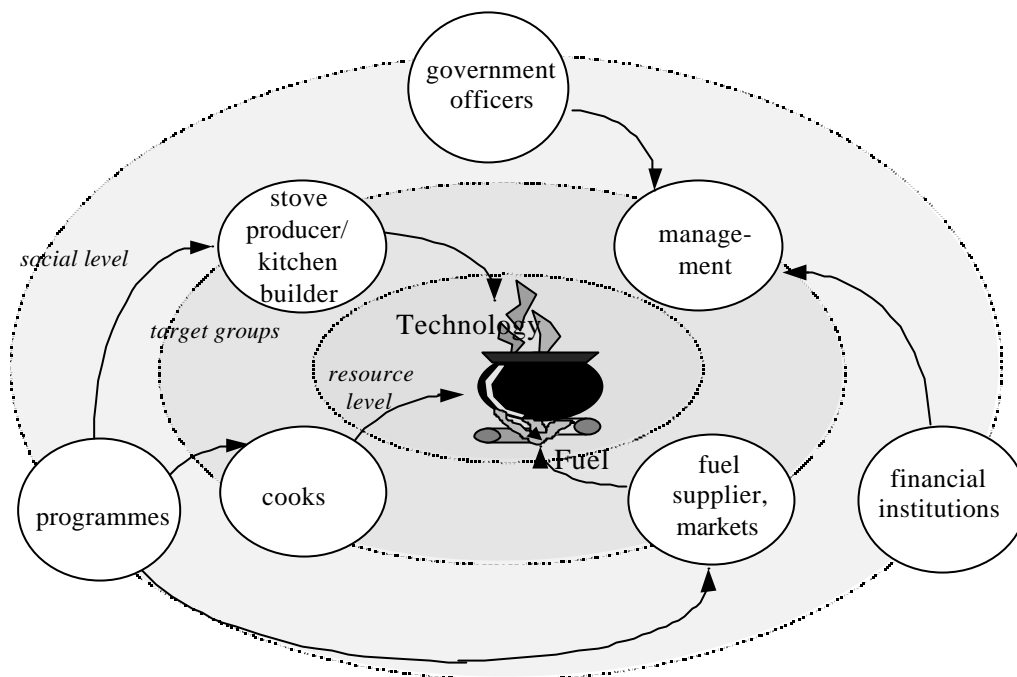


Figure 7

Identifying the people concerned

As one of first steps it is important to identify all the groups and individuals concerned and involved in the process of large-scale cooking. In figure 7 there is an inner and outer circle, characterising the directly involved individuals and indirectly involved institutions.

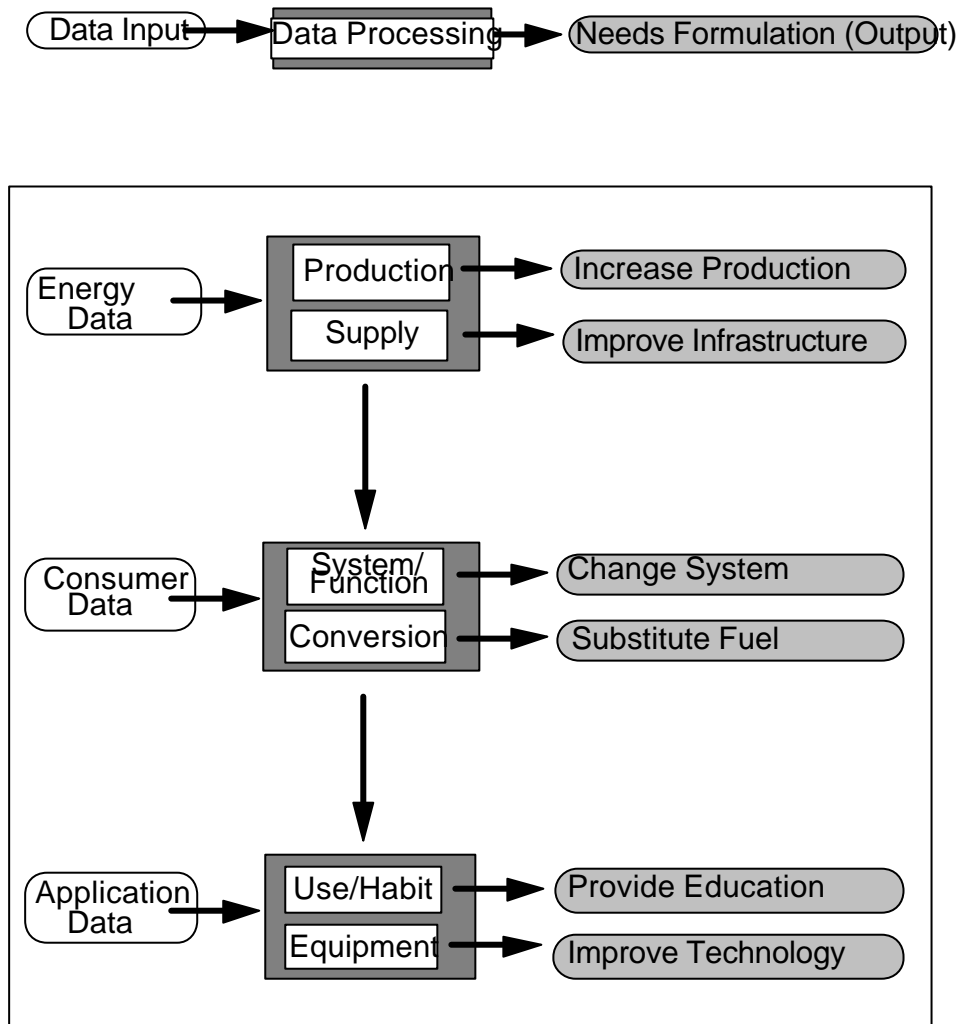
The assessment needs to be open and not technically or otherwise biased. Views, perceptions and expectations of all the people, who play a role in the field of institutional/commercial cooking have to be represented in this assessment. For example:

- **cooks** using the technology
- **decision makers in institutions or business owners**
- **stove producers/market distributors**, those who produce/distribute the technology
- **legislators** who are responsible for environmental protection
- **decision makers** in governmental or non-governmental organisations who want to help/develop/protect
- **kitchen builders**, those who construct kitchens
- **fuel suppliers**, those who supply the biofuel to the institution
- **financial support institutions** like small scale banks

Generally it is difficult for small projects to carry out statistically appropriate surveys, in terms of time and resources. In small surveys the emphasis should be on quality rather than on quantity. In this case, it is better to base a trend on a few good quality case studies than on twice as many haphazardly collected interviews.

If you are not familiar with these needs assessment methods mentioned above, please refer to the description of a short appraisal method, which is specifically designed for conflict assessment in the traditional energy sector (Usinger, 1996). There are also two checklists on technical questions and frame conditions in chapter 4.3 and 5.

The next figure illustrates the process of data collection, processing and potential needs formulation at various levels.



In this process of data collection, processing, analysis and needs formulation is illustrated in three major steps.

In the first step general data on national, regional and/or local energy management is needed to formulate and verify the weighting of a problem in a more comprehensive context. It is analysed to which extent the problem is a fuel production or supply aspect.

In the second step, general data on major consumers and the various system approaches to performing similar tasks are compared and analysed. It can thus be seen, which systems are less fuel efficient, in performing certain functions.

In the last and most detailed step, specific problematic energy applications are selected for further investigation. The impact that technology and peoples' practices have on energy use are differentiated and analysed. The analysis and needs formulation has to take the whole system approach into consideration. User needs are of prime importance when planning any improvements.

4.3 Conceptual design of the programme

4.3.1 Alternative analysis and targeted cooking system

As a result of the needs assessment, we will have a list of criteria, which describes the underlying qualities of our objective. As a first step, it is important to compare possible system innovations and alternatives to the established list of criteria. From this, the future elements of the envisaged cooking system are selected in terms of:

- fuel use
- equipment use
- kitchen design required
- technology use
- food preparation
- production cycle

A more detailed list can be found in the annex . In each step it is important to discuss the result of this step intensively with the people concerned (specifically on a subjective level).

After the analysis of problems and needs, potentials and objectives need to be transferred to activities. As a general recommendation for smaller programmes it is helpful wherever possible to work only through existing structures and, as a general rule, **avoid providing any subsidies**. Programme investments should only be provided for educational or motivational activities. If those activities fail to promote a product, the product is at fault, and the product concept will have to be reconsidered.

One of the major mistakes made in smaller programmes is to try to develop artificial structures.

For example:

A frequently encountered mistake is that programmes start to develop and disseminate improved stoves using self-financed and own logistic structures, even though there are locally qualified craftsmen at hand and appropriate market channels through which stoves could be disseminated.

It is better to depend right from the start on local users/producers of traditional technologies and existing structures and markets and accept the given limitations.

Therefore it is important to adapt programme concepts to the existing state of the art, prevalent user needs and perceptions and other existing frame conditions, as already described in chapter 3.1.

In short, planned activities should be "SMART"

- | | |
|---|------------|
| S | Simple |
| M | Measurable |
| A | Attainable |
| R | Realistic |
| T | Timeable |

Typical activities of conceptual strategies in institutional/commercial cooking may include:

- teaching cooks about efficient fuel processing/storing technology
- introducing cooks to new food processing methods
- teaching cooks about efficient methods of kitchen organisation and management
- introducing cooks to sophisticated pots and pans for cooking
- teaching kitchen builders about appropriate ventilation facilities
- introducing alternative fuels and stoves in the market
- teaching producers how to construct stoves for a variety of purposes
- suggesting and initiating institutional/commercial fuel planting with decision-makers in management
- developing concepts for fuel harvesting and pricing with government officials
- teaching stove operation techniques to cooks

If somebody carefully studies the range of programmes, one will find that most activities can be summarised in a number of general development concepts, for example:

- system modernisation
- optimise productivity, efficiency, economy
- status increase
- improvement of organisational structure/capacity

These principles can be applied to almost any development activity. In the development of a project it helps to list those concepts in relation to the various project levels, to identify the necessary range of activities and to ensure a minimal amount of integration of all levels. The following overview serves to illustrate a typical range of such projects' implementing activities.

Note that the development activities concentrate only on the contents of projects and are therefore either educational, advisory, promotional or awareness raising in their nature. The overview does not include the obligatory planning, logistical or organisational activities necessary in every development project (see chapter 9 for this).

Level Field Operation Development Concept	Resource		Individual		Social	Political
	Fuel	Technology	System Operation	Management	Legislative	Financial
	fuel suppliers, forest owners	stove producers, kitchen builder	cooks, kitchen personnel	institutional/ commercial deci- sion makers	government offi- cers	Banks, credit schemes, insur- ance
System modernisation	check scope for alternative fuels	identify alterna- tively fuelled stoves	check use of adaptability alternative fuels	check economic scope	check macro- economic viability	promote loans for alternative investments (e.g. gas tank)
Optimisation of productivity	introduce new fuel plantations	produce higher quality stoves	improve hygiene and food quality	shift investment to quality	promote regional energy planning	support private investments in the energy sector
Improvement of efficiency	suggest better species for plant- ing	introduce fuel- efficient construc- tion princi- ples/materials	time-efficient planning	advocate invest- ment in efficiency	help to set na- tional quality standards	administer loans for stoves
Economising of activities	illustrate advan- tage of selling less for more	reduce expendi- ture on fuel cost	reduce costs of waste food	illustrate eco- nomic cycles	suggest regulat- ing price of fuels	help to assess economic scope of activities
Increasing status of job	introduce li- cencing for legal harvesting	improve construc- tion skills	demonstrate healthy working conditions	invest in appro- priate kitchen building	help to set na- tional working place standards	generate private investment in renewables forms of fuel
Improve organisational structure	regulate harvest- ing	initiate dissemi- nation channels for stoves	rationalise system operation	organise/ratio- nalise production	support institu- tions/commercials on improved en- ergy use	provide special saving schemes
Sustain long-term project benefits	organize long-term ownership of plantations	train service and maintenance skills and spare supply	train stove and chimney mainte- nance	establish services according to mar- ket needs	assign long-term ownership of pro- ject follow-up	Interest private banks to take over small scale banking

4.3.2 Lay-out of the conceptual projects

After the range of activities has been identified, a project strategy on how the implementation can be developed may be considered. It is necessary to consequently define the following step in a programme:

- support structures
- conceptual design of instruments
- dissemination concept
- project monitoring and evaluation

Specific project components are described in detail in the following chapters.

4.4 Project components of improved large scale cooking projects

Project components cement the project concept and objectives. Instruments necessary for infra-structural support and the organisation of the programme have to be designed and initiated. There are various ways of developing such components, and there are some crucial factors to consider:

- developing with participation of envisaged target groups/users (e.g. Participatory Technology Development (PTD))
- having detailed knowledge of the traditional system and being able to distinguish clearly between technical-physical, subjective or socially related problems
- the concept should avoid elements or materials that have to be imported from outside
- build on the common knowledge, skills and capabilities of local people, avoid basing your assumptions and concepts on "clever" local outsiders
- go step by step, concentrate your own capacities and time on the most effective activities (lowest involvement, highest impact)

4.4.1 Support structures

In order to generate a supportive working environment, it is important to distinguish between activities (mainly promotional) with groups of people who are not directly concerned, but play an important role in supporting and influencing local infrastructure.

Such components involve for example:

- support government officers on setting standards in work places and stoves
- developing concepts on sustainable
 - fuel supplies
 - credit schemes
 - energy consultancy
 - economic consultation
- integrate other programmes in extension services
- identify new producers of technology
- identify new actors for the dissemination

4.4.2 Conceptual design of system components

In the conceptual design of system components, the project concepts and objectives are translated into the physical look alike of the envisaged cooking system and its components, such as fuel, stove, equipment, kitchen, food and production. The "ideal" cooking system is designed with the participation of or by the concerned people and with the help of criteria lists. An overview is listed below.

Fuel use

- type of fuel(s) used
- acquisition
- production
- fuel processing
- storage
- sizing/cutting
- use of residues
- fire management

Equipment use

- type of equipment used
- acquisition and production are only the issue, where completely new quality equipment needs to be introduced (e.g. stainless steel pots)
- procedure of efficient utilisation (e.g. use of lids, thermal boxes)
- storage, transport
- cleaning
- maintenance

Kitchen design required

- provision of ventilation
- work place lay-out
- proper location

Technology use

- functions required
- working principal (e.g. fuel combustion, chimney,)
- operation/maintenance
- manufacturing
- equipment used
- ergonomics/safety
- system operation
- economy

Food preparation

- energy efficient practices in food preparation
- selection of type of meal and equipment needed

Production cycle

- optimal planning of dining and cooking times

4.5 Dissemination strategy

The dissemination strategy is strongly influenced by the support structures and the system components. If the process above is followed carefully, the general dissemination of implements and services will be determined through:

- the economic viability to commercialise,
- the infrastructural potentials for distribution, and
- the prevalent skills, capability and know-how deficits in producing and maintaining implements and services locally

Here, the various stages of the dissemination strategy are worked through in detail. A dissemination strategy involves the following levels:

- production
- extension/marketing
- installation
- service/maintenance
- promotion
- quality control

Production

The production of stoves can be partially or wholly commercially viable. Stoves can be produced commercially by industry, small workshops or professional stove builders who construct stoves on the spot. Stoves can also be built by cooks themselves. The materials used in production should preferably be of local origin. Every use of imported materials increases price instability and dependency on more elaborate infrastructure.

During the conceptual design of stoves, it should be decided to whom the construction know-how is to be transferred. Whether these people later market the whole stoves or only stove parts or build them only for themselves, will have a strong influence on the production range of stoves.

The total number of stoves produced is chiefly influenced by the following factors:

- number of producers to be trained
- time required to train a stove constructor (depends on stove complexity in terms of quantitative and qualitative work)
- the number of units installed or produced by one trained producer (productivity)

Extension

There are possibilities for direct commercial marketing done by industry, but there is also the possibility of disseminating stoves through merchants and in the existing markets. The extension can also be realised through professional stove builders who can be asked to construct stoves on-site.

If cooks install stoves by themselves they need to be reached either through extension services of the programme or other existing organisations. However, extending training through organisational structures is always the most crucial approach in terms of long term sustainability.

Installation

Purchased stoves can be installed either by professionals or by cooks themselves, depending on specific requirements in terms of the workmanship or know-how. Installation is part of the training provided when cooks construct stoves themselves.

