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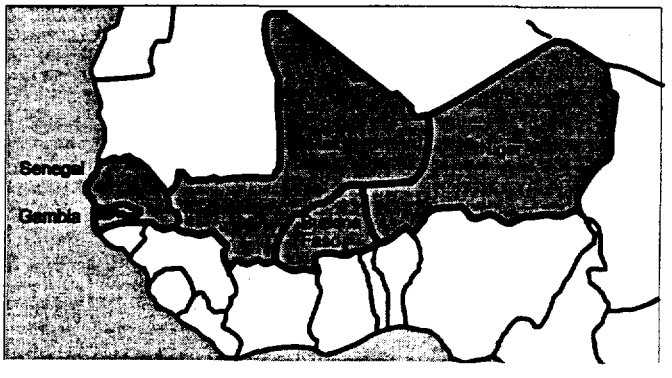
RPTES

Regional Program for the Traditional Energy Sector



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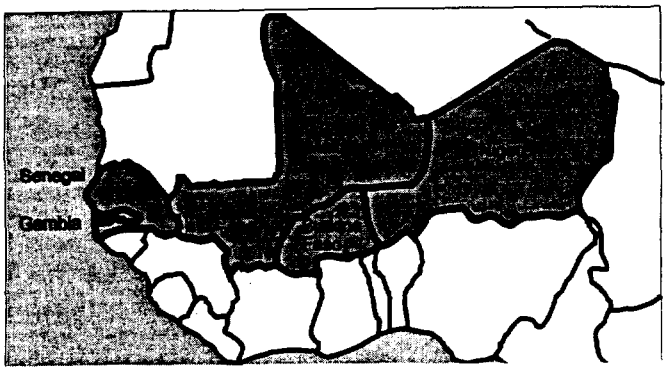
Title / *Titel*

RPTES
Review of Improved Stove and Fuel Substitution Projects



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List of abbreviations

3PA	Trois Pierres Améliorés - improved stove model
AFTPS	Africa Technical Private Sector Division
AFVP	Association Français des Volontaires du Progres
ATI	Appropriate Technology International
CERER	Centre d'Etudes et de Recherches sur les Energies Renouvelables
CILSS	Comité Permanent Interétats de Lutte contre la Sècheresse dans le Sahel; Permanent Interstate Committee for Drought Control in the Sahel
CNESOLER	Centre National de l'Energie Solaire et des Energies Renouvelables
DANIDA	Danish Internation Development Agency
DNAS	Direction Nationale des Affaires Sociales
EC	European Community (now European Union)
FED	Fonds Européen de Développement, European Development Fund (EDF)
FSSTD	United Nations Financing System for Science & Technology for Development
GTZ	Gesellschaft für Technische Zusammenarbeit
IBRD	International Bank for Reconstruction and Development
LPG	Liquefied Petroleum Gas
OPEC	Organization of Petroleum Exporting Countries
PNUD	UNDP
PRG	Programme Régional de promotion de l'utilisation du Gaz butane dans les pays sahéliens
RPTES	Review of Policies in the Traditional Energy Sector
UN	United Nations
UNDP	United Nations Development Programme
UNIFEM	United Nations Women's Development Fund
UNSO	United Nations Sudano-Sahelian Office
UNV	United Nations Volunteers
USA	United States of America
USAID	United States Agency for International Development
VITA	Voluteers In Technical Assistance
WB	World Bank (IBRD)

Executive summary

Introduction

Facing the environmental problems of the Sahel region, the CILLS countries decided in 1986 to allocate at least 60% of the regional funds of the VIth EDF to the struggle against desertification in the Sahel.

Although domestic consumption of woody fuel (firewood and charcoal) is not the single or main cause of desertification, the collection of woody biomass for use as household fuel has a negative impact on the forest cover. In certain areas the decrease in forest cover is striking, and the cause of ever rising concern.

The growth of urban areas has caused the rise of a commercial sector, providing the urban population with firewood. The regional concentration of firewood demand and the lack of government control on the commercialization caused systematic over-exploitation and even destruction of important forest reserves near the cities.

Reducing the household firewood demand is one of the means to relieve pressure on forest resources. Basically, two options exist to reach this objective:

- to reduce woody fuel consumption by introducing better cooking equipment (improved woodstoves), promoting efficient cooking techniques and improving charcoal production efficiencies (improved kilns);
- to substitute woodfuels by promoting other energy sources (such as butane gas, LPG and/or kerosene).

Over the last two decades a large number of stoves projects have been implemented, comprising one or both of these elements. The general impression is that the projects have not been as effective as expected.

In the Regional Study: Review of Policies in the Traditional Energy Sector (RPTES) of the World Bank's Africa Technical Private Sector Division (AFTPS), a study was initiated to review and analyze stove projects and to identify the reasons for their success or failure.

In early 1994, a consultant[1] undertook a retrospective review of the principal improved wood and charcoal stove projects, fuel substitution projects, and charcoal kiln programs carried out over the last 10 years in the Sahel. The five countries involved in this review were the RPTES sample countries: Niger, Burkina Faso, Mali, Gambia and Senegal.

[1] The mission was carried out and this report prepared by Piet Visser, a domestic energy specialist of BTG, The Netherlands.

Evaluated were nine improved wood and charcoal stove projects, six fuel substitution projects, (including the regional LPG project and the Tchip kerosene stove substitution project in Niger) and four improved charcoal kiln projects in Senegal.

Improved stove programme

The main objective of the **improved stove programmes** was to reduce deforestation through reduction of fuelwood consumption by disseminating improved stoves. The strategy followed generally included a research and development stage, aimed at developing a stove that was adapted to local cooking habits and attractive to the user. In the next stage, the stove was promoted through demonstrations and publicity campaigns, which emphasized the fuel economy and comfort aspects of the improved stoves, with reference to the environmental background. In the urban areas, craftsman were trained on improved stove production techniques (e.g. by using templates); in the rural areas the user herself was trained to construct and maintain her stove.

The average length of the stove programmes was 7 years, spread out over up to 3 phases. The shortest project had a duration of 3 years (1 phase only); the longest project a duration of 11 years (3 phases). At present, most projects reviewed have been completed.
Total budget of the reviewed projects was about 10-12 million US dollars.