Service/Maintenance

If service and maintenance are provided by workshops or stove professionals, there is little programme involvement. If cooks do the servicing by themselves, programme involvement/follow-up of a longer duration is required to ensure that promotional activities are properly received by cooks.

Advertising

Advertising is needed to promote the advantageous use of improved large-scale stoves. It could be done by commercial producers/dealers or as a part of the programme. There needs to be promotion targeting of various groups, such as cooks, managers, commercial dealers and producers. The media chosen for advertising should be locally tested and verified as appropriate. For example: are people able to read instructions? Are people's consumption habits affected by TV advertising?

Quality control

This is one of the most critical issues in the whole dissemination process. There have been many attempts to implement programme-based quality controls, which have generally all failed after they were stopped. The only really successful quality control so far, has been on the part of the customer. Another equally important activity is that of focussing on raising the awareness of potential customers and educating them about the features of a good quality product. This of course mainly applies to commercial manufacturers of stoves and parts. In the case of self-built stoves, it depends on how appropriately the stoves have been designed, on the motivation and on the locally available materials.

In order to clarify the various possibilities for dissemination we must distinguish between three approaches:

- commercial dissemination
- semi-commercial dissemination
- self-help dissemination

These approaches can be explained briefly as follows.

4.5.1 Commercial dissemination

A commercial dissemination in conjunction with a partly mechanised production is the simplest answer to standardised quality. Commercially manufactured stoves have generally higher savings than self-built ones, but require higher investments. The amortisation time is an important factor in the decision-making process for or against these products. Typical amortisation periods range from three months (Ghana) up to two years.

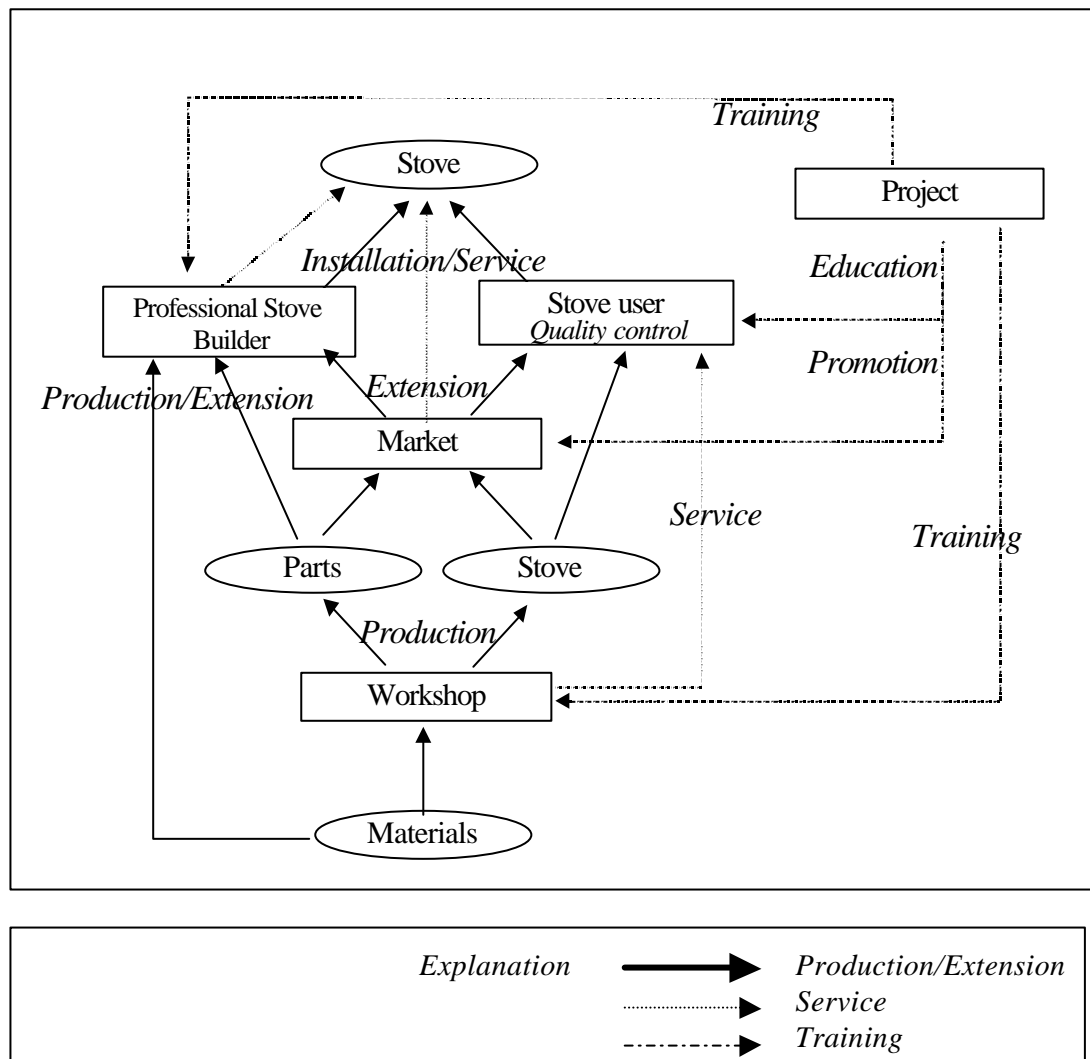
In commercial dissemination, the training provided by the project goes either to industry, workshops or stove professionals who earn their money through the production/installation of stoves. The extension is either directly through the industry, workshop or stove professional, or indirectly through the existing markets and other distributors. The various possibilities are illustrated in the figure below.

Commercial production of ready-made stoves, equipment or parts of stoves, offer the following advantages:

- improved potential for high production standards and skills development with trained workers
- larger-scale production viable
- central quality control feasible
- machines and machine tools used in production become more easily available

Some of the disadvantages of commercial production are:

- commercialised production may not be adaptable to the economic situation of institutions/businesses
- dependency on a few producers may be problematic if problems arise (no alternatives)
- commercial enterprises may switch to designs with inferior features which may be more successfully marketed
- without programme supervision the quality of stoves may deteriorate
- local infrastructure prevents centralised production



In the Tanzania stove project (a component of the Special Energy Programme there), institutional kitchen stoves have been disseminated since 1988. These have comprised various models which were developed by the project and technically improved during a

The advantages of semi-commercial production are:

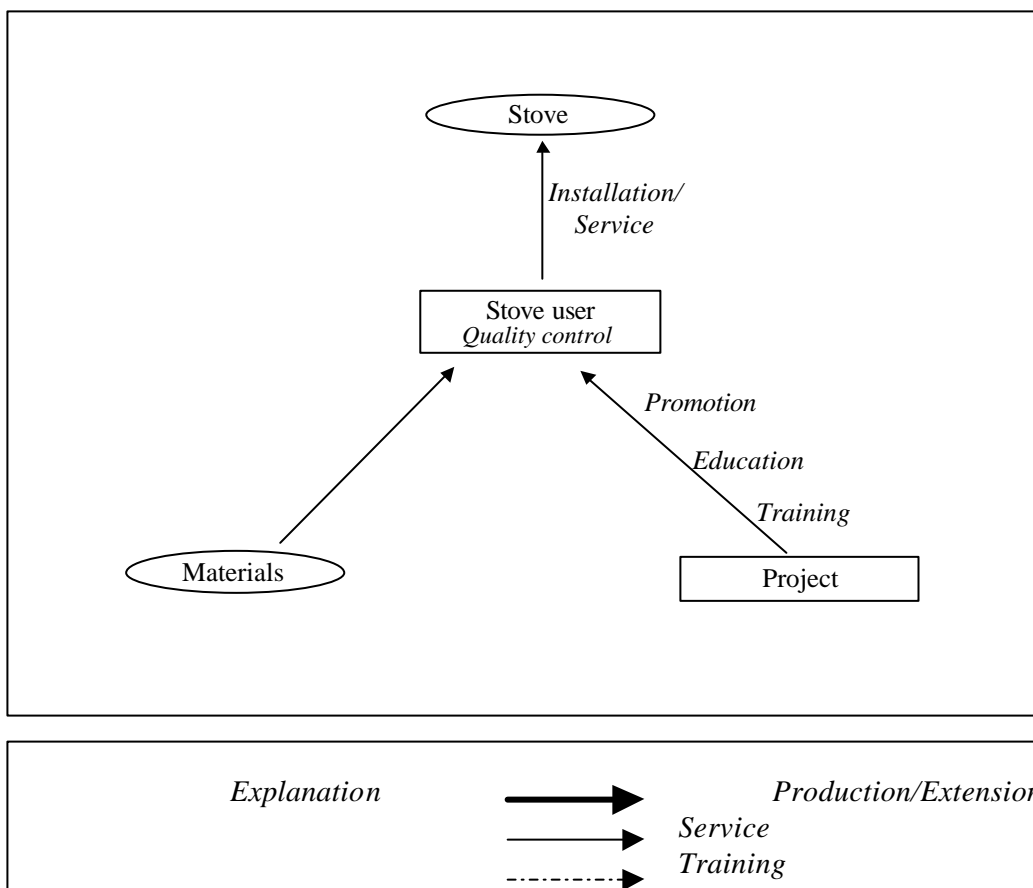
- standardisation of essential stove parts
- larger scale dissemination, with limited training input for the stove user
- economically disadvantaged groups may be able to afford parts , but not a whole stove
- the transport of stove parts is cheaper than that of already assembled stoves

The major disadvantages are:

- poor institutions/commercial enterprises may not even be able to buy parts
- producers may switch to other designs
- quality control is difficult to implement with customers
- in very remote areas semi-centralized production may be a problem

4.5.3 Self-help dissemination

In the self-help approach, as the name suggests, the stove users are trained in how to produce, install and maintain stoves by themselves. Usually only costs for materials and time taken to build the stove are involved. As in the semi-commercial approach the technical messages/training is limited to the most important facts and is kept low-level. This approach thus favours awareness raising rather than engineering.



Major advantages are:

- even poor institutions/commercial enterprises may be able to help themselves and reduce their fuel use
- training in stove construction and use is incorporated and directed at the same persons
- cooks' training improves their working status
- maximum utilisation of the stove, i.e. no waiting times for servicing

Major disadvantages found are:

- quality control is difficult
- low potential for standardisation
- very limited in terms of number disseminated
- requires a high manpower-input in training

5 Choice of Technology

The design of large-scale stoves requires expertise that usually does not exist in NGO's or GO's. Nevertheless solutions to problems found with large-scale cooking need to be investigated. In the following chapter ways of evaluating the introduction of already existing principal designs are illustrated. This part is called conceptual selection and requires considerable effort and patience if it is to be carefully completed.

Conceptual selection is not a perfect method of "developing a local concept for large-scale stove design", but if properly used, it is very helpful in initiating the work to be done.

In general, projects are advised to employ experts for the selection of locally and adaptable designs, especially if larger scale dissemination is intended (e.g. more than 100 units). However, in the past there have been many attempts to solve these problems without the necessary expertise and in effect many projects failed, because:

- fuel consumption increased
- working conditions in terms of smoke and heat exposure became even worse
- cooking systems had a poor economic impact
- the project failure created a general negative image for such type of projects
- they badly reflected the general perception influence of development programmes in the concerned regions

In order to avoid these negative impacts, this chapter is mainly devoted to those who want to work on their own but cannot afford to employ experts. It will also be very useful for those who can afford and employ experts and want to verify and monitor the quality and outcome of the experts' work.

The existing challenge for stove designers is to achieve maximum acceptability, while achieving the maximum impact in terms of the programme objectives. A valid design principle is that complete unity develops only to a point where a design cannot be further reduced without questioning the whole concept.

Basically there is no principal difference between development requirements of modern industrial furnaces product and low cost stoves, they need to be profitable to producers, merchants and customers. In addition, the development of low cost stoves has to generate also general social benefits according to the project objectives, thus making the development even more demanding in terms of engineering, design and innovation. Low cost stoves are a true product of social marketing.

There are many examples, how institutions have successfully improved existing stove designs or adapted new stoves to reduce their fuel bills. In general, the price of an improved stove is one of the most important criteria for potential dissemination. A survey carried out in Kenya by KENGO revealed, that many institutions wanted to acquire more efficient charcoal and fuel-wood devices, but could not afford to pay for existing designs in the market (Walubengo and Joseph, 1988).

Appropriate design and production strategies can only be achieved by understanding the range of potential stove customers. To plan for large scale centralised mass-production is absurd, if the target market is at most only a few units per year.

5.1 Technical components of large-scale stove systems

5.1.1 Technical characteristics of stoves

Combustion chamber:

The combustion chamber (also called fire box) in a large-scale cooking stove is the most important component. Combustion chambers in ILCS are exposed to higher temperatures for longer periods than for example household stoves. The temperature in the grate remains at 1000° C for hours and most materials wear out in a very short time. Normally fired bricks cannot stand the alternating high and low temperatures typical of heating and cooling. Black sheet metal wears out fast under these conditions, grates of two centimeter thick round iron need to be renewed every six months to a year. Apart from the thermal stress, the use of 100 to 300 litre pots over the combustion chamber puts physical stress on the entire construction if not properly considered in the design. Typical materials for combustion chambers are made of high quality thermo-resistant cast iron, or refractory bricks.

Combustion chamber volume and size need to be adapted to fuel and combustion quality. Wrong dimensioning generates incomplete combustion and uncomfortable charging with fuel. The air inlet determines partly the combustion velocity and the exhaust losses. Thermal losses can be limited if the combustion chamber is sufficiently insulated.

The combustion chamber advantages is also one of their biggest disadvantages. Because the combustion chamber limits power range and is adapted to specific cooking requirements, it is not as flexible as a three stone fire for example, which can always be adapted to other possible needs (height, size, use of charcoal).

Grate:

A grate is a perforated ceramic or metal plate on which the fuel is burnt allowing the provision of primary air and the separation of ashes. The question whether a grate is needed or not cannot be answered simply. Depending on the fuel quality (consistency and humidity), the amount of combustion residues (ashes) and the stoves geometry, a grate may serve various functions. In many cases a grate may be counterproductive in one sense (e.g. increasing the combustion velocity unnecessarily), but productive in another sense (e.g. allowing comfortable ignition or separating of ashes). In principle wood is best burnt in its ashes, but only if the wood is properly processed, dried and stored (1-3 years), which is the exception rather than the rule in developing countries. Grates should preferably be made from thermo-resistant cast iron, but also from thick angle and round iron. In general grates are designed as replaceable parts for stoves.

In the case of Bellerive stoves for example, the fire-grates (cast iron) need to be replaced approximately every six months and the combustion chamber (cast iron) will be completely replaced every two years (Bellerive Foundation).

Ashbox:

The ashbox is situated under the grate (if there is one). It stores combustion residues and is usually accessible through a door in the bottom of the stove. However if the doors are not properly utilised, the air inlet characteristics are generally negatively influenced, excess air increases and cools the exhaust gas or generates a very high burning velocity. There are some special tricks involved in designing ashboxes which automatically close themselves during operation.

Chimney or flue:

Proper chimney design is one of the most variable and complex engineering parts of a stove. Consequently poor quality design has very negative effects on a stove's functioning. Poor design leads to increased fuel consumption, incomplete combustion, increased fire hazards and indoor or outdoor air pollution, even complete malfunction or stove break down. The design depends on many factors, such as: ambient air pressure, humidity, wind, seasonal temperature changes, fuel humidity, power range, combustion quality, exhaust gas temperature/volume, maintenance requirements, construction materials, diameter, channel length/height and direction.

Stove chimneys have to be cleaned periodically to remove the accumulated combustible substances (soot, creosote) which may ignite. A piece of old sack or special chimney brushes are generally used. However, it should be noted that the build up of soot and creosote is mainly brought about by incomplete combustion, typically when using wet firewood.

Hoods:

A hood is an open provision for extracting exhaust gases and must be seen as an integral part of a stove system. Hoods have an important advantage over chimneys - they are cheaper and easier to build and maintain. Even though there are basic rules to follow in designing a functional hood, the materials used could be metal, mud, cement materials or brick constructions. Thus their construction leaves a good deal of room for flexibility. The relationship between the opening and the height is an important parameter.

Regulation:

Doors and dampers or flaps are generally used in more sophisticated designs to control and optimise stove function. The more variation possible, the smaller the chance that they are used properly. In contradiction, the misuse or wrong use leads often to dramatic malfunctions of stoves in terms of fuel economy, combustion quality and operational comfort. Therefore these features always have to be regarded as a major potential source of failure in the stove system. Because it is so user dependent, in many cases it is better to avoid any regulating device and design the stove just for one specific power range which is appropriate for the intended range of cooking activities. Even though, technical efficiency might be slightly less than with sophisticated regulated stoves, they are more reliable and more economic in practice (and less expensive to purchase). In general there is no real regulating mechanism for wood stoves (regulating air influences combustion negatively) other than through fuel quantity (putting in more or less). The maximum load is usually limited by the size of the combustion chamber.

Pot seat:

The pot seat is where the pot sits inside or on top of the stove. Because the pot is generally a moveable part of the stove, the pot seat requires specific constructional attention and is crucial in terms of the efficiency of improved stoves. Traditional stoves make very little use of convective heat transfer (using the energy from the hot exhaust gas). This is the greatest potential of "modern improved stoves" being more efficient. Exhaust channels along pots have to be produced with high precision in order to generate significant thermal heat gains. The optimisation of produceable pot seat quality is therefore of primary importance in designing LCS's. The physical strength of pot seats is potentially the most important factor in avoiding accidents from scolding through hot spilling liquids. Especially with ILCS's this has to be taken into careful consideration, if a hundred litre pot of boiling food collapses it will burn severely or even kill the operating personnel.

Stove body:

The stove body serves important aesthetic and technical functions. First of all it provides the framework for the stability of the whole construction. It is what people actually see, so it should

be attractive. Stability and comfort are not always easy to combine, e.g. the visibility of combustion chamber and pot contents are dependent on the wall construction.

Pots/pans:

In stove construction pots/pans have to be seen as a part of the stove. There are two ways of dealing with the problem of adapting both, either by building the stove around existing pots, or by producing/purchasing specific pots for specific stoves. Here again, economic constraints are the major problem in the decision making process. The investment in stoves cannot be seen as separate from the purchasing of a stove. They combine to form part of the initial investment, if traditionally used equipment cannot be used with the new improved stove. Respectively the equipment requirements form part of the amortisation and rentability of the stove system and has to be considered in any financial analysis (also for the traditional stove system).

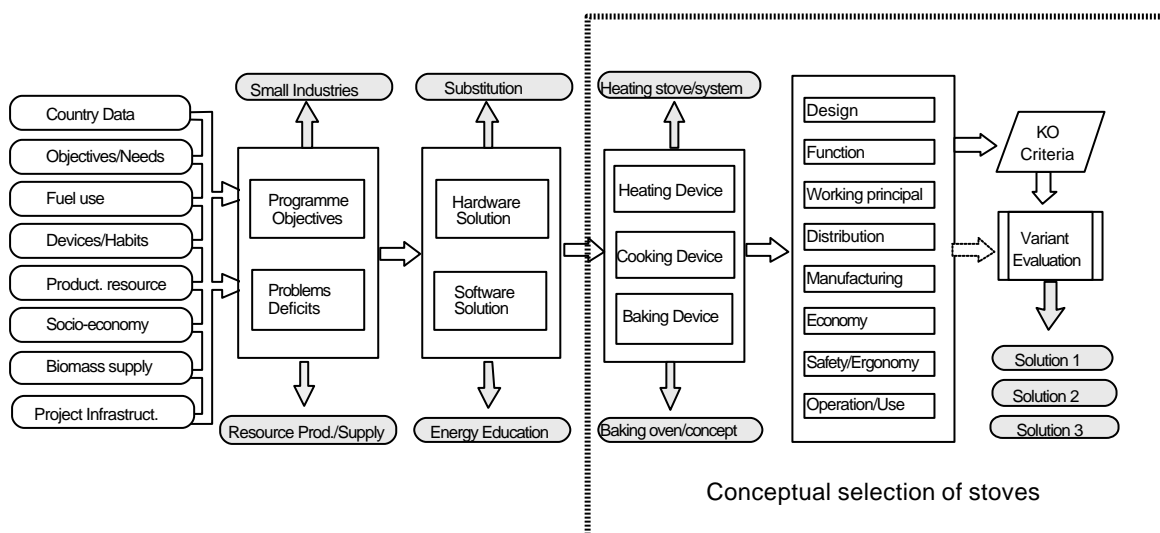
However, as the pot has to fit the stove like a hand fits a glove, it seems worthwhile to consider the manufacturing of durable and robust pots (which do not loose their shape). In the long run this option may be more economically beneficial than the use of existing pots. Many low quality traditional pots are very difficult, sometimes impossible to adapt any stove principle. Pots which are suitable for large scale cooking are either made from thick aluminium or stainless steel. But there are also other pots made of normal steel, cast iron or aluminium alloys.

5.2 Stove selection criteria

There are various ways of categorising stove selection criteria. Here we have divided them into:

- function
- working principle
- design
- manufacturing
- distribution/service
- economy
- safety/ergonomy
- operation (including socio-cultural practices)

The figure below illustrates again the process flow of stoves selection:



5.2.1 Function

Function defines the actual production tasks to be carried out with the stove. In most cases it will be cooking, but in some cases, the same stove can be used for a combination of tasks, such as cooking and heating, cooking and baking, cooking and permanent hot water production. The combinations are many and stoves become more economic, if they can be utilised for multiple purposes.

5.2.2 Working principle

The working principle describes the technical characteristics of a stove, for example fuel use, exhaust gas system, regulations and other specific working principles.

Fuels in use in African rural institutions include gas, electricity, kerosene, charcoal and wood. In China, crop residues have been used to supplement firewood in the countryside. In addition, efforts to market peat in institutions in China have been successful. Prior to the current civil war, many institutions in Burundi were switching from woodfuel to peat (Adam, 1986).

In developing countries, fuelwood and charcoal are widely used in institutions for preparing meals. Fuel costs and availability is one of the main factors which govern the choice of a stove. It is therefore possible to design stoves which can be used with more than one fuel .

The working principle includes not only the choice of fuel, but also the technical efficiency and the required power range of the stove. With regard to the reliability of cooking times in institutions (e.g. for fixed breakfast or lunchtimes), the proper layout of power ranges is very important. Technical efficiency plays an important role in this, stoves working at half their potential efficiency need twice the power rate to cook in the same time. The power rate and efficiency of the traditional stove provide important information on required cooking times.

With regard to the exhaust outlet and convectional heat transfer, we can basically differentiate between two forms of improved stoves:

- channel type, and
- jet type

Channel type stoves are designed for a fixed size of pot. They can be built with or without chimney. Jet type stoves (the Gugu/Zaire) have the advantage, that they can be used with various types of pots and pans. The disadvantage of this design is that they can only be built without a chimney.

5.2.3 Design

Here we consider the appearance, the aesthetics and other "external qualities" of a stove like stability, durability and so on.

The aesthetics of stoves plays an important role in their being accepted by cooks. In many cases cooks will persuade their managers to buy stoves, if they consider them "modern". This will increase their own and the business status. Most of the design criteria however, actually refer to the quality of system operation.

5.2.4 System operation

The cooking stove influences the cooking system and vice versa. Experience has shown that similar stoves consume varying amounts of fuel as well as producing pollutant emissions when the cook is not properly skilled at firing the stove (Bellerive foundation, 1993).

For the selection of stoves, system operation is expressed as a functional criteria. For example, in case of Rwandese refugee camps in Zaire, cooks had to use freshly cut wood due to the absence of properly dried wood, because of the sudden demand generated by the arrival of refugees. One criteria considered in the design was, that the stove should comfortably burn also relatively wet wood.

In the list of criteria, this is called "wet fuel can be comfortably used for cooking (yes/no)". Because the list is a hardware selection, the criteria are formulated functional and hardware specific.

Other criteria in use are :

- use of long uncut logs, e.g. when people lack the means to cut up branches
- number of doors or dampers, that need to be operated
- the stability of the stove during use, e.g. while stirring
- aesthetic design, if the stove has a traditional, functional or modern appearance
- if the attendance needs are high or low while cooking
- if charcoal remains after cooking, it can then be utilised for other cooking purposes
- fast cooking, relationship between power range and efficiency
- what type of skills are required for maintenance
- kitchen requirements in terms of ventilation, outside ventilated, inside ventilated, poorly ventilated and with exhaust hood

In this list of criteria it is important to differentiate between *existing*, *potential* and *required* practices and habits for improved cooking systems. Whenever the new system includes a new practice, it will have important repercussions in training or awareness raising activities.

5.2.5 Manufacturing

When it comes to manufacturing, innovations present a general change in skill and material choice. Therefore it is important to carefully research local and regional alternatives in terms of producers, skills and materials.

The level of skills and production changes tremendously from individual production to automated factory production. In general factory production offers the best quality materials and a high level of standardisation. Because of their large scale production factories are in a position to utilise materials at lower cost than small scale workshops. However, centralised production has another price to pay and that is transport. In many cases where customers are in far away, poorly accessible regions the transport costs will exceed the possible marketable price. There is also another disadvantage, centralised production often draws capital from the poorer regions into the industrialised regions, thus creating more unsocial imbalance (see also chapter 3.5).

The social marketing aspect, creating jobs in a specific region thereby enhancing local producers' business, generally plays an important role in the decision making process. This a very critical point and its impact is often underestimated as producers at this level mostly require general training and promotion to qualify for dependable stove production. In such case, however,

the provision of business promotion programmes will be beyond the capabilities of stove programmes.

Thus, the area of production and marketing stoves represents a major bottleneck in the whole process. It is very important for programmes to be clear from the beginning on the amount of resources in terms of time, money, and logistics that are available for the promotion of small scale entrepreneurs.

Nevertheless, social marketing is in fact a very important concern in all development projects and there are many regional programmes which concentrate primarily on income generation activities. Stove programmes may cooperate with income generation projects serving as partners and catalysts in an effort to promote local production and marketing. In this cooperation stove programmes concentrate on training in cooking and construction skills, whereas the marketing and business promotion are implemented through the income generation project.

The availability of materials plays another important role in considering options for the manufacturing process. Different materials have a variety of characteristics, thereby influencing manufacturing, marketing and use. Materials such as unfired clay are cheap and easy to work, but difficult to standardise and less durable in most cases. Ceramics are breakable, but more standardised and still relatively cheap. Cast iron is ideal in terms of workability, and durability, it can be transported easily and lasts long, but is generally not cheap and requires a certain type of industrial production. Unfired clay is ideal for cooking times of over two hours, ceramics for over one hour and metal sheet stoves can be efficiently used also for short cooking times.

The list below illustrates the various characteristics of materials:

Type of material	Work-ability	Impact resistance	Thermal shock	Insulation properties	Durability	Cost	Short cooking < 1 hour	Medium >1<2 hours	Long > 2 hours	Production facilities
Cast iron	o	+	+	x	+	o	+	+	+	Factory
Mild steel sheet	o	+	+	x	o	o	+	+	o	Artisan
Stainless steel-sheet	o	+	+	x	+	x	+	+	+	Factory
Aluminium sheet	o	o	+	x	o	x	+	o	o	Factory
Unfired clay	+	o	o	+	o	+	x	o	+	Built in situ
Ceramics	+	o	x	o	o	o	o	+	+	Potters
Cement-like material	+	+	o	x	o	o	x	o	+	Fac./Artis.

+ denotes good o denotes medium x denotes poor

Based on: Sharma, S.K., Improved Solid Biomass Burning Cookstoves - A Development Manual, 1993

5.2.6 Distribution/Service

Likewise the manufacturing of improved stoves usually requires new local alternatives for distribution and servicing.

Parts which require periodic cleaning need to be easily accessible and the parts susceptible to wear and tear need to be easy to replace at a reasonable cost. Optimally these parts should be locally made new, with the use of simple tools . The Bellerive Foundation, for example, published an installation manual that helps users install, operate and maintain institutional stoves with minimal assistance (Bellerive Foundation, 1993) . The service package includes not only information on fuel management, stove operation and maintenance, but also a consumer advisory service on stove selection and follow up visits by professionals. If the selected stove requires such extensive service, it has to be checked from the beginning whether or not the necessary resources and capacities can be provided.

For the selection concept of stoves it is essential to distinguish between the three options of self-built, semi-, and commercial dissemination. This includes a number of criteria such as transportability and the requirements for installation and service.

5.2.7 Economy

For commercial and institutional managers, the economic decision is the most important. This decision is generally based on three factors :

- the total investment necessary and its impact on budget and liquidity (for stove, equipment and fuel)
- the amortisation period of stove systems
- the financial viability of stove systems

Generally the total investment is the most restrictive criteria. In many cases, managers prefer lower investments before short amortisation periods and rentability, because of poor financial liquidity. If two stoves require a similar investment, but show a difference in amortisation time and rentability, managers will usually prefer the one with a shorter pay-back time, in preference to a higher rentability.

5.2.8 Safety /ergonomy

Accidents and poor working conditions have economic consequences on the well-being of kitchen personnel in terms of extended sicknesses. Many cooks and managers are not sufficiently aware of these facts and the unhealthy impact of poor quality systems. Only those stoves which can obviously solve some of the problems of traditional systems should be selected.

The Economy of LCS Projects

Institutional and moreover commercial cooking underlies some economic constraints which are important to consider. The stoves' economy therefore forms the basis for decision making. This restraint however provides also a chance, because institutions and commercial enterprises mostly maintain a commercialised fuel supply and the economic benefits of fuel saving activities can be demonstrated more easily and effectively with non-commercial fuel supplies.

As a first step the economic impact of investing in improved stove systems needs to be understood. Therefore we need to look at the,

- general situation of the enterprises/institutions,
- financial resources
- investment structure, and the
- liquidity

Following this it is important to analyse

- the cost structure
- the income structure

Based on this, it is possible to illustrate the impact in terms of:

- turn over
- product range
- financial budgets
- pricing policy
- investment policy
- productivity
- rentability

However, we are not going into detail here about sophisticated business administration or industrial management. But it is important to understand that without a proper understanding of the institutions or commercial business, it will not be possible to give any professional advice on energy use. For assistance you may look for programmes specialised in business promotion and discuss the locally relevant issues.

We will discuss here only a few simplified methods of analysing the economic impact of investments.

Amortisation (also: pay-back-period)

There are basically two ways of calculating the amortisation in investment analysis, the static and the dynamic. The first one includes only the paid investment, whereas the second includes also the interest rate for the credited money (or own capital). In our simplified analysis we will only work with static amortisation, since the dynamic is difficult to generalise (depending on the minimum interest rate from country to country). However, if the pay-back-period exceeds several months, this issue becomes important to consider.

Generally, the static amortisation is calculated by:

$$\text{financial investment} / \text{increased monthly profit} = \text{pay-back-period in month}$$

Return-on-investment

describes the profit increase in relation to the investment. The point at which an investment becomes profitable is called the break-even-point. We will illustrate here only a simplified method of calculating the return-on-investment for improved stove systems.

A simple indicator can be calculated by dividing the profit over the lifetime of the device by the total investment.

For example:

stove cost : 1000 \$

increased income through reduced fuel expenditure: 40\$/month

projected lifetime of stove : 60 months

service and repair for 60 month operation: 300\$

Total investment: 1000 +300 = 1300\$

increased profit or return = 60 *40 = 2400

Return of investment $(2400/1300) * 100 = 185 \%$

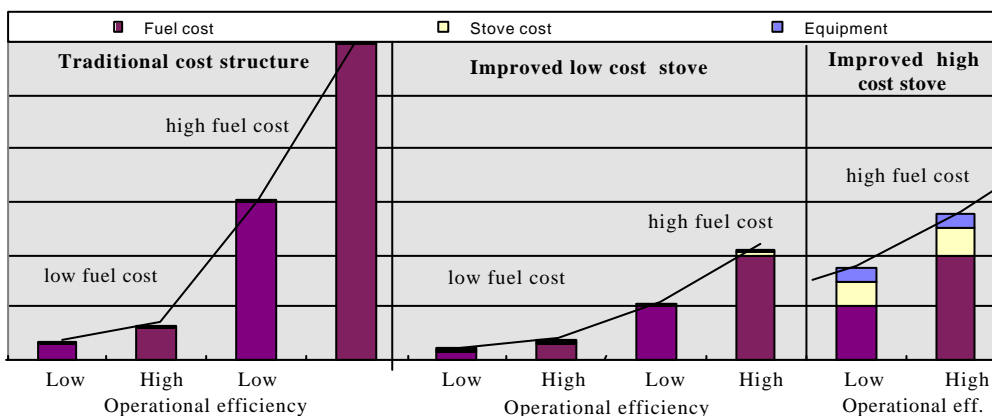
This calculation neither considers the interest rates on the investment, nor does it consider opportunity costs generated by improved working and health conditions and other previously described beneficial impacts. It is also understandable, that a return on investment less than 100 % is not acceptable. A good return is for example 200 %. In case of low cost stoves the return is often 2000 % and more.