On one hand, woodstove and charcoal stove programs in the reviewed countries have been successful: the project goals set in numbers of stoves to be disseminated were met or even surpassed, and (former) project staff members were positive about the results of the projects they were managing;

On the other hand, the impression exists that the final overall effect of the introduction of improved stove has not been as expected, because of the resulting low number of improved stoves in use. Here two principal aspects play a role:

a. the replacement rate of improved woodstoves is low because they do not fulfil their promise to lead to the expected reduction in fuel consumption, generally due to improper use of the stoves.

b. after ceasing project activities, the sales of improved stoves generally declined, because no new promotional activities were undertaken (no new customers)

Recommendations to improve the results of improved wood and charcoal stove project are:

- Woodstove programs should be integrated in overall programs that combat the ecological disaster developing in the sahelian zone. These programs should contain elements on saving and substitution of traditional (woody) fuels.

- Programs should have a clear linkage to related policy-areas, such as forestry, public housing, health, water and sanitation, social welfare, education, etc.

- On an intraregional level, an active exchange of information should be promoted. Periodical meetings on the exchange of information and experience can contribute to this. Efforts developed in one country should not be seen isolated form other countries.

- Programs should from the beginning be carried out in clearly distinguished phases. An example of such approach is given in table ... (project-phasing).

- The program set-up should take the following factors into consideration:
  a. Reducing firewood demand should be the overall objective. All other objectives should be related to the overall objective;
  b. Strategy should contain a differentiation towards target groups:
     - lowest income groups: fuelwood saving through energy saving cooking techniques;
     - low income groups: cooking techniques and improved stoves
     - low-middle income groups: introduction of improved stoves and kerosene as a substitution fuel
     - middle and high-income groups: LPG as a substitution fuel.
  c. Development of improved stoves should be based on the knowledge present at the target groups. End-users should participate in project priority assessment and the (technical) development of improved stoves;
  d. Dissemination of improved stoves and substitution fuels should be accompanied by an extensive information and awareness campaign on their correct use;
  e. Adequate monitoring systems should be set up, which permit a continuous evaluation of it's results and impacts, all over the chain of firewood commercialization and consumption;
  f. Sales and taxation policies on firewood, charcoal, substitution fuels and stoves;
  g. A follow-up phase, providing funds to continue publicity, monitoring and evaluation activities, as well as continuation of promotion activities through a limited number of channels (schools, churches).

- In order to avoid duplication of efforts, promotion of improved cooking techniques should be executed through existing programs on education, nutrition, health, women, credit funds, water and sanitation, social reforestation, etc, through schools, churches and projects. In order to provoke the desired mobilization, the energy project's activities

should aim at training and motivation of promoters, teachers and other staff of these organizations.

The Sahelian Regional Butane Gas Program

Main objective of the **Regional Butanization Program** of CILSS was to promote the use of butane gas as a cooking fuel in urban centres in order to stop the progressive exploitation of forests for firewood. Funds were put at the disposal of the national governments of the CILSS member countries to be spent at their judgement on the production and/or purchase of equipment (gas bottles, burners and supports), the purchase of fuel (butane gas) or to subsidize equipment and/or gas. Equipment and fuel were to be made available to the urban population in cooperation with the gas importing petroleum companies: Shell, Total, Mobil and smaller local companies. Loans were provided to the petroleum companies in the form of capital or equipment (gas bottles). The petroleum companies took care of the (re)filling of the bottles and the sale of bottles and other equipment. These loans, with a modest interest of 2.5%, were returned to the project in monthly terms, and formed a revolving fund. In the case of gas subsidies the money did not flow back to the project and eventually the government of the country concerned had to find its own funding to maintain the subsidy. Generally this was done by increasing the tax on other petroleum products, such as gasoline and diesel fuel.
The gas stoves were promoted through demonstrations and publicity campaigns, which put emphasis on the comfort and modernity aspects of the new stoves. Usually, reference was made to the environmental reasons to substitute woody fuels. The average length of the country programs in was three years.

Except for Gambia, the project goals set in terms of numbers of stoves to be disseminated and quantity of gas sold, were not met, although in Burkina Faso, Senegal and Mali reasonable results were obtained. In absolute numbers, gas consumption and market penetration in Senegal is much higher than in the other countries, because the introduction of butane gas as a household fuel for the poor households started already in 1974.

For the Regional Gas Programme it can be concluded that:

- The duration of a three year project is far too short to reach all of the urban population in the Sahel. Only in Senegal, where gas was introduced almost a decade before the start of the CILSS program, other cities outside the capital were reached in the butane promotion programme. In the other countries it was but a start of a process, which now risks to be frustrated by the recent devaluation.

- The limited number of disseminated stoves is partly due to a lack of infrastructure; in particular disruptions in supply of gas and equipment. On the other hand the limited number of stoves disseminated does not justify large investments in an

improved LPG infrastructure like storage capacity, bottling plant etc., and certainly not on a national level.

- The introduction of butane, as a strategy to reduce woody fuel consumption in the urban areas of the reviewed countries, can be of interest for the population of a certain (middle and high-income) group. Gas is a relatively expensive fuel, and investment costs (bottles and gasstoves) and the refill costs make it beyond reach of low-income groups;

- Gas prices differ between the five countries: In Senegal, gas subsidies make operational costs for gas and wood cooking similar, while in the other four reviewed countries gas prices make cooking on gas twice as expensive as cooking on wood;

- The introduction of liquid gas requires time: In Senegal, were gas was introduced to the urban population during the early eighties, a substantial part of domestic energy supply is covered. In the other countries, the short period since introduction (two-three years) has been too short to reach a major part of the urban population. On the other hand, even in countries like Niger and Mali, where only a small part of the population has switched to gas consumption, the effect on wood fuel demand is comparable to a major improved stove program;

- The recent devaluation of the F.CFA may have a negative impact on the dissemination of LPG as a cooking fuel: the relative price gap between gas and firewood has increased, and investment costs for purchasing gas bottles and cookers, both imported, are now even further out of reach than before. In order to overcome this, a major effort should be done to establish the local production of gas bottles and burners

The Niger kerosene "Tchip" stove project

The main objective of the Projet Energie II - Energie Domestique (PEII-ED) project in Niger, of which the Tchip kerosene stove project is a main component, is to create a diversification of household energy fuels, to stabilize the woodfuel consumption of the urban population at the 1989 level and to gain effective control on the woodfuel demand in the cities.