The most important costs to include in the economic analysis of stove systems are:

- the investment costs for equipment (including interest payments)
- cost for service and maintenance of equipment
- the efficiency of stove systems
- the fuel cost
- the influence of operational efficiency on the cost structure (in terms of durability, consumption, etc.)
- opportunity costs, generated by improved health conditions etc.

Traditionally, investment costs for stoves have been almost zero. Therefore investments in stoves generally also implies a switch in financial traditions. It is necessary to build up acceptance before managers start to invest in a new product. The arguments for improved stoves are mostly focused on technical efficiency. But as we can see from the list above, the economic benefit does not depend only on the stove system, but on many other factors usually beyond the reach of projects.

Proportional comparison of cost structure for typical traditional and improved systems at low/high fuel cost and varying operational efficiency



5.3 Evaluation list of criteria

For the selection and evaluation of stoves, we have prepared a list of criteria, according to the one that can identify the type and typical range of application for each stove. The list and range is of course not a complete guide.

For your own evaluation of the necessary features, design and cost, you can fill in the following checklist and compare it to the list of the six typical stoves.

Entry form

1. Each line starts with a specific criteria in the first column, which is analogue to the discussed needs assessment discussed in chapter x.
2. In the second column you can enter the priority that the criteria has had in the local needs assessment. You may use four categories, to verify the importance of the given criterias:

0 = not relevant at all

1 = low priority

2 = moderate priority

3 = high priority

KO = KO criteria, a criteria, which is exclusive, for example, the function cooking will be in most cases a KO criteria, because if stoves cannot be used for cooking they will be automatically excluded from the list (except stoves, designed to be used for another function).

3. In the third column you enter the characteristics of the typical prevalent, existing traditional cooking system.
4. In the fourth column you enter possible local alternatives to the existing cooking system.
5. In the fifth column it is possible to enter various improved stove (systems) one by one and compare them to your first two entries. The selected characteristics of a number of existing stoves (systems) can be found aside.

As a result, you will understand where specific data is lacking. However, this list is far from being complete. You may miss criteria and adapt/complement this list according to your own needs.

Analysis and evaluation

In the latter evaluation, improved stoves meeting all criteria, KO criteria and most of the high priority points can be selected as potentially transferable. If none of the improved stoves described in the list meet your KO-criteria, none of the stoves are potentially transferable according to your assessed needs. By this stage you will perhaps need to seek technical advice or the help of a consultancy service (see contacts).

If several stoves meet all KO criteria, you may want to select the most economic, or the one which provides most correspondencies with respect to your given set of high priorities.

Function, can the stove be used for:	Rank	Traditional Stove	Local Alternatives
Cooking			
Water boiling			
Grilling			
Baking			
Heating			
Lighting			
Agro-processing:			
If relevant - specify local applications, describe:			
Provide light			
Provide space heat			
Permanent hot water production			
Working principle of the stove	Rank	Traditional Stove	Local Alternatives
1 st preference fuel used for cooking (name)			
2 nd preference fuel used for cooking (name)			
other fuels used with the same stove (name)			
Stove has/needs chimney (yes/no)			
Type of pan/pot used			
Is the pot fixed to the stove (yes/no)			
Multiple pot/pan use (one size, multiple)			
No. of pots simultaneously used (1,2,3)			
Powerrange (enter kW)			
Technical efficiency			
Ideal working time (hours)			
Economic use of big size fuel (yes/no)			
Design, system operation	Rank	Traditional Stove	Local Alternatives
Stability during use (high, medium, low)			
Esthetic design (traditional, functional, modern)			
Low attendance operation (yes/no)			
Wet fuel can be comfortably used for cooking			
Charcoal remains after cooking (yes/no)			
Fast cooking-relation powerrange to efficiency			
Maintenance skill requirements (low, medium, high)			
No. of dampers/doors			
Durability (high, medium, low)			
For outside use unprotected (yes/no)			
Ventilation conditions for inside use			
Range of sizes in liters			
Economy, enter the cost	Rank	Traditional Stove	Local Alternatives
Enter the maximum feasible investment possible for improved stoves			
<i>Stoves' economy</i>			
1. Stove cost			
2. Installation cost			

Improved stove need	Gugu Zaire	Bellerive Kenia	ICS Argentina	ITP Ghana	Bagasse Cuba	Suharti Indonesia	BCS Burundi
	yes	yes	yes	yes	yes	yes	yes
	yes	yes	yes	yes	yes	yes	yes
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
	no	no	no	no	no	no	no
Improved stove need							
	wood	wood	wood	wood	bagasse	wood	peat
	waste	waste	waste	waste	sawdust	waste	waste
							wood
	no	yes	no	no	yes	yes	yes
	any	flat bottom	flat bottom	round bott.	flat bottom	wok	flat bottom
	no	no	no	no	no	no	no
	multiple	one size	one size	one size	one size	one size	one size
	1	1	1	1	1	2	1
	10 - 30	20	15 - 30	20	10 - 50	10 - 20	10-30
	32	45	42	30	25	25	29
	1	1	0,5	2	1	2	3
	yes	no	yes	yes	no	no	no
Improved stove need							
	high	high	medium	medium	high	medium	high
	functional	modern	functional	traditional	modern	modern	modern
	yes	yes	no	yes	no	no	yes
	yes	no	no	no	yes	no	no
	no	no	no	yes	no	no	no
	medium	medium	high	low	high	medium	low
	unskilled	skilled	unskilled	unskilled	skilled	unskilled	unskilled
	1	3	0	1	1	0	2
	high	high	medium	medium	high	high	high
	yes	no	yes	yes	no	no	no
	hood	low	hood	hood	low	moderate	low
	100-150	100-500	100	100-200	100-300	2x100	100
Improved stove need							
	20	500-1000	20	15	50	80	30
	0	20	0	5	10	30	20

Economy, enter the cost cont.	Rank	Traditional stove	Local Alternatives
3. Construction time if self-constructed (enter opportunity costs per hour work)			
4. Installation time if self installed (enter opportunity costs per hour work)			
5. Total in local currency			
6. minimum lifetime in month			
Monthly depreciation of stove (divide total by stove lifetime)			
<i>Equipment economy</i>			
Necessary expenditure on additional new equipment			
Lifetime of new equipment in month			
Monthly depreciated equipment (divide expenditure by lifetime)			
Total monthly depreciation of stove & equipment			
<i>Fuel economy</i>			
Monthly cost fuel 1 (e.g. enter monthly expenditure on wood)			
Monthly cost fuel 2 (enter only if 2 nd fuel is used)			
Monthly cost fuel 3 (only if 3 rd fuel is used)			
Total expenditure on fuel per stove/per month			
Monthly savings (subtract improved from traditional fuel cost)			
Amortisation (divide total cost/monthly savings)			
Rentability (multiply monthly savings by lifetime divided by total cost)			
Manufacturing, enter potential and need	Rank	Traditional stove	Local Alternatives
Self made clay construction			
Self made brick construction			
Clay construction by professionals			
Brick construction by professionals			
Ceramic construction by professionals			
Metal construction by professionals			
specific materials necessary			
specific tools necessary			
Distribution, service enter potential and need (yes/no)	Rank	Traditional stove	Local Alternatives
Dissemination			
Transportability (in terms weight, stability, etc.) (high, medium, low)			
Professional installation (necessary, possible, non)			
Service, Repair (self, professional)			
Ergonomy/safety - are cooks affected by: (low, medium, high)	Rank	Traditional stove	Local Alternatives
Smoke exposure			
Heat exposure			
Accidents			
Ergonomic height (bad, good, excellent)			
Fire visibility (bad, good, excellent)			

Improved stove need	Gugu Zaire	Bellerive Kenya	ICS Argentina	IIP Ghana	Bagasse Cuba	Suharti Indonesia	BCS Burundi
	20	320 - 720	20	20	60	110	50
	36	48	12	12	48	24	36
	0,56	10,00	1,67	1,25	1,04	3,33	0,83
	0	200 - 300	0	0	0	0	0
		580					
	0	0,43	0	0	0	0	0
	0,56	10 - 20	1,67	1,25	1,04	3,33	0,83
	69	78	71	71	60	67	67
	0,6	13,1	0,6	0,6	2,0	3,3	1,5
	12275	618	4186	4186	4700	1355	4700
Improved stove need							
	no	no	no	yes	no	no	no
	yes	no	no	no	yes	yes	yes
	no	no	no	yes	no	no	no
	no	no	no	no	yes	yes	yes
	no	no	no	no	no	no	no
	yes	yes	yes	yes	yes	yes	yes
	brake drum	stainlesssteel	metal sheet	metal sheet	brake drum		
	welding	stainless weld			welding		
Improved stove need							
	commercial	commercial	commercial	self, semi	self, semi	semi	semi
	good	no	high	no	no	no	no
	self	professional	self	self	self, prof.	professional	professional
	unskilled	professional	unskilled	skilled	skilled	skilled	skilled
Improved stove need							
	high	low	high	high	low	low	low
	moderate	moderate	moderate	low	low	low	low
	moderate	low	moderate	low	low	low	low
	good	good	good	good	very good	good	good
	very good	low	good	good	low	low	low

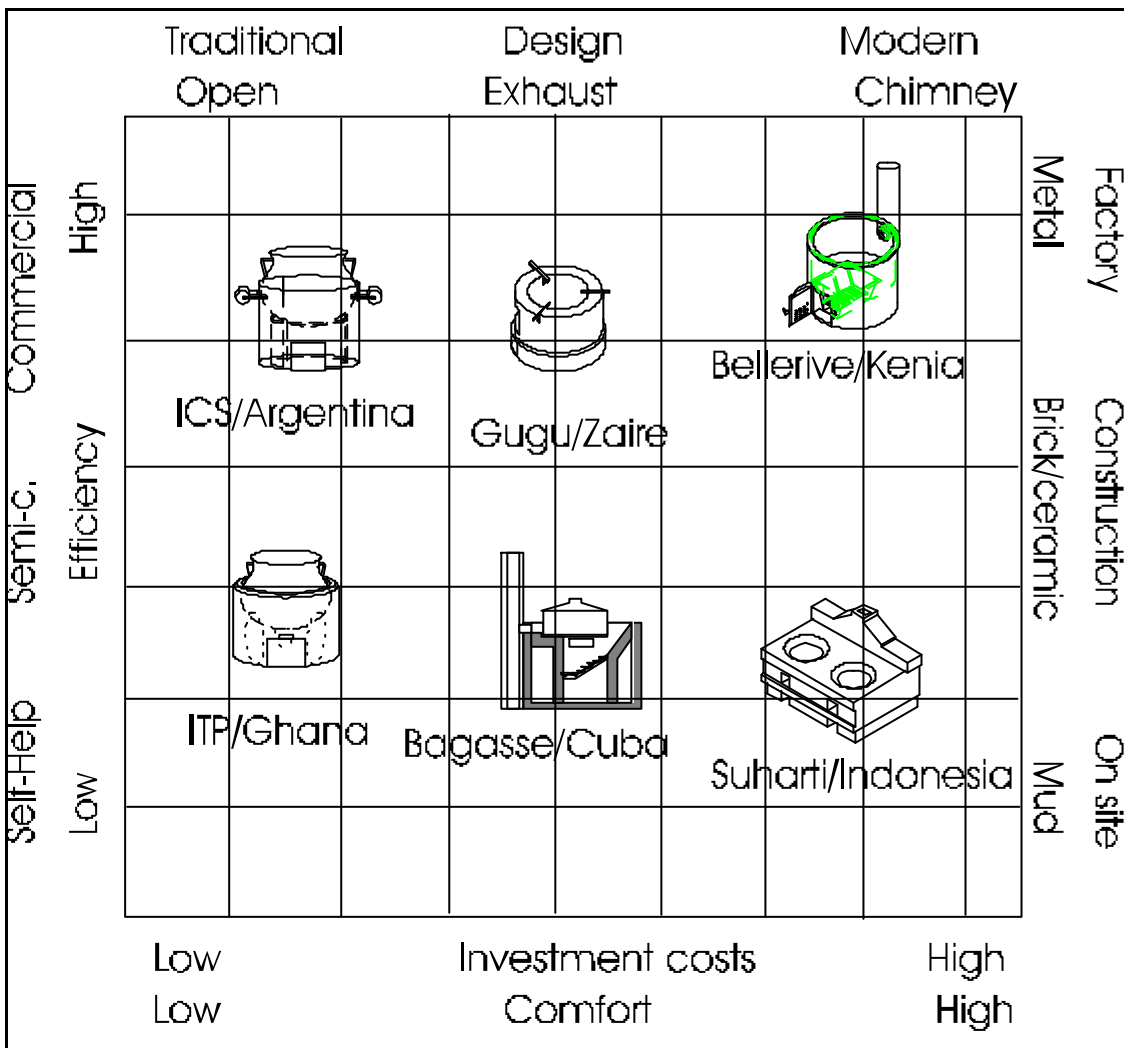
System Operation / Practices and Habits	Rank	Traditional System	Local Alternatives	Educational Needs
Fuel handling: (enter yes/no)				
Do cooks use large size pieces of wood?				
Are they able to cut wood?				
Do cooks use remaining charcoal for cooking?				
Do cooks use wet fuel?				
Is fuel sheltered against rain?				
Pots and equipment: (yes/no)				
Do cooks use lids on pots?				
Do they use metal pots?				
Do they use pressure cookers?				
Do they extinguish fire after cooking and save the left over fuel?				
Food preparation: (yes/no)				
Do cooks water/soak grains or beans before cooking?				
Do cooks keep food hot for longer periods?				
Do they have many cooking cycles during the day?				
Socio-cultural: (yes/no)				
Does the fire serve social/cultural/religious functions?				
Is the work of the energy user socially accepted and appreciated?				
Do social differences correspond to differences in fuel use?				

6 Technical Broadsheets

The figure below illustrates the range of possible technical innovations in the field of ILCS's and shows six exemplary stoves. Each of them characterises a specifically adapted solution in terms of economy, design and dissemination.

There are many more designs, but for many reasons we cannot present all of them in this book. Therefore, we have only concentrated on a few typical designs, each of them representing a whole range of similar stoves.

Each technical broadsheet contains some general information and a principle drawing. If you need more detailed information on specific designs, you may contact HEP for further information. HEP maintains a whole set of drawings of most of the ILCS. The figure below shows the approximate classification and selection of sample stoves in terms of dissemination, efficiency, design, exhaust, construction level/materials, investment costs and comfort.



6.1 Surharti Institutional Stove

Stove description

The Surharti institutional stove is a modification of the Chinese stove, NG II. It is a composite stove made of cast iron and brick and is capable of using several biomass fuels. It can accommodate pots of up to 70 cm diameter and is ideal for restaurants and small hotels.

Type of fuel used

Firewood, coconut husks, straw, shaved wood, leaves.

Laboratory and field test results

The stove has a thermal efficiency of 28 % and a high power output. Temperatures of up to 600° C can be attained in the combustion chamber and 300 C in the chimney (Sujarwo,1991).