For the Tchip kerosene stove project the kerosene wick burner was imported from Indonesia and the supporting structure was made locally. Initially the burners were imported directly by the project, but soon this activity was taken over by a private entrepreneur. There entrepreneur also installed a workshop for the production of the supports and a network of selling and service points for the Tchip stove. The kerosene stoves were promoted through demonstration and publicity campaigns, which emphasized the fuel economy, comfort and

modernity aspects of the new stoves, referring to the environmental background of the problems.

For the Tchip project is can be concluded:

- By the end of 1993, finalizing the Energie II project, 8000 kerosene stoves had been imported of the possible 24.000, including the 4000 burners imported by the project. The single reason for this poor performance is the lack of adequate financial management by Tchip-import;

- To date, all imported Tchip stoves have been sold without problems. Publicity campaigns have been successful, the Tchip stove is widely and well known, and there are sales points in every neighbourhood. At first, negative consumer reactions have been observed, concerning the (high) fuel consumption and the requirement to replace wicks frequently;

- To stabilize woodfuel consumption in Niamey in 1993, the total wood-saving capacity of sold improved wood, kerosene and gas equipment is approximately 6,000 tonnes of fuelwood. In practice, it was estimated that 3900 tonnes were economized (PEII-ED, 1993), of which 2,300 tons result can be contributed to the use of Tchip stoves.

- Project sustainability depends to a very large extent on the availability of burners. If they can no longer be imported, the success of the stove project depends on the creation of local production facilities. Production of burners is technically not very complicated, but not an easy job either, especially under African conditions and without prior production experience.

- The negative consumer feedback should be taken into account. The high kerosene consumption can be taken care of by using a less powerful burner, or by better training in the use of the actual burner

- In the case of involvement of the private sector, a good and legally sound contract should be drawn up so that some level of control and correction is possible in case the entrepreneur shows to be unable to manage his business. Stove activities should be separated from other commercial activities in order to avoid priority problems.

- The devaluation of the F.CFA will have an important impact on the price of the Tchip stove. Madon (1993) estimates that after devaluation the stove will cost 18.000 F.CFA (imported from Indonesia) and 13.000 F.CFA if locally produced.

- The price of kerosene is also likely to increase. The price will probably reach 200 F.CFA/l shortly.

- Both factors can cause the costs of cooking with kerosene to increase with 50 to 100%. Up to now, in spite of the devaluation, the costs of cooking with wood have hardly increased, what makes kerosene less attractive and less affordable.

The "Casamance" improved kiln program (Senegal)

The main objective of the Casamance Improved Charcoal Kiln Programme in Senegal was to improve the yield of charcoal making in Senegal through the introduction of the Casamance kiln and the training of charcoalers in its use.

During the implementation of the programme 700 charcoalers were trained in the use of the Casamance kiln. Today an estimated 350 of them still use the Casamance kiln. Apparently the investment for the metal chimney is the bottleneck in the system, as long as there was financial assistance to buy chimneys. As long as there was financial assistance to buy chimneys and other equipment, charcoalers tended to keep using the Casamance kiln. But as soon as they needed to invest themselves in new equipment the tended to return to the traditional kiln. Whether the additional profits of the Casamance kiln weren't apparent enough to make the investment for the chimney themselves or that the financial means were lacking, is not clear.

No data were available to the mission on how much charcoal has been produced by the charcoalers trained in the use of the Casamance kiln, nor about the amount of wood saved.

It has proven difficult to organize the charcoalers in the Casamance kiln project and this lack of organization and structure has obstructed financing and training facilities, as well as project sustainability. Therefore, the implementation of improved kilns might be more successful in the settings of more general programs, that also promote the organization of the target population.

Table of contents

Introduction

Facing the environmental problems of the Sahel region, the CILLS countries decided in 1986 to allocate at least 60% of the regional funds of the VIth EDF to the struggle against desertification in the Sahel.

Although domestic consumption of wood fuel (firewood and charcoal) is not the single or main cause of desertification, the collection of woody biomass for use as household fuel has a negative impact on the forest cover. In certain areas the decrease in forest cover is striking, and the cause of ever rising concern.

The growth of urban areas has caused the rise of a commercial sector, providing the urban population with firewood. The regional concentration of firewood demand and the lack of government control on the commercialization caused systematic over-exploitation and even destruction of important forest reserves near the cities.

Reducing the household firewood demand is one of the means to relieve pressure on forest resources. Basically, two options exist to reach this objective:

- to reduce woody fuel consumption by introducing better cooking equipment (improved woodstoves), promoting efficient cooking techniques and improving charcoal production efficiencies (improved kilns);
- to substitute woodfuels by promoting other energy sources (such as butane gas, LPG and/or kerosene).

Over the last two decades a large number of stoves projects have been implemented, comprising one or both of these elements. The general impression is that the projects have not been as effective as expected.

In the Regional Study: Review of Policies in the Traditional Energy Sector (RPTES) of the World Bank's Africa Technical Private Sector Division (AFTPS), a study was initiated to review and analyze stove projects and to identify the reasons for their success or failure.

In early 1994, a consultant[2] went on mission to five of the CILSS countries to undertake a retrospective review of the principal improved wood and charcoal stove projects, fuel substitution projects, and charcoal production programs carried out over the last 10 years in the Sahel. The countries visited were Niger, Burkina Faso, Mali, Gambia and Senegal.

[2] The mission was carried out and this report prepared by Piet Visser, a domestic energy specialist of BTG b.v. (The Netherlands)

Based on interviews with (ex-) project staff, on the RPTES country studies and on a review of the most important evaluation reports, improved wood and charcoal stove projects, fuel substitution projects, (including the regional Butane Gas project and the Tchip kerosene stove substitution project in Niger) and improved charcoal kiln project in Senegal were evaluated.

The terms of reference for the mission mention a number of aspects that should be specifically addressed, including (See Annex 1 for the complete TOR):

- project organization and management
- specific technologies
- targets and achievements
- dissemination strategies
- current status and sustainability
- principal reasons for success or failure

The five weeks of the mission, from March 12 to April 13, have been equally divided over the five countries. In each country a work program was set up in collaboration with the RPTES country team and officials from the selected projects were interviewed.
From the projects visited a general picture arises, because most projects have more in common than that they differ in concept, execution and follow up. For a number of the aspects mentioned above however, a distinction should be made between rural and urban projects.
The underlying report tries to present a synthesis of the structure, execution and results of these projects.

All prices in C.CFA mentioned in this report are from before de devaluation in 1993, unless stated differently.

The first chapter deals with the improved wood and charcoal stove programs and presents a generalization of "the Sahelian Stove Project".

Chapter two deals with the butane gas programs in the five countries and the third chapter will consider the kerosene wick stove project of the Energy II program in Niger.

The only country of the sample where charcoal is used and produced on a large scale is Senegal. Chapter 4 gives a short summary of the Senegalese charcoal kiln projects.

1 REVIEW OF THE IMPROVED WOODSTOVE PROGRAMS

In this part of the report a general picture will be presented of "the Sahelian Improved Stove Project". From the interviews held with the representatives of the different stove projects, the picture arises of projects that have more in common than that they differ in concept, execution and follow-up. The information will be structured according to the main aspects suggested in the Term of Reference for the mission. When necessary a distinction will be made between rural and urban projects.

1.1 Improved woodstove programs - underlying rationale and justification

Facing the environmental problems of the Sahel region, the CILSS[3] countries decided in 1986 to allocate at least 60% of the regional funds of the Sixth European Development Fund (6-EDF) to the struggle against desertification in their countries, and although domestic woody fuel consumption (firewood and charcoal) is not the single or most important cause of desertification, it has a negative impact on the wood-covered area of the region. In certain zones, the wood deficit is striking, and the cause of ever rising concern.

The growth of the cities has caused the establishment of a commercial sector to provide the urban population with firewood. Concentrated firewood collection and the absence of government control on the commercialization caused systematic over-exploitation, even destruction, of an significant share of the forest reserves close to the cities.

Reduction of the firewood demand is one of the means to relieve the pressure on the forest resources and contributes to the struggle against the environmental degradation of the sahelian zone.

Basically, two options exist to reach this objective:

- On the supply side:
  - to increase the production of firewood, through better forest management, re-plantation and commercial wood production;
  - to substitute woody fuels through the introduction and promotion of other energy sources, such as butane gas, LPG and/or petrol.
- reduce woody fuel consumption, by introducing better cooking equipment (improved woodstoves), disseminating more efficient cooking techniques and improving charcoal production efficiencies (improved kilns);

In the Sahelian zone numerous projects were started to reduce woody fuel consumption by the rural and/or urban population. The five countries reviewed in this study, multiple projects were counted on this theme, while the present review will consider 18 projects and

[3]The nine CILSS countries include: Burkina Faso, Cape Verde, Chad, Gambia, Guinee-Bissau, Mali, Mauritania, Niger and Senegal. Five of these countries are covered in this study.

programs, executed in the period between 1980 and 1994. Amongst these eighteen were programs on development and dissemination of improved woodstoves, charcoal stoves and kilns.

Fig. 1 presents a cause-effect scheme in the context of domestic energy programs.

The principal problem for our concern is mentioned in the bold printed box "*increasing firewood demand for domestic purposes*, and the three main causes of this problem:
- Lack of alternative fuels at reach to the people
- Inefficient use of woody fuels, and
- Corrective actions are little effective and not sustainable.

Indications exists that efforts realized to correct the problems were not very successful: The actions undertaken by the projects were not as effective as expected, were not efficiently undertaken and the effects were not very lasting, while users of the stoves seem to be only partly satisfied, which is expressed in the low replacement rate of improved stoves: users do not replace their improved stove by a new one.

How does these problem occur, and how have projects dealt with them. Which actions were undertaken to correct them, which of them were successful and what lessons were learned?

1.2 Program objectives and strategies

Table 1 resumes the objectives of the reviewed programs. In general, the objective is to alleviate the serious deforestation problems and it's climatic consequences this zone is suffering from. Most projects adopted specific objectives, derived from this final goal: research and development of improved stove models and/or the commercialization (i.e. production and dissemination) of stoves. Two programs mentioned the improvement of the conditions of women and/or children as a specific objective.

In order to comply with these objectives, the programs adopted the following strategies:

research and development
- *research and development* of improved stoves through local research institutes,
- *monitoring* of consumers reactions and satisfaction with the product

production
- *training and technical assistance* to local craftsmen, to stimulate the commercial production of improved stoves
- *monitoring* of production quality
- *direct support*, through initial working capital and credits

dissemination
- *communication* for creating awareness in sahelian society on the deforestation problem and the role of improved woodstove programs in these, through television