Raw materials

- brick is used for the main body
- the stove is insulated with pumice
- steel and cast iron used for major components
- cement
- sand
- clay pipe for the chimney

Major components

- two sets of fire-box bowls (cast-iron)
- fuel inlet (cast-iron)
- fuel inlet door (steel)
- two fire grates (cast-iron)
- two sets of insulation cover rings (cast-iron)
- two pot rests (steel rings)
- chimney (15 cm diameter clay pipes)

Relevant addresses

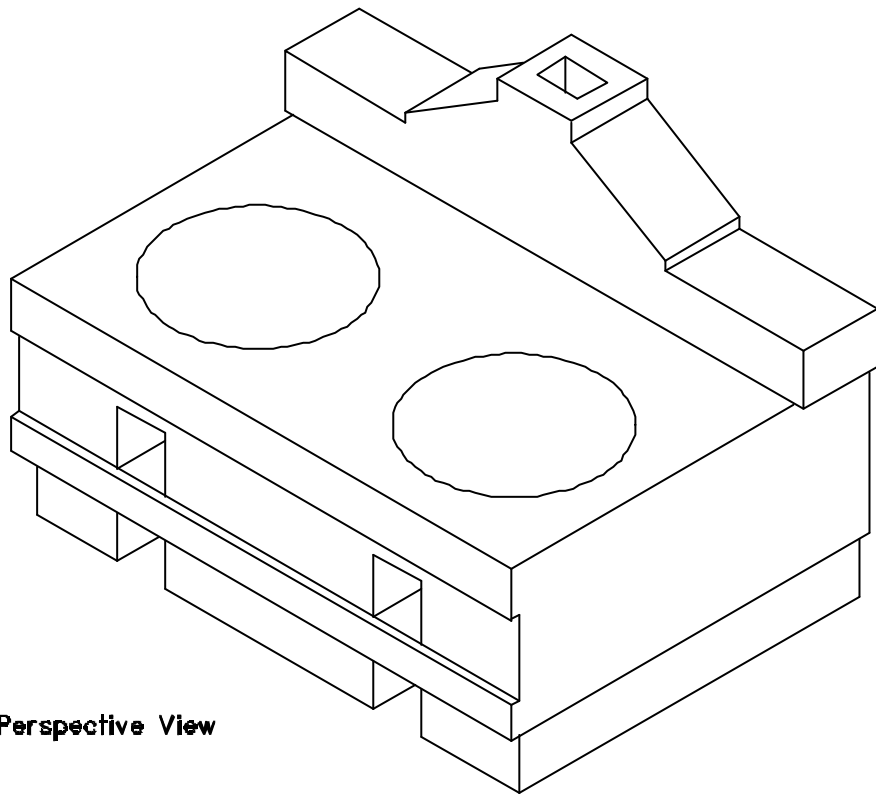
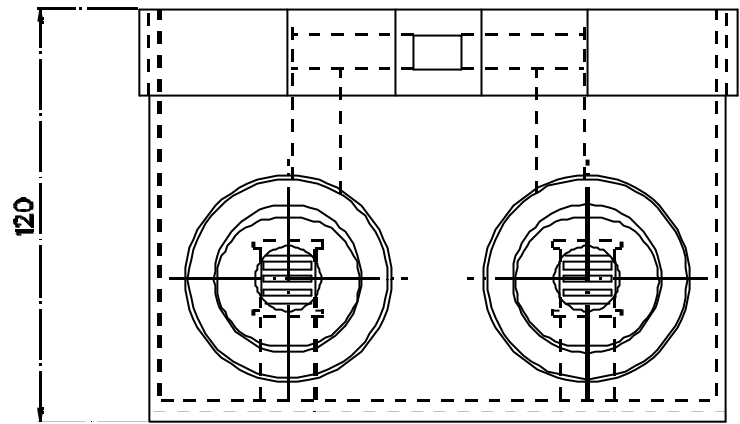
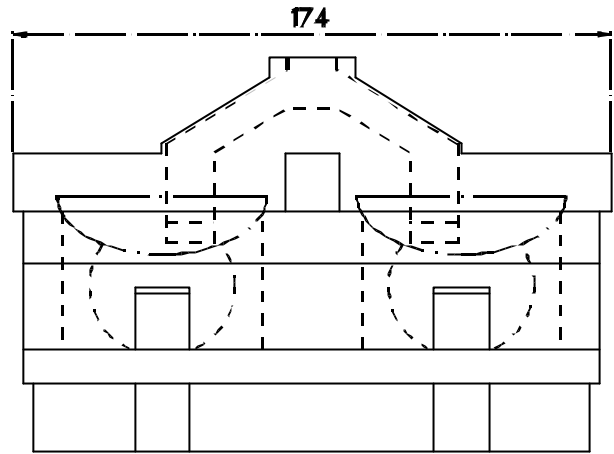
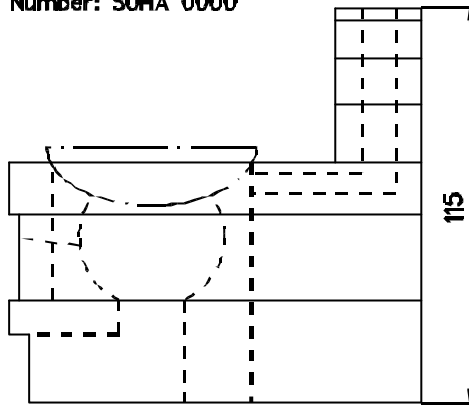
The Director ARECOP
Yayasan Dian Desa Jalan Kaliurang KM 7
P.O.Box 19 Ulaksumur
YOGYAKARTA
INDONESIA
Phone:62-274-61 247, 63423
Fax :62-274-63423

Relevant references

Subjarwo, Aryanto (1991). "The Secret to Good Taste - How to make Surharti Institutional Stove." Glow Magazine September Vol.2. Yogyakarta, Indonesia.

The Suharti Stove

Drawing Number: SUHA 0000



Perspective View

1994	Date	Name
Editor	29.9.	Legatis
Dept.	Institutional stoves	
all dimensions in mm		
Scale	1:20	
HEAT GmbH Glashütten (Ts)		

6.2 Cuban Institutional Bagasse Stove

Stove description

The Cuban Institutional Bagasse Stove is designed for the use of sugar bagasse, but can also alternatively be used for other waste fuels such as: sawdust, coffee husks, rice husks etc.

In principle, a channel type stove with a stepwise grate. It has an additional door directly under the front side, for easy fire control and additional air supply for larger power ranges. Depending on the fuel the fuel hopper on the side closes up completely. With the help of a little stick it is possible to comfortably influence the supply of bagasse or sawdust. The stove has a chimney and can be built in various sizes.

Type of fuel used

Bagasse pellets, sticks, other pelleted or powdered waste fuel

Laboratory and field test results

Laboratory tests showed an efficiency of 25 %. This is low for wood stoves, but quite high for bagasse pellets. In many regions there is no alternative use for bagasse pellets, therefore the stoves present are a tremendous advance in replacing woodfuel or solving local energy problems.

The stove is generally used for 150 liter pot

Raw materials

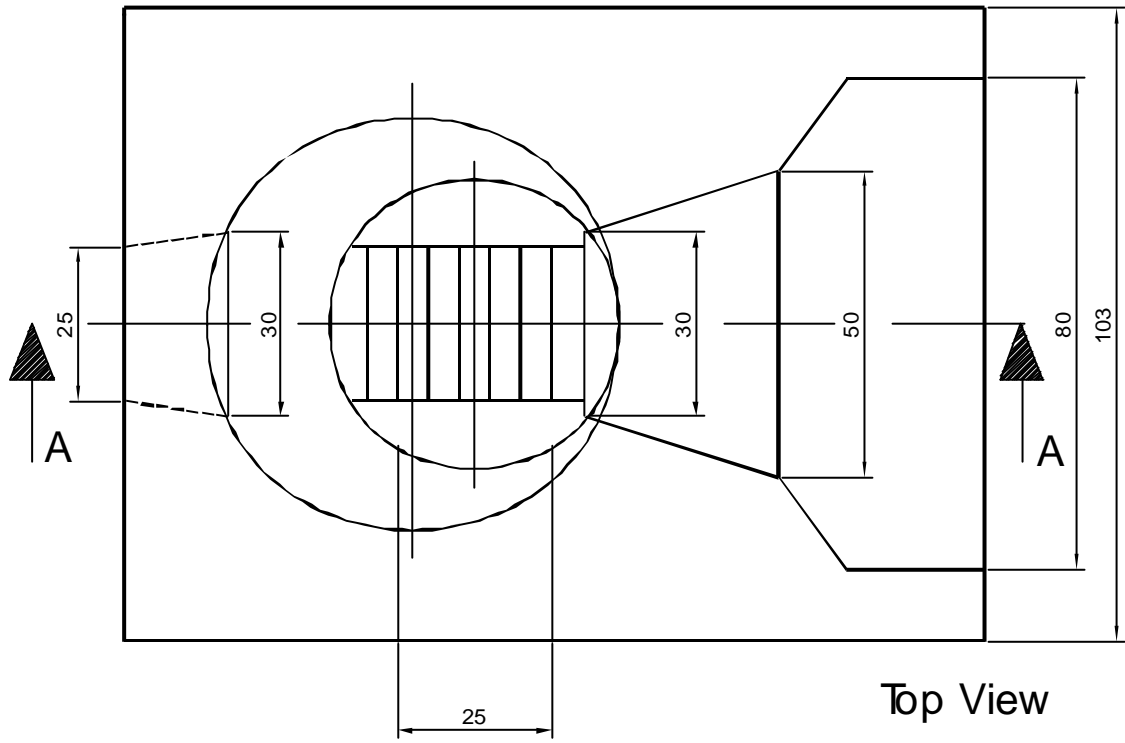
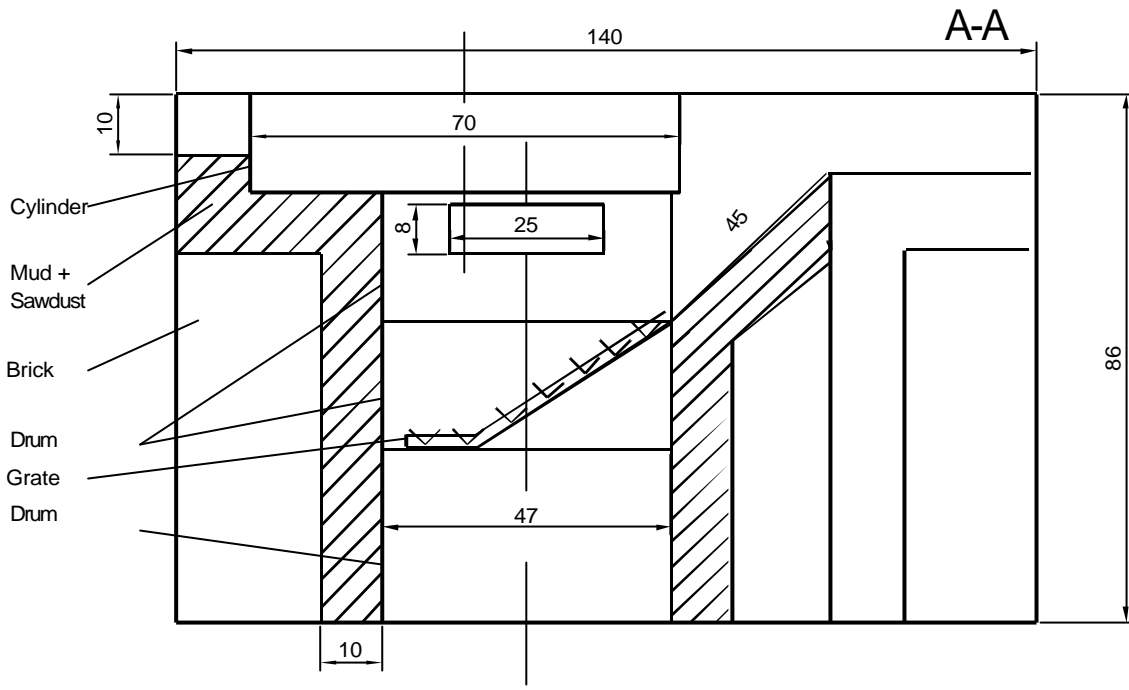
- sheet metal for the pot cylinder
- waste lorry brake drums
- bricks
- cement
- clay
- sawdust

Major components

- internal cylinder
- stepwise grate from angle iron
- chimney

Relevant addresses

HEAT Ltd.
Household, Energy, Appropriate Technologies
Limburger Str. 29
61479 Glashütten
Germany
Tel. ++49-6174 964077 , Fax ++49-6174 61209



Top View

Part	Design Nr.	Date	Name	Scale: 1:10
1	Grate	Cuba 0002	Comp. 23.9.96	Legatis
1	Cylinder	Cuba 0003	Prov.	
2	Drum	Cuba 0004	Norm	
1	Drum	Cuba 0005		
HEAT GmbH Glashuetten/Ts				Cuban Bagasse Stove Cuba 0001
Origin			As for:	As from:

Blatt
Blätter

6.3 Ghanaian Street Vendor Stove

Stove description

The Ghanaian street vendor stove was developed for street food sellers, who are found all over Ghana. Street food sellers have very little scope for major investment and can only afford investment which amortise in a few weeks.

Dissemination

Deal for semi-commercial, the metal sheet ring for the pot seat and the door are produced by local blacksmiths. There is also a self-constructed version with no metal parts.

Type of fuel used

Mainly wood, agricultural waste.

Laboratory and field test results

Laboratory tests showed an efficiency of 35 %. In field tests fuel savings of 50 % were realised. The stove is generally used for 50 to 100 litre pots.

Raw materials

- sheet metal for the pot cylinder and door
- three big stones (latherite)
- unfired clay
- sawdust

Major components

- internal pot cylinder
- door

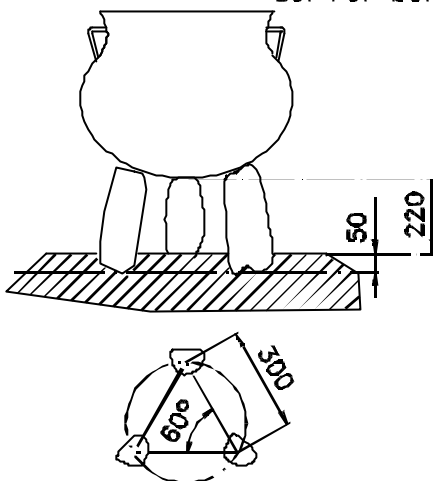
Relevant addresses

HEAT Ltd.
Household, Energy, Appropriate Technologies
Limburger Str. 29
61479 Glashütten
Germany
Tel. ++49-6174 964077
Fax ++49-6174 61209

Ghana Institutional Clay Stove
Building Instruction

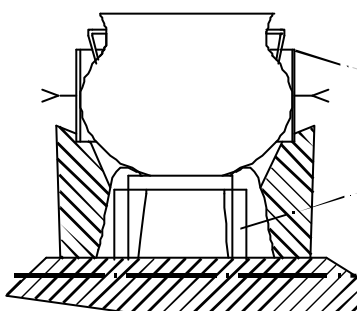
Drawing Number: GICS 0001

1. Set 3 stones of similar size on the ground, 300 mm apart. Sink approx. 50 mm into the ground. Set Pot-bottom in 220 mm distance.



2. Set clay wall, drum assembly and gatebox. Set level.

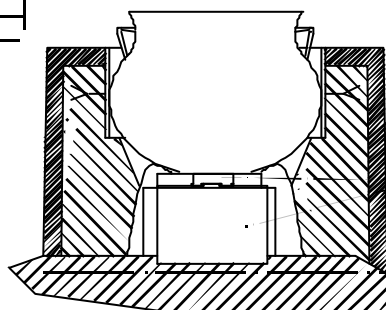
Clay/Rice Husk Mix:	Clay	10
	Rice husk	5



metal ring assembly
drawing no. GCIS 0003

door insert
drawing no. GICS 0004

Clay/Rice Husk/Cement Mix:	Clay	10
	Rice husk	5
	Cement	1



3. Build up clay wall until wall flushes with rim of metal ring.

door assembly
drawing no. GCIS 0005

1994	Date	Name
Editor	23.3.	Legalle
Dept	Institutional stoves	
all dimensions in mm		
Scale	1:20	

HEAT GmbH
Glashütten (Ts)

6.4 The Zairian Gugu Mobile

Stove description

The gugu mobile is a stove, which was specifically designed for use in collective refugee kitchens (e.g. orphan camps). It is characterised by a highly ventilated combustion chamber, which allows it also to burn slightly fresh wood. It is mobile so it can be moved to new camp sites. It is made from an oil drum, which is generally available in refugee situations. The combustion chamber is made from a lorry brake drum, a common waste metal to be found alongside roads in Zaire. The pot seat is typically jet-like.

Dissemination

Commercial through local black smiths. Organisations buy from the workshop. The stoves weigh about 50 kg.

Type of fuel used

Mainly wood and agricultural waste to some extent.

Laboratory and field test results

Laboratory tests showed an efficiency of 32 %. In field tests fuel savings of 70 % were realised.

The stove is generally used for 100 to 150 litre pot.