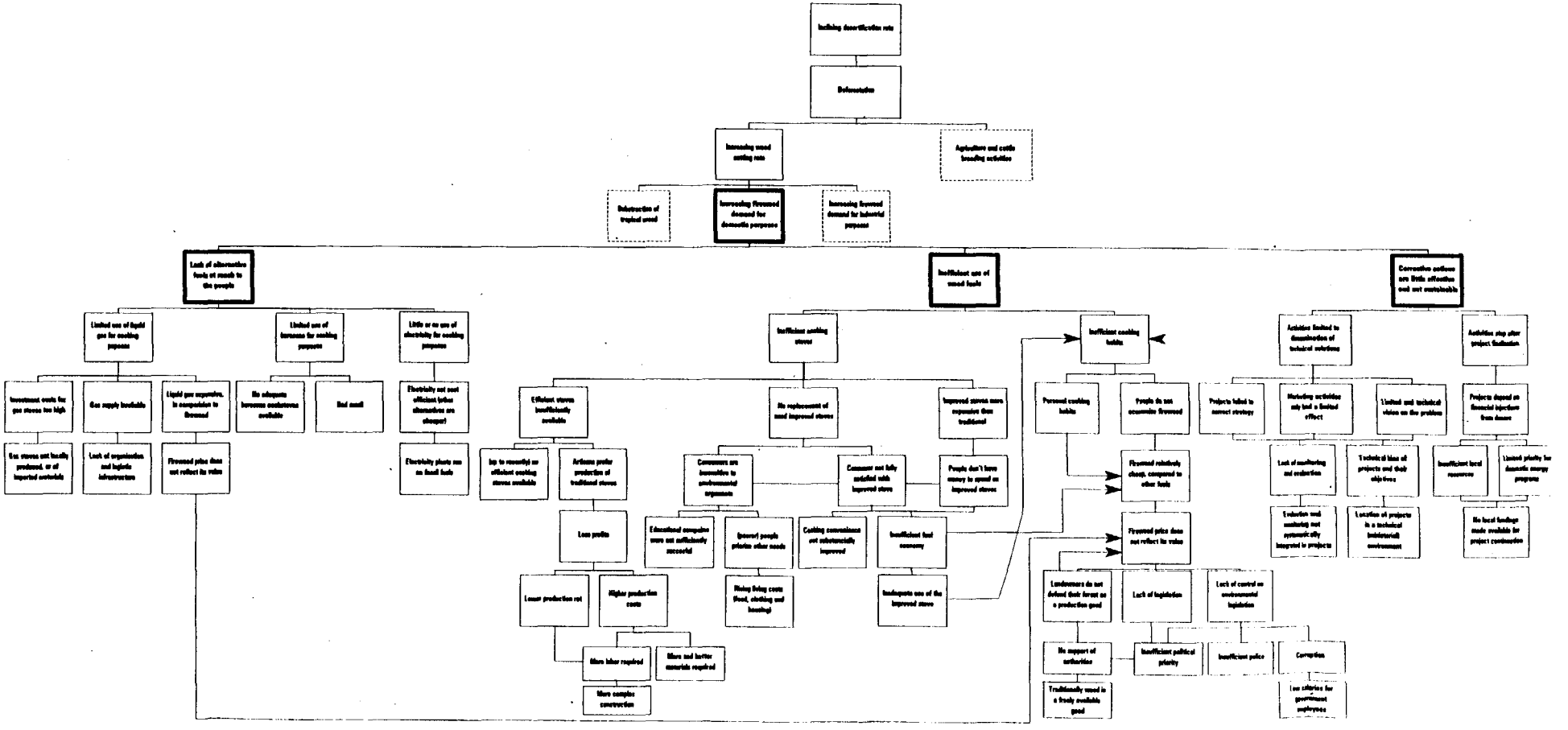
Inclining desertification rate
Deforestation
Increasing wood cutting rate
Agriculture and cattle breeding activities
Deforestation of tropical wood
Increasing firewood demand for domestic purposes
Increasing firewood demand for industrial purposes
Lack of alternative fuels at reach to the people
Inefficient use of wood fuels
Corrective actions are little effective and not sustainable
Limited use of liquid gas for cooking purposes
Limited use of kerosene for cooking purposes
Little or no use of electricity for cooking purposes
Investment costs for gas stoves too high
Gas supply inadequate
Liquid gas expensive, in comparison to firewood
Use stoves not locally produced, or of imported materials
Lack of organization and logistic infrastructure
Firewood price does not reflect its value
No adequate kerosene cookstoves available
Fuel small
Electricity not most efficient (other alternatives are cheaper)
Electricity plants run on fossil fuels
Inefficient cooking stoves
Efficient stoves inefficiently available
Up to recently no efficient cooking stoves available
Artisans prefer production of traditional stoves
No replacement of used improved stoves
Consumers are insensitive to environmental arguments
Educational campaigns were not sufficiently successful
(poorer) people priorize other needs
Rising living costs (food, clothing and housing)
Consumer not fully satisfied with improved stove
Cooking convenience not substantially improved
Improved stoves more expensive than traditional
People don't have money to spend on improved stoves
Inefficient fuel economy
Inadequate use of the improved stove
Loss profits
Lower production rate
Higher production costs
More labor required
More and better materials required
More complex construction
Inefficient cooking habits
Personal cooking habits
People do not economize firewood
Firewood relatively cheap, compared to other fuels
Firewood price does not reflect its value
Landowners do not defend their forest as a production good
Lack of legislation
Lack of control on environmental legislation
No support of authorities
Traditionally wood is a freely available good
Inefficient political priority
Inefficient police
Corruption
Low salaries for government employees
Activities limited to demonstration of technical solutions
Activities stop after project finalization
Projects failed to correct strategy
Marketing activities only had a limited effect
Limited and technical vision on the problem
Projects depend on financial injections from donors
Lack of monitoring and evaluation
Technical bias of projects and their objectives
Insufficient local resources
Limited priority for domestic energy programs
Evaluation and monitoring not systematically integrated in projects
Location of projects in a technical institutional environment
No local funding made available for project continuation

Table 1 Objectives and targets of the reviewed projects

Project	Country	Objective	Quantitative targets
WS1	Niger	Reduction of firewood demand	20,000 stoves in Phase I
WS2	Burkina Faso	Stove development (I) Reduce wood consumption (II) Develop forestry actions with women (III)	120,000 stoves
WS3	Mali	Stove dissemination	25,000 stoves (I) 100,000 stoves (II)
WS4	Mali	Stove development Stove dissemination, urban training of craftsmen	
WS5	Mali	Stove development, rural Stove dissemination, rural	
WS6	Mali	Reduce wood consumption Improve conditions of women	5,000 stoves 20 craftsmen trained
WS7	Gambia	Stove development Stove dissemination Improve conditions of women and children	
WS8	Senegal	Stove dissemination	500,000 stoves 10,000 craftsmen trained
WS9	Senegal	Reduce charcoal consumption	-

and radio spots

- *promotion* of improved stoves, through publicity campaigns, demonstrations, etc.
- *direct support*, through subsidies, etc.
- *monitoring* of sales and consumers satisfaction

domestic energy policy

- *pricing and taxation*
- *legislation* on (de-)forestation and wood commerce

In practice, each project has developed and adopted its proper mix, according to its specific objective. Also the applied strategy mix may have varied by project phases.

1.3 Project Organization and Management

1.3.1 Funding and donor coordination

Donor countries that have financed the stove programs reviewed include Denmark, Norway, Germany, the USA, the European Union and the OPEC fund. Financing has been channelled through development agencies like the World Bank, GTZ, USAID and UNSO.

Donor finance was basically used for local and expatriate personnel, cars, equipment and materials. Also demonstration activities, promotion and publicity activities were paid from external funds.