Raw materials

- oil drum for the stove body and door
- cement
- waste lorry brake drum
- metal rods for grate and pot support
- sawdust

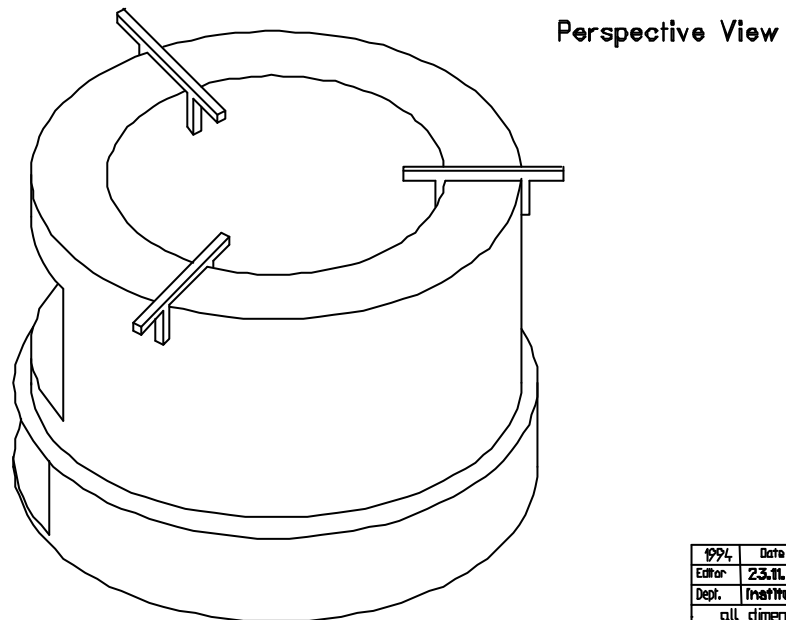
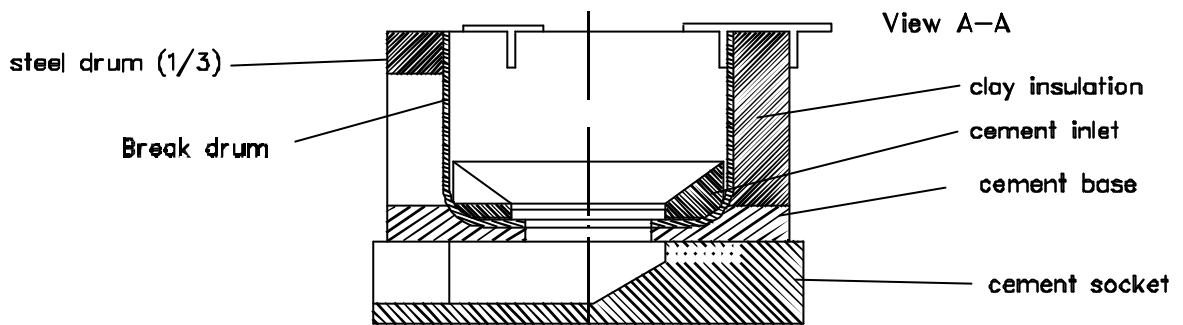
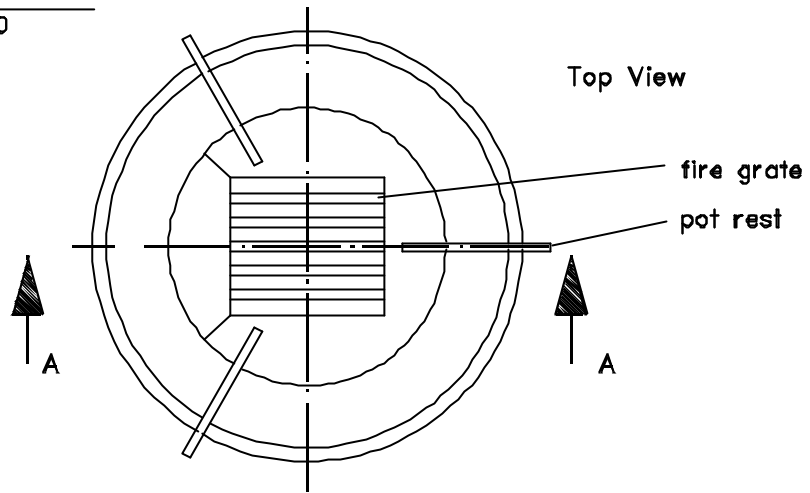
Major components


- Combustion chamber
- Grate

Relevant addresses

HEP
Household Energy Programme
Postfach 5180
Eschborn
GERMANY
Fax ++49-6196 79 7325

Drawing Number: GUGU 0000



1994	Date	Name
Editor	23.11.	Legalla
Dept.	Institutional stoves	
	all dimensions in mm	
Scale	1:10	
 HEAT GmbH Glashütten (Ts)		

6.5 Argentinean Community Stove

Stove description

The Argentinean Institutional Stove is a sunk-pot design, made from sheet metal and is capable of accommodating pots of 44 cm diameter. It mainly comprises of the external and internal cylinders. Air enters through air-holes at the base of the stove to maintain a high temperature fire. The stove was designed for use in the community kitchens of 35 poor neighbourhoods in Argentina.

Type of fuel used

Firewood

Laboratory and field test results

Reduced consumption of firewood by 50 % to 70 % with a stove in comparison to the open fire. Reduction in cooking time by 50 % in comparison to an open fire. Cooks 45 kg of stew in 1.5 hours, enough to feed 80 children. The technical efficiency is claimed to be 42 %.

Raw materials

- sheet metal for main body
- steel bars

Major components

- external cylinder: diameter 45 cm, height 50 cm (sheet metal)
- internal cylinder: diameter 30 cm, height 21 cm (sheet metal)
- grate: diameter 44 cm with 33 holes, 12 mm diameter (sheet metal)
- grate ring (sheet metal)
- pot support (T-steel bar)

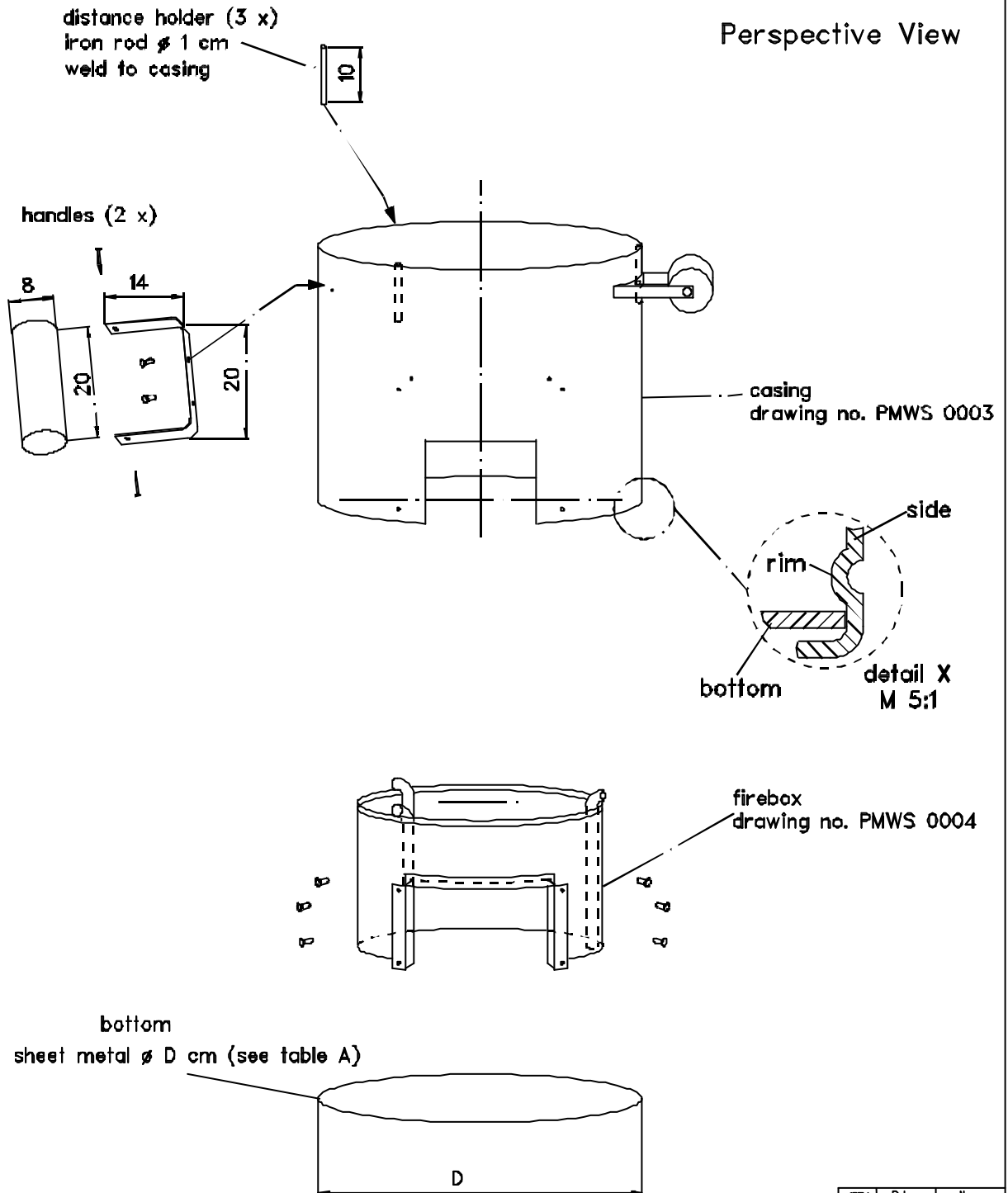
Relevant addresses


Brace Research Institute
P.O. Box 900, Macdonald College of McGill University.
Ste. Anne de Bellevue
Quebec
Canada H9X 3V9
Phone: ++001-514-398-7833
Fax: ++001-514-398-7767

Portable market wood stove
exploded view

Drawing Number: PMWS 0002

Perspective View



1994	Date	Name
Editor	28.3.	Legoffe
Dept.	Institutional stoves	
all dimensions in cm		
Scale	1:10	
 HEAT GmbH Glashütten (Ts)		

6.6 Bellerive Institutional Stove

Stove description

The Bellerive Institutional Stove (SMP 200) is a wood burning stove. It is 87 cm diameter by 76 cm high, made of a mild steel frame, and has a stainless steel pot with a capacity of 200 litres. It is ideal for use in large institutions and is suitable for the preparation of a wide variety of meals (soups, tea, etc).

Type of fuel used

Dry firewood, split and cut to a length of 20 cm.

Laboratory and field test results

Water boiling test on the SMP 200 has demonstrated a woodfuel burning rate of 6.0 kg /hr to raise 135 litres of water from ambient temperature to boiling point in 75 minutes (Specifier's Guide, 1993). The stove can be used for long cooking tasks due to its high thermal mass.

Raw materials

- the outer body is galvanised 3 mm steel
- the stove is insulated with fibreglass (this can be replaced by locally available insulating materials)
- brick, in the base of the stove, provides thermal mass to retain heat and provide the required rigidity

Major components

- 200 litre stainless steel pot
- inner cylinder - (mild steel)
- outer cylinder - (mild steel)
- top ring - (mild steel)
- firebox - (cast iron)
- chimney cowl - (mild steel)
- water heater - (mild steel)

Relevant contact addresses

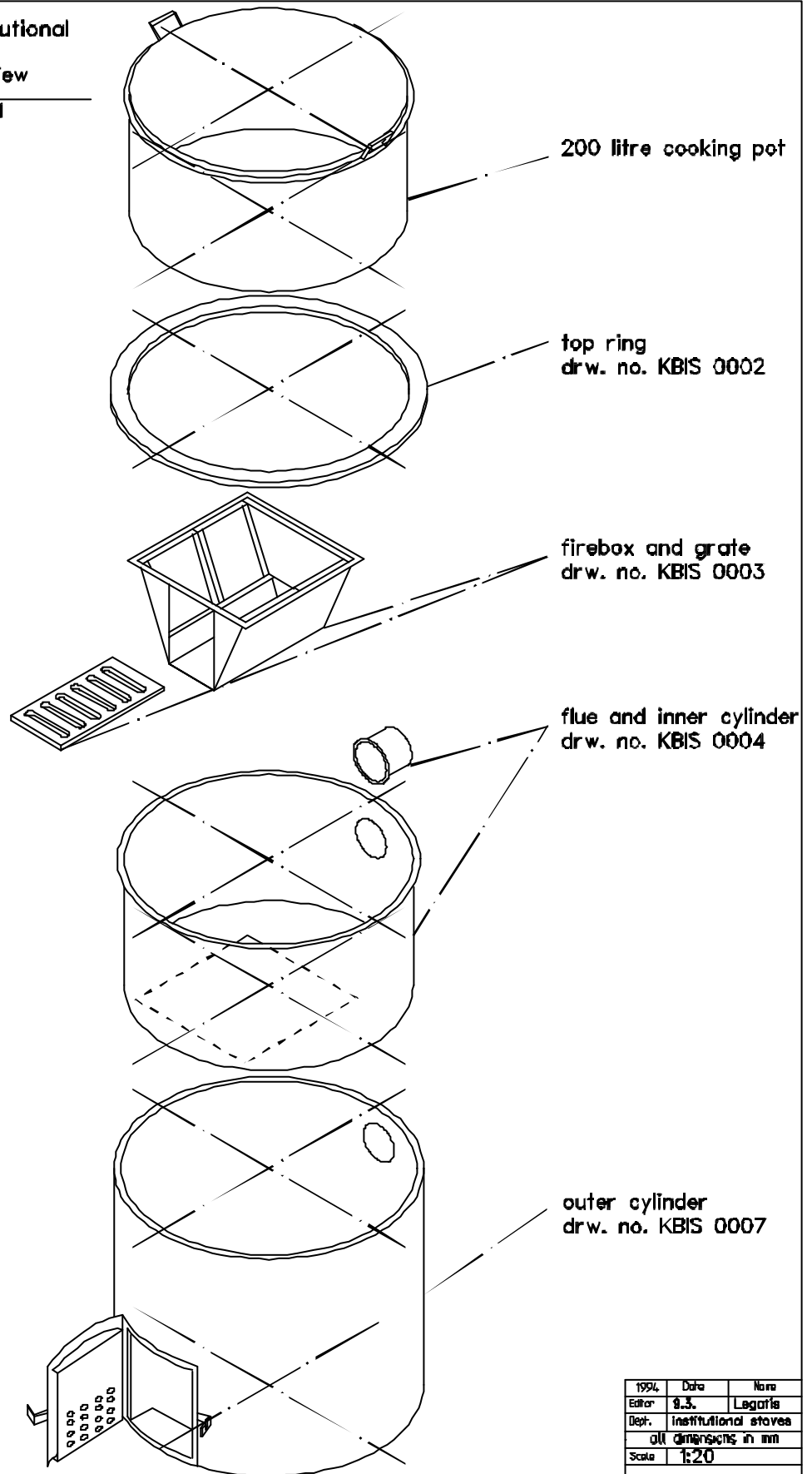
Director Bellerive Foundation
P.O. Box 42994
Nairobi, Kenya.
Tel. ++254-2-720274\726740
Fax. ++254-2-726547

Relevant references

Walubengo, D. and Joseph, S. (1988). 'Wood Energy in Kenyan Institutions'. Kenya Energy and Environment Organisations (KENGO). Nairobi. SMP 200 in "Specifiers' Guide-To fuel efficient cooking systems designed and manufactured by Bellerive Foundation".(1993). Third world Interface. Edgware, United Kingdom.

**Kenyan Bellerive Institutional
Stove** Exploded View

Drawing Number: KBIS 0001



200 litre cooking pot

top ring
drw. no. KBIS 0002

firebox and grate
drw. no. KBIS 0003

flue and inner cylinder
drw. no. KBIS 0004

outer cylinder
drw. no. KBIS 0007

1994	Date	Name
Edith	9.3.	Legatta
Dept.	Institutional stoves	
all dimensions in mm		
Scale	1:20	

HEAT GmbH
Glashütten (Tz)

7 Test Procedures for Stoves

7.1 Efficiency and consumption tests

It is recommended that efficiency testing procedures are standardised so that results can be compared. Procedures and results must also be reproducible and well documented. Furthermore, efficiency tests should take into account the cooking practices of a given region or country. Since these factors vary widely, the requirements for the measurement of stove efficiency are often very different. To resolve this problem, international standards for testing the efficiency of wood-burning cookstoves were developed at a Volunteers-in Technical-Assistance (VITA) Conference in 1982 in which major donors and institutions interested in Improved Stove Programmes were involved. At this conference, three test procedures were established, that will be described in detail on the following pages. These three testing procedures should not be considered as three alternative but complementary tests with different objectives:

- Water boiling test
Objective: to compare the technical efficiency (%) of the traditional stove with the one of the improved stove. Efficiency means here the heat (energy) utilised for boiling water.
- Controlled kitchen test
Objective: to test the stove according to local conditions (preparing local meal) and to compare the specific wood consumption (e.g. kg wood per kg meal prepared) of the traditional stove with the one of the improved stove.
- Wood consumption test
Objective: to assess the actual wood consumption in the field (kg per day per household and person) either of traditional or improved fuel use.