Table 2 Executing organizations and donor funding

Project	Executing organization		Expatriate organization		Donor
WS1	Min. of Energy and Mining, Dir. of Energy	Govern.	GTZ	Dev. Agency	WB, GTZ
WS2	Ministry of Environment and Tourism	Govern.	-		Sweden, UNSO
WS3	Direction Nationale des Affaires Sociales	Govern.	GTZ	Dev. Agency	GTZ
WS4	CNESOLER	Res. Inst.	VITA	Techn. Assist.	USAID
WS5	CNESOLER	Res. Inst.	?	Dev. Agency	USAID
WS6	Ministère des Eaux et Forêts	Govern.	-		Norway, UNSO, UNIFEM
WS7	DCD: Ministry of Econ. Planning and Ind. Dev.	Govern.	UNDP	Intern. Agency	Denmark, UNSO
WS8	CERER	Res. Inst.	-		Denmark, UNSO, USAID, OPEC
WS9	ATI (Appropriate Technology International)	NGO	-		USAID

Govern.	Governmental organization	Intern. Agency	International Agency
Res. Inst.	Research institute	Dev. Agency	Development Agency
NGO	Non Governmental org.	Techn. Assist.	Technical Assistance Agency

The contribution of the local governments consisted in general of local personnel, office space and the cooperation of governmental organizations like research institutions.

Projects were generally financed by one single donor. In the rare case of a co-financing one of the donors only contributed to the funding, without further participation in the execution of the project. Sometimes several subsequent phases of a project were financed by different donors. In some projects assistance was provided by voluntary organizations like Peace Corps, AFVP, EU, UNV, etc.

1.3.2 Length and phasing of activities

The average length of the program periods was 7.2 years, mostly spread over several project phases. The shortest project had a duration of 3 years, the longest a duration of 11 years over 3 phases. To date, most projects reviewed have been terminated. Some continue on

Table 3 Project duration

Proj.	Start	End	Duration	Phases	Budget
WS1	1985	1993	9	2	FCFA 90,000,000 (I) DM 744,000(II)
WS2	1984	1992	9	3	US 238,000 (I) US 860,333 (II) US 2,416,440 (III)*
WS3	1988	1998	11	3	FCFA 640 mln (I) FCFA 640 mln (II) FCFA 640 mln (III)
WS4	1986	1988	3	1	US 482,000
WS5	1980	1985	6	1	US 4,000,000*
WS6	1988	1991	4	1	US 212,000
WS7	1982	1991	10	2	US 1,300,000
WS8	1980	1988	9	2	FCFA 770,000,000
WS9	1991	1994	4	1	US 340,000

* Woodstove project forms part of a larger project

residual funds of the official project budget, but on a very limited scale. Only one wood stove program is likely to continue, the DNAS/GTZ program in Mali on new GTZ funding. Proposed is a three year continuation with an additional 2 years of follow-up activities.

1.3.3 Linkage to regional programs and experiences

The linkage of individual stove projects to other stove programs in the region is very low. The common factor in the different projects originated from the recommendations done by CILLS following the international CILSS/FSSTD seminar of Ouagadougou in 1984 [CILSS, 1984]. There the Improved Three Stone Fire (3PA = Trois Pierres Améliorés) and the cylindrical sheet metal stove (Ouaga Métallique) were recommended as the preferred stoves to be disseminated in rural and in urban areas respectively. Also, thanks to the Ouagadougou seminar, the set up and organization of the projects is very much alike.

1.3.4 Institutional framework: actors and roles

local counterpart organization

National counterparts for the donor organization or executing agency in a stove project were governmental organizations, such as ministerial departments, research centres or, in one case, an NGO (see Table 2). The project coordinator, generally from the energy department, is responsible for project management, together with expatriate counterparts.
Stove testing and demonstrations are performed in cooperation with a national stove research centre, often a department of a national research centre on renewable energies.
For stove promotion in many cases (women) promotion teams are formed and trained, while for the promotion campaigns, and especially for the production of mass media spots, most projects have been assisted by professional publicity agencies.
Statistic offices are contracted for realizing monitoring surveys on culinary habits, kitchen equipment and consumer satisfaction.

international technical assistance

In most projects technical assistance was provided by expatriates. Sometimes a stove technician, sometimes also a sociologist and/or a marketing specialist, sometimes both. One expatriate technician normally was resident for the duration of the project, others came on shorter (one to three months) missions.

Stove technicians assisted in testing and adaptation of the stoves to local habits and cooking equipment, the training of the artisans in stove production and the execution of stove demonstrations. The sociologist and/or marketing specialist assisted in the information campaigns, the consumer and market surveys and the organization of the stove demonstrations.

private sector

In the urban components of the stove projects the informal private sector played an important role as the producer of the stoves. Stoves were made from scrap metal by informal sector artisans. While these artisans usually operated in small self owned shops, sometimes more organized, larger, informal outfits participated in the production of improved stoves. Most projects have assisted the artisans with credits to assure a sufficient supply of steel sheet for the production of the improved stoves. Setting up an organizational structure for the artisans was a part of the proposed goals of the DNAS/GTZ project in Mali.

The private sector also played a role in the commercialization of improved stoves, again in the urban areas. Artisans sold the stoves at their workshops, but these are normally centralized at markets or in a quarter of town. To make stoves more widely available, merchants order and buy the stoves from the artisans and sell them in the other quarters. In Mali, in order to stimulate the availability of stoves in the different quarters of towns, the project gave credits in kind in the form of stoves, to merchants that operated in those neighbourhoods.

1.4 Adaptation of the stoves

1.4.1 Technological criteria and benchmarks

For a description of technologies, a distinction must be made between urban and rural applications. For both categories, however, basic technology is the same: stoves are closed with a shield to protect the pan against wind and to improve heat transfer between pan and fire, resulting in stoves that cook faster and use less fuel. Based on this technology a number of improved stove types was developed in the Sahel by different research centres.[4]

At the CILSS meeting in 1984 recommendations were made on the stove models to be considered for dissemination. The Improved Three Stove Fire, or 3 PA, was recommended for rural areas, and the portable Ouaga Métallique for urban applications.

Three technical parameters characterize the performance of an improved woodstove: power output, efficiency and fuel consumption. See Annex 6 for a more elaborate discussion.

efficiency: The efficiency is the ratio between the heat absorbed by a water pan and the total energy released by the fuel under the assumption of complete combustion.Efficiency varies with the power output.

power output: Maximum power output together with the efficiency determine the time required to bring the content of a pan to the boil; minimum power output determines the fuel consumption for the simmering phase of the cooking process.

[4] ONERSOL in Niger, IBE in Burkina Faso, CNESOLER/LESO in Mali, CERER in Senegal and the test centres in Bekama and Mansakonko in Gambia

fuel consumption: Fuel consumption is the amount of wood needed for the preparation of a standard meal, such as a local main dish compared to the fuelwood consumption with a traditional stove.

For comparison of different stoves the fuel composition is compared to the fuel consumption of a traditional stove (*fuel economy*). For the determination of *energy economy* fuel consumption of alternative fuels is compared to fuel consumption with traditional fuel.

1.4.2 Improved stoves for urban markers

The CILLS recommendation for urban areas was the Ouaga Métallique, the Sahelian adaptation of the shielded fire (Fig. 2). Reason for the choice of this stove was that is was adapted to Sahelian cooking habits and easy to make from scrap metal by local artisans using existing production technologies. Tests in several Sahelian stove laboratories had shown a fuel economy of at least 30% compared to the traditional stoves or open fires. (see, i.e. GTZ (1994)). The Ouaga Métallique model was introduced by a number of projects, with slight adaptations, under different local names.

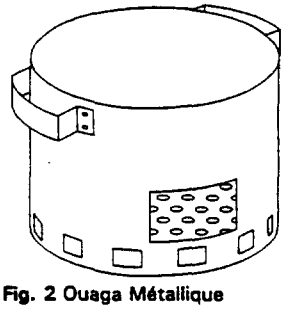

Fig. 2 Ouaga Métallique

One of the disadvantages of the Ouaga Métallique model, as was felt by the users, was the limitation that it could only be used with one size of pan. Several projects therefore developed a version of a MultiMarmite stove that could accommodate several sizes of pans. In addition, in Burkina Faso stoves were developed that could burn both wood and charcoal, the so-called Mixte stoves.

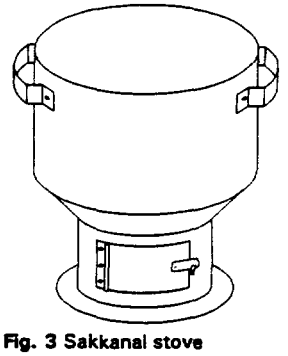

Fig. 3 Sakkanal stove

Of the countries visited, only in Senegal charcoal is the basic urban fuel, and therefore only in Senegal specific charcoal stoves were developed and introduced, called the Sakkanal and the Diambar stoves. The Sakkanal (Fig. 3) is an original Senegalese design while the Diambar is the Senegalese name for the Kenyan Jiko (Fig. 5)

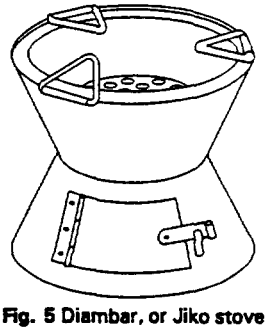

Fig. 5 Diambar, or Jiko stove

Fig. 4 Urban ceramic stove

In the Gambia the Nofly stove, which appears much like the Sakkanal stove, was developed out of the Danish EKO-briquette stove. The Nofly could burn briquettes from peanut shells as well as wood. This stove was made in a semi-industrial way and the production involved welding. Originally it was made from new steel

sheet, but this proved to be too expensive and the sheets of old oil drums became the construction material. At first only the Nofly was disseminated, later also the Ouaga Métallique, as a cheap alternative to the Nofly.

Finally projects in Burkina and Gambia have introduced urban ceramic stoves (Fig. 4).

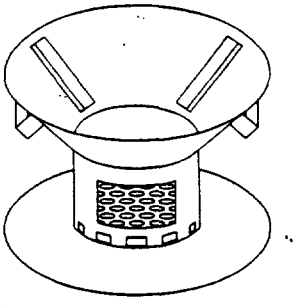

Fig. 6 Example of a Multi-Marmite stove

1.4.3 Improved stoves for rural markets

The CILLS recommendation for rural areas was the Improved Three Stone Fire, or 3PA (Trois Pierres Améliorés, also known in some areas as Cumba Gaye or Al Barka etc, Fig. 7), a mud version of the shielded fire. Reasons for this choice were the close resemblance to the traditional three stone fire, for which it was well adapted to Sahelian cooking habits, and the simple and cheap construction from locally available materials: clay sand and stones, sometimes mixed with cow dung and/or straw. Tests in several Sahelian stove laboratories had shown a fuel economy of at least 30% compared to the traditional three stone fire.

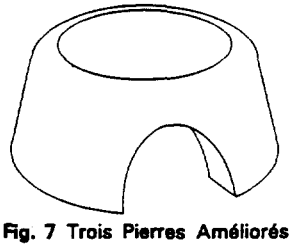

Fig. 7 Trois Pierres Améliorés (3PA)

No efforts have been made (or were necessary) to develop a local model or to adapt the 3PA to local conditions. Besides the 3PA some other mud stoves have been disseminated on a small scale, like models with 2 and three pot holes and models with a chimney (Fig. 8).

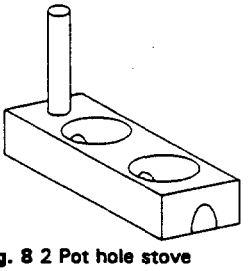

Fig. 8 2 Pot hole stove

1.4.4 Improved stoves and fuel economy

Most projects have tested their stoves by using their country specific utensils and preparing their country specific meals. The potential fuel economy of the improved stoves established by the tests was at least 25% and up to 40% compared to the traditional metal stoves (mainly in urban environments) and open fires (for rural environments). Higher economies, up to 50%, are also reported, but only for gas and kerosene stoves (Bussmann & Visser 1986; Chatain 1988; Visser 1989; Jorez 1991). As explained in the previous paragraph these differences are possible because not al the improved stoves are compared to the same traditional stove. In general, the lower fuel economies origin from comparisons with traditional metal stoves, the higher economies from comparisons with the Three Stone Fire.

Fig. 9 Malgache (Niger, Burkina Faso)

To verify the expected fuel economies, as predicted by the laboratory tests, the actual fuel savings were determined by surveys. In most of these surveys the housewives were asked how much fuel their improved stove saved in comparison to the traditional stove. The outcomes of these surveys tended to confirm the lab results.