Note: Despite of these standardised test procedures and calculations you will find regional modifications and small deviations in the presented formulas depending on specific cooking habits, fuel use, the duration of the measurement of the simmering phase or different ratings of evaporated water (i.e. in the case of boiling 'dolo' in Burkina Faso or the production of sirup of palinfruits in Thailand). These deviations must be inquired into before testing is begun. In West African Sahel Countries, see the definition of the 'rendement thermique', 'Consommation spécifique' et 'Puissance' in the 'Test d'eboullition de Feu - Methodologie pour foyers à bois', CILSS, Ouagadougou, 1986. Be careful with translations: the word 'efficiencies', used here in a more global sense by introducing the three test procedures, cannot always be translated as 'rendement' in French. It is only equivalent to the word 'efficiency' in the context of the water boiling test.

Sources:

- VITA, Testing the efficiency of wood-burning cookstoves, Arlington, May 1985
- FAO, Guidelines for the Monitoring of Pilot Stove Development Schemes, Rome 1985
- Association Bois de Feu, Manuel pour réaliser des enquetes de consommation de combustibles en milieu domestique, Aix-en-Provence, Paris 1986
- FAO, Guidelines for planning, monitoring and evaluating cookstove programmes, Rome 1990

7.2 Waterboiling test

Characteristics: The Water boiling test measures efficiencies during the high power phase when water is brought to the boiling-point.

Water boiling test results should provide reliable comparisons as long as the producers are not varied, and are well documented. Consistency in seemingly minor matters, such as use or not use a lid, the type of pots, and fire maintenance, are important for the results.

Objectives:

- to compare the efficiency of stoves (traditional and improved) under similar laboratory conditions
- to measure the wood consumption of a stove that is needed to boil water
- to analyse the influence of different parameters of the stove-pot-system on wood consumption
- to measure the stove's quality of heat transfer

Actors : - trained project staff/ technicians

Equipment:

- a balance for measuring fuelwood and mass of water
- a thermometer
- a chronometer or a watch for measuring the time from the starting to the boilingpoint
- a hygrometer
- form for recording data and calculations (see next page)

Advantages: - theoretically, the overall efficiency in percentage of different stove models can easily be compared because of the quasi-standardisation of the testing procedures and calculation

Disadvantages:

- cooking is only simulated by boiling water
- the real situation of cooking a traditional meal is not considered
- cooking habits (i.e. long simmering phase for beans that consume a lot of wood)are not taken into account

7.3 Controlled cooking test

Characteristics: The controlled cooking test - also known as the standard meal test - was developed to reflect efficiencies achieved in cooking. In the controlled cooking test, a regular meal representative for a region or country is cooked to simulate actual cooking procedures carried out by local households. Cooking efficiencies derived from these tests should correspond more closely to actual household efficiencies. That means, the technical efficiency of the stove is tested in relation to its cooking function. Given the many variables in the controlled cooking test that could affect efficiency results, these tests require careful measurements of ingredients and documentation of pot sizes, pot types, fuel and sequencing of procedures by the cooker.

Objectives:

- to measure the specific wood consumption of traditional and improved stoves during the preparation of a local meal,

- to check on the field adaptability of the stove,
- to compare the specific wood consumption of different stoves while preparing the same local meal with the same quantities of food, ingredients and fuel to identify deviations in the specific wood consumption and
- to identify the influences that effect those deviations (e.g. techniques, handling, etc.)

Actors : - trained project staff

Equipment:

- a balance for measuring fuelwood, food, water
- a chronometer or a watch measuring the time from the beginning to the end of cooking
- a thermometer
- a hygrometer
- form for recording data and calculations (see next page)

Advantages:

- reflects technical capability and efficiency to serve local cooking functions (cooking, baking, heating, etc.)
- reflecting cooking habits and real field conditions, the controlled cooking test gives more information than the waterboiling test (which in this sense is merely a "specific controlled cooking test, boiling water")

Disadvantages:

- analysis of efficiency is limited
- unlike the water boiling test, tests are not comparable world-wide because the efficiencies depend not only on technical parameters (stove models, pot sizes, etc.) but also on the specific heat capacity of specific food and local cooking tradition

7.4 Wood consumption test

Characteristics: The implementation of the wood consumption test is most efficient if it is used for individual case studies in households where stoves will be introduced. It needs to be done two times:

1. before a stove programme or project is started (to record traditional stoves)
2. after the adaptation of an improved stove.

The wood consumption test incorporates all field parameters, though it is more realistic with regard to the assessment of changes of local household fuel consumption. The wood consumption is usually expressed in kg fuel per person and day. Using individual families and 'normal' household conditions, household cooks prepare their usual meals on traditional and/or improved stoves. These tests also show the impact of a new stove on the overall use of energy by the household. Observations of the real cooking habits of individuals allow reflections of potential differences between the real fuel savings through improved stoves and the fuel savings predicted by the Waterboiling test in the laboratory. This test can therefore be far more than a measure of stove efficiency through combining scientific

data gathered with active household participation. It has to be done over a period of seven days.

- Objectives:**
- to compare the wood consumption of traditional and improved stoves concerning
 - the impact of the use of improved stoves on fuel consumption by the household and fuel savings (through technical and operational improvements)
 - to demonstrate the fuel saving potential of a new stove in the household, and to understand, illustrate and to correct operational practices of stove users
- Actors :**
- women/cooks of households
 - trained investigators evaluate (interviewing, observing and measuring)
- Equipment:**
- balance for measuring fuelwood
 - forms for recording data and calculations (see next page)
- Advantages:**
- shows the wood consumption
 - and the real fuel saving potential of new stoves
 - under field conditions
- Disadvantages:**
- tests cannot be compared like the water boiling tests because the individual fuel saving rate depends on parameters like the number of household members which eat together, correct use of new stove, multiple use of the stoves (i.e. water heating, cooking of traditional medicine, etc.)

7.5 Standard test protocols

On the following pages you will find a selection of commonly used test protocols for the above described test procedures.

7.5.1 Waterboiling test protocol

Test No.:	Date:.....	Operator
Locality :	Height:..... (m)	Temperature: °C
Pressure:.....	Wind:.....	Relative Humidity (RH):.....%
Moisture content of wood (dry wood basis): x =.....		

Sketch of stove, grate and pot (dimensions):

Type of pot:.....

Outer Diameter of pot:(mm)

Height of pot:.....(mm)

Weight of pot:.....(mm)

Capacity of pot:(litres)

Type of stove:

Inner diameter:(mm)

Wall thickness:.....(mm)

Weight of stove:.....(kg)

Type of grate:

Type of wood:

Weight of wood:.....(kg)

No. of pieces:

Diameter: and length:.....(mm)

Use small wood sticks to start the fuel burning = starting fuel: A1=.....(kg)

Water temperature (start):	T1 =.....(OC).....	Water temperature (boiling):.....T2=..... °C
	T2 - T1 =..... °C	
time till boiling:	tb =.....(min).....(sec).....(sec)	
Weight of empty pot with lid and thermometer		M1 =(kg)
Weight of pot with 2/3 capacity of water, lid and thermometer at start		M0 =(kg)
Weight of pot with 2/3 capacity of water, lid and thermometer at boiling point		M2 =(kg)
Boiling water produced: M3 = M2 - M1 (kg)=.....(kg)		

Weight of wood at start:	B1=.....(kg)
Rest of wood at boiling point:	B2=.....(kg)
Remaining charcoal at boiling point:	C2=.....(kg)
Dry wood consumption: WC	$(A1 + B1 - B2) \times (100\% - x\%) - 1,5 \times C2 = \dots\dots\dots(kg)$
Power :	$Ph = WC \times 19000 / tb \text{ (sec)} = \dots\dots\dots.kW$
Efficiency	$E = \{ (4,2 \times M3 (T2-T1)) + ((M0-M2) \times 2260) \} / W = \dots\dots\dots \times 100 = \dots\dots\dots (\%)$

7.5.2 Controlled cooking test protocol

Test No:	Date:.....	Opera-
tor:.....		
Locality:.....	Height: (m)	Tempera-
ture:.....(°C)		
Pressure:.....	Wind:.....	Relative Humidity (RH):.....(%)
Moisture content of wood (dry wood basis): x =.....		

Type of pot:	Sketch of stove, grate and pot (dimensions):
Outer Diameter of pot:..... (mm)	
Height of pot:..... (mm)	
Weight of pot:..... (mm)	
Capacity of pot:..... (litres)	
Type of stove:	
Inner diameter:..... (mm)	
Wall thickness:..... (mm)	
Weight of stove:..... (kg)	
Type of grate:	
Type of wood:	
Weight of wood:.....(kg)	
No. of pieces:	
Diameter and length:.....(mm)	
Use small wood sticks to start the fuel burning = starting fuel: A1=.....(kg)	

Food temperature (start):	T1 =.....(°C)	Water temperature (boiling):	T2=..... (°C)
	T2 - T1 =.....(°C)		
time till boiling:	tb =.....(min).....(sec).....(sec)		
Weight of empty pot with lid and thermometer.....	M1 =.....(kg)		
Weight of pot with 2/3 capacity of food, lid and thermometer at start	M0 =.....(kg)		
Weight of pot with 2/3 capacity of food, lid and thermometer at boiling point.....	M2 =.....(kg)		
Food prepared/cooked	M3 = M2 - M1 (kg)		

Weight of wood at start:	B1=... (kg)
Rest of wood at boiling point:	B2= (kg)
Remaining charcoal at boiling point:	C2 = (kg)

Dry wood consumption: $WC = ((A1 + B1 - B2) \times (100\% - x\%) - 1,5 \times C2 =.....(kg)$
Spec. Stand. Consumption: $SSC = WC / M3 =.....(kg)$ dry wood/kg food prepared

7.5.3 Wood consumption test protocol

Basic data	No. of test:.....
Town/ Village:.....	District:.....
Name of the household:.....	Time of passage:.....
Name of evaluator:.....	Date of beginning of survey:.....

Day of survey	FIRST FUEL		SECOND FUEL		OBSERVATIONS
	rested.....	added	rested	added	
1		kg.....	 kg	(e.g. No. of eaters, food cooked meals per day, etc.)
2	..... kg	.....kg	..... kg	..... kg
3	..... kg	.....kg	..... kg	..... kg
4	..... kg	.....kg	..... kg	..... kg
5	..... kg	.....kg	..... kg	..... kg
6	..... kg	.....kg	..... kg	..... kg
7	..... kg	.....kg	..... kg	..... kg
8	..... kg		..... kg	

Calculations	FIRST FUEL	SECOND FUEL
Total fuel added:	.....kg	..... kg
Fuel left last day:	.....kg	..... kg
Total fuel consumed during survey:	.....kg	..... kg
Duration of survey: .....days		
Total consumption per day per household:	kg	kg
Number of persons eating meals together in this household:.....persons		
Consumption per day per person:	.....kg/P	..... kg/P

Comments of evaluator: (duration of cooking, operational habits, etc.)
.....
.....
.....

8 Follow-Up / Monitoring Issues

Proper monitoring of ILCS programmes is essential for their success. If conflicts or problems arise, they will be noticed at an early stage and not when it is almost too late to do something about it.

Monitoring needs sound preparation and a good data base. Out of the needs assessment you will know the critical points of traditional technologies. How these change with the new technology must be documented.

In order to verify objectively measurable impacts like fuel consumption, emissions, etc. it is crucial that sound data about the original consumption, concentration levels are at hand. Once the new technology has been adopted it is impossible to realistically go back to the traditional setting. It can be also observed that with new technologies levels change, either because they wear out, or because cooks become more or less skilled in their use.

For fuel consumption tests and controlled cooking the formats in chapter 7 can be used.

For further detailed information on monitoring please refer to the „Guidelines on monitoring and evaluation“ from HEP, 1996.

9 Project Purpose, Results, Quantities and Costs

The objectives and results of community kitchen projects can vary widely, depending on how the partner country formulates its application and/or how the project is arranged within a broad programme. The following hierarchy of objectives and outputs, however, may be regarded as typical for the implementation of programme components and individual projects.

Project purpose:	Use of improved community kitchen technology by institutions helps to conserve forests by reducing firewood consumption.
Results:	<ol style="list-style-type: none">1. Target regions and types of institutions for introduction of technology are identified.2. Community stoves and cooking pots have been identified for suitability, acceptance and economic efficiency and subsequently optimised with respect to local requirements.3. Public authorities and institutions have been advised on the offer and made aware of the impacts of the new community kitchen technology.4. The institutions' management is receiving information on how to reduce fuelwood consumption with the aid of improved community stoves.5. Private-sector artisans and small-scale enterprises have been trained and qualified for manufacturing the products.6. A privately organised consulting, installation and maintenance service for community kitchens has been established.7. An operative monitoring & evaluation system is in place.

Specification of inputs (per annum)

Personnel:	1 training, consulting and project-management specialist 1 community kitchen technology specialist short-term experts (4 man-months) - organisational consulting - establishment of dissemination/ marketing structures - special issues
Material/operating sources:	Re-vehicles, fuel stainless steel and consumables (start-up phase) individual processing equipment
Total cost:	A national community kitchen project can be expected to cost roughly US\$ 4 million over the course of 8 years.

ANNEX I

The Tanzanian Experience In Short

Contributed by Heini Schneiders/GTZ

-Individual institutional consulting (energy consulting)

Institutional kitchens are central supply units whose internal function is well one of the institution's most important. Any change taking place in an institutional kitchen necessarily involves a complex process of innovation in which diverse organisational units must successfully cooperate in order to meet the set of objectives. Institutional consultancy therefore is extremely important for the successful dissemination of community stoves. The services rendered must by no means concentrate solely on inducing an investment decision in favour of improved cook-stoves, but must include such additional inputs as familiarising the kitchen personnel with the proper (= thrifty) use of the appliances, advising the institution's management with respect to the ordering and preparation of firewood, etc.

-Institutional information and sensitisation (market development)

The institution's management and relevant authorities are kept abreast of the services, products and their savings. Leaflets, circulars, press releases and advertisements are no less important than the provision of advisory services to ministries or of consultancy services to the supervisory organs of private-sector institutions. With deference to the need for innovational receptiveness on the part of institutional management, implementation-oriented solutions should be elaborated and presented.

-Transfer of expertise to private-sector artisans (production)

Local metal workshops are given the requisite know-how for producing stove bodies, flues, a masonry lining and, as necessary, accessory articles (e.g. stainless steel cooking pots). Additional training in the form of on-the-job-training or special-purpose programmes may be necessary, depending on the existing level of skills and knowledge. This applies in particular to the introduction of stainless steel processing techniques. As a back-up measure, private entrepreneurs are advised on the importance of high quality standards, and their products are subject to routine quality control measures.

-Establishing a private-sector service system for consultancy and maintenance services (dissemination)

In most partner countries, target-group institutions amount to "widely scattered bulk consumers". Consequently, all communications, consultancy services, and the delivery, installation and maintenance of community stoves are costly individual inputs. The sustainable provision of such services requires that private enterprises and consultants be trained and entrusted with most of the relevant activities. From a certain minimum regional dissemination density onward the services are decentralised in that local enterprises and/or free-lance agents are trained for the job.

The back-up monitoring & evaluation system provides a basis for long-term customer support. Despite high logistical and material expenditures, it is objectively justifiable and economically advisable to establish lasting ties to the user-institutions.

-Advisory services to national executing organisations with regard to the backstopping and selective support of the dissemination process required (ensured sustainability)

In the course of the project, the local partner organisation is systematically advised and qualified to critically monitor the various actively involved parties and their contributions toward the establishment of a sustainable dissemination network and to provide assistance in case of need. In everyday practice, areas typically requiring support include, for example, the financial implementation of orders of stoves, the first import consignment of stainless steel, and the introduction of consultants, advisers and producers to public authorities and ministries.

In the long run, institutions can only be induced to use energy rationally by expanding the consultancy perspective from "stove consulting" to "energy consulting for institutions". Such an expansion benefits from:

- the thinly scattered locations of institutions within the project region,
- the large individual order volumes,
- a lack of price-versus-demand elasticity and
- the long-term nature of the consultancy relationship.

Within the envisaged commercial structure of energy consultancy for institutions, the product-specific cost of consultancy inputs can be maintained at a low level by way of diversification, i.e., by expanding the product array to include, say, solar water heating, biogas generation, photovoltaics, etc. Such a consultancy package covers a range of requirements and applications, thereby reducing the relative amount of consultancy inputs specific to individual products.

Consulting institutions in their energy needs planning

The provision of consultancy services to a particular institution ideally proceeds according to the following 15 steps, gradually progressing from awareness-raising efforts to the actual commissioning of a new community kitchen:

1. Project activities devoted to sensitisation/awareness-raising, advertising and sales promotion.
2. Inquiries from institutions (resulting from 1.).
3. Information concerning the consulting procedure (1st letter to client, incl. questionnaire) and/or initial consultation.
4. Client's reply and/or documentation of the results of consultation in the questionnaire form including all data of relevance to the community kitchen.
5. Register and process the relevant data and select stoves and cooking pots.
6. Consult with the client and present proposals adapt as necessary.
7. Bill the client for advance payment on the order.
8. Following receipt of payment, award the subcontracts with designation of stoves and cooking pots.
9. Compile the total order volume, including cooking pots and chimneys.

10. Inform client and organise transportation.
11. Plan and prepare the installation of stoves (2nd letter to customer).
12. Ship the appliances (normally accompanied by a producer's artisan).
13. Install, inspect and commission the equipment (3rd letter to customer).
14. Instruct the kitchen staff in the correct operation and maintenance of the equipment.
15. Hold final meeting with the client to finalise acceptance and perhaps conclude a maintenance agreement.

The time span of such a process can be expected to range from four months to several years (in exceptional cases). Once an appropriate level of standardisation has been reached, the institutional consultancy phase can be substantially shortened by engaging the services of "free-lance agents" on a commission basis.

Also, the key positions of certain professionals such as architects can be exploited for their multiplier effects. This would cover, for example, the selective involvement and provision of advisory services to relevant authorities, many of which oversee multiple institutions, e.g., ministries of the interior, education, health and agriculture.

The institution's management

From the managerial standpoint, community kitchen stoves are perceived as: reliable, thrifty, robust, maintenance-free, clean, safe, versatile, fast and easy to operate. Thus, the decision to purchase new community stoves derives mainly from the aspects of primary concern to the managerial scope, e.g., operational reliability, regular expenditures for wood procurement, frequency of repairs and maintenance.

Assuming a case in which one or the other executive officer of the institution has a material interest in a consistently high rate of wood consumption, serious problems can arise in connection with the decision to purchase, the payment of invoices, and/or the installation and proper operation of the stoves.

The institution's neighbours

The neighbours may not even notice that new stoves have been installed until the resultant savings on wood have generated a tangible reduction in the felling of trees - at which point the new stoves' thriftiness will be perceived in a positive light. The second positive effect for the neighbours may well be that the new stoves provide access to kinds of food that could not be prepared before, e.g., bread baked in the stoves' special-purpose oven.

The superior authority or administrative organ (private institution)

As seen from the standpoint of the authorities thriftiness and durability are by far the most important attributes of the new community kitchen stoves. As indicated by the Tanzanian examples listed in the following table, the calculated energy savings alone, i.e., with no consideration of the reduced workload, the improved cooking conditions or the more hygienic cooking pots, yields a payback time of four to eight months.

Institution	No. stoves/ size of pots [n/(l)]	Ttl. capital outlay [Tanz. Sh.]	Annual savings [Tanz. Sh.]	Payback time [months]
Police Academy	10 (200 L)	1 197 640/=	2 457 000/=	6
Boarding School	6 (100 L)	461 740/=	658 120/=	8
Hospital	3 (100 L)	210 000/=	665 200/=	4

Local industrial production processes

The local industrial production processes receive different developmental inputs, depending on their prior standards. Assuming, for example, that local artisans are well-versed in the processing of sheet metal, no major problems should be encountered in connection with the introduction and standardisation of stove and chimney production processes. If, however, the local artisans have little experience in the processing of rolled sheet metal, instead concentrating on the recycling of scrap metal, then the sector stands to gain lasting advantages impulses from the manufacture of community stoves. Naturally, the new know-how and skills can also be applied to other manufacturing processes.

By comparison, a wave of developmental progress in production techniques usually results from the introduction of production processes for stainless steel cooking pots. The high-quality material demands more sophisticated cutting, edging, bending, welding and cleaning techniques, and the substantially higher cost of the material and its processing calls for levels of accuracy and cleanliness in the manufacture of stainless steel products that surpass many times over the standards that apply to normal sheet metal. In addition, such new products as bowls, ladles and mixtures can be made from the scraps and used, appropriately, in community kitchens.

The natural environment

The substantial savings on firewood resulting from the use of improved community kitchen technology leads directly to less felling of trees and corresponding reductions in erosion damage. Having to transport less wood saves fuel and reduces air pollution. The conserved biomass can be used as organic fertilizer, and less carbon dioxide is emitted into the atmosphere.

ANNEX II

Rapid Conflict Appraisal (RCA)

Problems are always perceived differently by each individual, who are involved in large-scale cooking.

This is an important precondition to understand, before looking for a solution. It stresses the need, that whatever solution we seek, it will always be directed to one or more groups of people concerned. Problems perceived between people develop due to three underlying factors:

- knowledge (e.g. on improved stove technology)
- willingness (or ignorance) to change attitudes or act
- capabilities (e.g. to organise and manage)

In a programme there is a lot we can do about knowledge (educate), less about willingness (lobby, promote) and very little about low capability which is caused by a lack of knowledge.

There is always a fourth and fifth one, which is generally claimed and referred to:

- structural frame conditions, which refers to the socio-cultural, political, institutional and market limitations
- geographic frame conditions, refers to specific local climatic and geological needs

In the frame sustainable grass roots development, development is only achieved through the people who sustain, maintain, produce and operate „their“ technologies.

In this context structural frame conditions are important, if man-made, and if they can be influenced by the programme.

While analysing problems of large-scale cooking it is first important to understand why a problem can be perceived. In case of improved stove technology it could be:

- stove producers don't know designs of improved stoves (educational)
- institutions responsible know about the negative effects on smoke but still resist to refit the kitchen with acceptable, affordable technologies (promotion/ignorance)
- cooks who are responsible for the purchase of fuel earn a commission from the fuel supplier and resist therefore to consume less fuel (non-knowledge based capability)

Basically there are seven major groups of people when it comes to institutional/commercial cooking:

- **cooks** or those who use the technology
- **institutional managers** or **business owners**
- stove **producers**/market **distributors**, those who produce/distribute technology
- **legislators** who control/protect
- **programme officers** in governmental or non-governmental organisations, who want to help/develop/protect
- **kitchen builders**, those who construct the kitchen
- **fuel suppliers**, those who supply the biofuel to the institution
- financial support institutions like small scale banks

Make a list for each group in the order with the rest of the other concerned people. Interview representatives of each group how they perceive themselves and other with regard to the needs and problems. For structure and background knowledge you will include the following columns:

- relationship to each other
- positive/supportive experiences with each group in scope of the problems
- problems/conflicts with each other concerned member
- suggestions for solving the problems/conflicts

How cooks perceive:	Relationship	Positive Experiences	Problems/Conflicts	Suggested solutions
Other cooks	see reliability and operation of stoves critical			
Stove producer/distributor	don't listen to cooks needs			
Government officials	show little interest in their problems			promote socio-economical advantages of improved stoves
Programme officers		Promote participatory development		
Institutional resp. business owners	try always to save money on food and fuel, pay bad salaries			Illustrate fuel saving potential of improved stoves
Kitchen builder	give no specific consideration to kitchen design			
Fuel suppliers	Fuels are not properly processed/ harvested			demonstrate the advantage of selling proper processed fuels

After you have visited representatives of each participating target group, you can enter all the results in a matrix as found on page 78. The matrix can be used for the illustration of relationships, positive receptions, problems/conflicts and suggested solutions. This matrix can be used to verify or plan your programme concepts and activities.

Problems/conflicts perceived:	Other Cooks	Stove producer/distributor	GO officials	Programme responsables	Institutional resp. business owners	Kitchen Builder	Fuel suppliers
Cooks	reception of hygiene, smoke and time problems	see reliability and operation of stoves critical	show little interest in their problems	don't listen to cooks needs	try always to save money on food and fuel, pay bad salaries	kitchen has low priority	Fuels are not properly processed/ harvested
Stove producers	no interest in new products	high competition	try to tax everything	disturbe markets w/subsidised products	can't pay immediately for stoves	no provision for chimneys	offered size of fuels
GO officials	little or no concern, cooks are difficult to deal with	charge government purchases more than necessary	little interministerial cooperation	programmes tend to ignore government policies	fear dependencies of institutions/ enterprises on subsidies	don't follow standards for buildings	cut wood illegally and are difficult to control
Programme responsables	low awareness of fuel consumption & health risks of cooking	high profits, little interest in low number production	not enough support during the implementation of programmes	little cooperation and coordination of programmes	only interested in economic advantages	no education in proper kitchen design	object activities to save biofuels
Institutional resp. business owners	fear low reliability of food supply	little information about existing range of products	fear of controlling their budets/ income	little understanding of institutional constraints	competition for government subsidies/customers	expenditure on materials and space	highly varying fuel quality
Kitchen builder	cooks have no plan on kitchen construction	no standardised products available	no standards on kitchen design	give not enough consideration to kitchen design	kitchen design has little priority	little innovation	storage required for marketed fresh cut fuel
Fuel suppliers	demand only for harvested woods	little communication	fear sanctions for fuel harvesting	fear that fuel saving programmes effect business	depend on the purchase of large-scale customers	little/no conflicts	high competition limits possible profits

ANNEX III

Technical Glossary

<i>amortisation</i>	pay-back-period
<i>baffle</i>	an obstruction in a pathway in order to direct or regulate fluids and their velocity
<i>biofuel</i>	processed and unprocessed renewable biomass fuels (wood, manure, agricultural waste, charcoal)
<i>break-even-point</i>	the point at which an investment becomes profitable
<i>channel type</i>	type of convective heat transfer, the hot gas is forced up through a narrow channel over a longer distance, e.g. alongside the pot
<i>combustion</i>	the action or process of burning
<i>combustion chamber</i>	fire-box
<i>conduction</i>	the transmission of heat from particle to particle of a substance
<i>convection</i>	the transportation of heat by the movement of a heated 'generally liquified or gaseous' substance
<i>commercial approach</i>	A partly mechanised production by industry, workshops or stove professionals who earn their money through the production/installation of stoves and market their services through existing local infrastructure
<i>controlled kitchen test</i>	also known as standard-meal-test compares the specific wood consumption during the preparation of a regular meal representative for a region or a country
<i>damper</i>	door or flap, used to control the flow or draft of air
<i>efficiency</i>	the ratio of effect obtained divided by the effort spent
<i>emissions</i>	the release of gases, liquids or particles in an environment
<i>ergonomy</i>	the science of limiting stress during physical work
<i>excess air</i>	surplus air, which exceeds the necessary air volume for combustion
<i>exhaust gas</i>	the gaseous product of combustion
<i>exposure time</i>	the time somebody is exposed to a pollutant
<i>grate</i>	a grid in a stove for the separation of ash and charcoal and for the supply of primary air
<i>heating value</i>	energy content of a fuel
<i>heat transfer</i>	the way heat is transported from source to target, e.g. through radiation, convection, conduction

<i>hood</i>	open exhaust system to guide smoke out of a room
<i>indoor air pollution</i>	the concentration of toxic combustion substances produced and emitted while burning wood, dung, straw and other bio-masses which pollute the breathing air of those persons near the fire place
<i>joule, J,kJ</i>	unit for energy, heat 1 J = 1 Ws
<i>jet type</i>	type of convective heat transfer, the gas is forced through a short narrow channel under the pot
<i>pollutants</i>	harming or toxic substances released by a source
<i>power range</i>	range of energy released in a given time
<i>radiation</i>	the action of expanding rays of light and heat
<i>self-help approach</i>	the stove users, e.g. women are guided to make improvements by themselves
<i>subsidies</i>	granted support, in cash or in kind
<i>watt, W, kW</i>	unit for power, (energy released in a given time) 1 W =1 J/s
<i>water boiling test</i>	test used to compare the technical efficiency of stoves, where a specific amount water is brought near boiling-point
<i>wood consumption test</i>	to assess the actual wood consumption for energy use in the field

ANNEX IV

Bibliography

- Adam, C: *Burundi Institutional Peat Stove Programmes. Boiling Point 1986.*
- Association Bois de Feu*, Manuel pour réaliser des enquêtes de consommation de combustibles en milieu domestique, Aix-en-Provence, Paris 1986
- Baldwin, S.*: Biomass Stoves, 1987, Princeton, Volunteers in Technical Assistance
- Kenya study on woodfuel*, 1984, Beijer Institute, New York.
- Bellerive Foundation*, "Guide-To fuel efficient cooking systems designed and manufactured by ", 1993, Edgware, United Kingdom.
- Birkle, M.*: Meßtechnik für den Immissionsschutz, 1979, München, Oldenburg Verlag.
- FWD*: ' China Centre of Rural Energy Research and Training' - No.1 October 1989.
- FAO*, Guidelines for the Monitoring of Pilot Stove Development Schemes, Rome 1985
- FAO*, Guidelines for planning, monitoring and evaluating cookstove programmes, Rome 1990
- HEP/GTZ*, Monitoring Guidelines, 1996, Eschborn
- ILO,ed.*: International Workshop on Rural Energy Crisis, Women's work and Basic Needs. Den Haag, 21-24.4.1986. Geneva 1986.
- Lund Centre for Habitat Studies (LCHS)*, Hidden Fires - Improving Kitchens and Stoves together with Users, Lund 1992
- Joseph S., M Howes*: Guidelines for the monitoring of plot stove development schemes interim version. FAO, 1985.
- Karekezi, S. and Patience Turyareeba*: Smoke in the kitchen. September 1994.
- Micuta*, Modern Stoves for All, 1981, Geneva.
- Otiti, Tom*: Stove Activities in Uganda, FAO 'Stove News' Sept/Oct 1991.
- Otiti, Tom*: Stove notes No. 6, Published by FOOD, Nairobi, Kenya 1991.
- Schneiders, H and F J Mkwawa*: Community Charcoal stoves in Dodoma - Tanzania. Papers No. 7, 10, 12. Tanzania National Scientific Research Council, Dodoma Rural Energy Project, 1985.
- Smith, K.R.*: Biofuels, Air Pollution, and Health, 1987, New York, Plenum Press.
- Sharma S K*: Improved solid biomass burning cookstoves - A development manual. 1993.

Struschka, M.: Schadstoffemissionen von Holzbriketts und Scheitholz, 1992, Stuttgart, Universität Stuttgart.

Subjarwo, A. "The Secret to Good Taste - How to make Surharti Institutional Stove." ,1991, Glow Magazine September Vol.2. Yogyakarta, Indonesia.

Taschenbuch für Klima und Heizungstechnik, 1992, München, Oldenburg Verlag.

Traynor, G.W.: Selected Protocols for Conducting Field Surveys of Residential Indoor Air Pollution Due to Combustion-Related Sources, 1989, Philadelphia, Special Technical Publication.

Turyareeba Patience and Kimani Muirui J.: Testing the efficiency of cookstoves. KENGO Regional Wood Energy Programme for Africa (RWEPA) 1992.

Usinger Jürgen: Indoor Air pollution in rural Tigray. 1993.

Usinger Jürgen: The Bakery Programme - A successful way of food commercialization. 1992.

Usinger Jürgen: Development & Pilot Installation of Improved Stoves, Tamale, Northern Ghana, 1994

Usinger Jürgen: Manual on Basic Techniques for Monitoring Indoor Air pollution and Working Place Standards. 1996.

VITA, Testing the efficiency of wood-burning cookstoves, Arlington, May 1985

Walubengo, D: Institutional stoves in Kenya: The present and future. Boiling Point, August, 1986.

Walubengo, D: Supply of metal for Jikos (stoves) in Kenya. Boiling Point, August 1988.

Walubengo, D. and Joseph, S. 'Wood Energy in Kenyan Institutions',1988, KENGO

WHO: Basic epidemiology, 1993, Geneva,

WHO: Human Exposure Assessment Location, 1986, Geneva.

Wickramagamage, P: Cookstoves in East & Central Africa. Improved Biomass Cookstove Programmes, Country Studies No.5. 1992.

World Bank: ESMAP Study Series: Traditional energy sector in Ethiopia, 1996, Washington

World Bank: What makes people cook with improved biomass stoves?, Washington 1994

World Bank: World Development Report, 1992 - Environment and development. Oxford University Press.

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