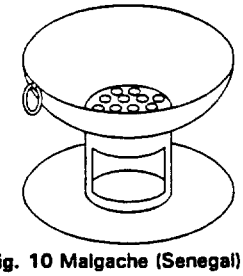

Fig. 10 Malgache (Senegal)

Fig. 9 and Fig. 10 give examples of traditional metal stoves, both called "Malgache".

In only a limited number of surveys field tests were done on fuel consumption:

- In Mali, the GTZ project undertook a socio-economic evaluation of the impact of improved stoves, considering as well the aspect of their proper use. In field tests in Bamako, 42% fuel economy was reached for Teliman (=*Ouaga métallique*) stoves, compared to the traditional three stone fire, provided the stove was properly used. In the same investigation resulted that 57% of the households used their stove properly (GTZ 1994). In this investigation, 30,000 stoves were considered, although no data were given on the sample size (GTZ, 1994).
- In the district of Sofara surveys were conducted, showing 26% fuel economy reached in the city of Sofara, whereas in the villages around this city 36% was reached. In this case, the results reflect the average of field test results. No data were available on the number of stoves considered, nor on the sample size (GTZ, 1994).

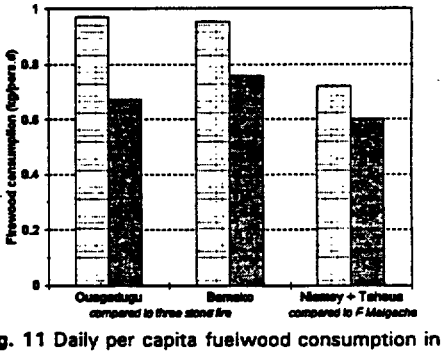

Fig. 11 Daily per capita fuelwood consumption in three capitals (Ouagadougou, Bamako and Niamey) (GTZ, 1994)

- In Niger by the Energy II project, field tests were done on fuel consumption amongst 353 Niamey households, taking into consideration different stoves and fuels. The results of this last survey show wood economies of 7% for families that use only improved wood stoves, to 19 % for combined kerosene and wood users. In this case, the traditional metal stove Foyer Malgache was taken as a reference. In general can be stated, that the fuel wood use per capita in Niger is lower than in other countries (GTZ, 1994), however it is not clear which part of this economy can be contributed to the use of the Foyer Malgache. The fuel economy reached with the Malgache as compared to the traditional three stone fire is has never been determined in field tests(PEII - ED, 1993).

The results from both evaluations show the importance of the proper use of the stove: if users do not employ wood saving cooking techniques, the effect of the introduction of improved stoves will be very limited. Fig. 12 shows in a simplistic model the importance

of cooking techniques ("proper husbandry") for the performance of improved woodstoves. In the same way, the cause-effect analysis presented in Fig. 1 puts emphasis on the dissemination of improved cooking techniques in improved woodstove programs, in order to achieve optimal wood-saving results.

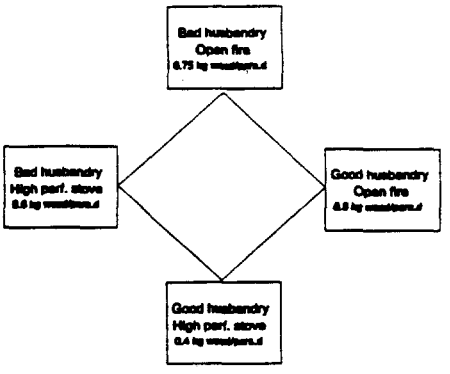

Fig. 12 The importance of cooking techniques on the fuel economy in improved cookstove projects (after: P.J.T. Bussmann, 1988)

1.5 Production of Improved Stoves

1.5.1 Production of improved stoves for the urban markets

Traditionally artisans produce stoves from scrap metal, such as old oil drums, car bodies etc. The artisans work under rather basic conditions: on the ground, sometimes under a small roofing, without workbench, etc.

The stoves were produced using traditional production technology (with hammer and chisel); seaming and rivetting were the (traditional) techniques for making joints. In general, the projects did not pretend to improve quality by the introduction of new or improved tools, with exception of the templates. (As an exception the production of the Gambian Nofly should be mentioned, which was set-up in a semi-industrial way, involving welding).

The urban artisans were trained to produce the improved stoves models by technicians from the projects or from a local research centre, making use of the already installed production capacity. The production was generally based on the traditional production techniques, although some improvements were introduced in order to increase production speed and to improve product quality, such as better materials and templates. Furthermore, much attention was paid to quality control, as the performance of improved stoves depends highly on the accuracy of production.

Finally, projects assisted artisans providing loans for materials and other inputs, in order to guarantee an uninterrupted production (mostly during an initial phase of the project).

1.5.2 Production of improved stoves for the rural markets

The production of improved stoves in rural areas was mainly carried out by the beneficiaries themselves: improved stove projects provided training and technical assistance to interested communities and/or individuals, mostly women.

Training of stove masons in the rural areas generally was done in a top-down approach (see Fig. 13): Project masons were trained by (expatriate) stove experts and/or technicians from the local stove centres. These project masons, in turn, trained district masons, who trained village specialists to assist rural housewives with the construction of their stoves.

This on-site construction was mainly done on request of the beneficiary, who was to provide building materials (mud and clay) and (part of the) labour. During the construction, the beneficiary was not only trained in stove construction, but also in the maintenance.

In order to reach remote areas of the country, some projects installed local project centres and used mobile teams.

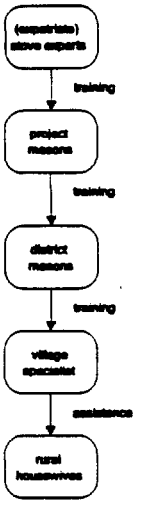

Fig. 13 Rural stove dissemination

1.6 Marketing of Improved Stoves

Marketing played an important role in all stove dissemination projects. Strategies employed were communication (awareness creation), promotion (demonstration, publicity campaigns, credits), monitoring of sales and consumers acceptation and satisfaction. Subsidies were not applied in any of the reviewed projects, except for the Kayes project in Mali.

Before starting dissemination activities, the improved stoves were to be acceptable to the users, specifically women. At the same time, women should be convinced of the use of investing in improved stoves: Prices of these stoves are always higher than of traditional stoves and the potential costumers should be convinced that the extra investment is made up by fuel savings.

In Niger, Mali and Senegal marketing studies were done to establish the housewives' stove preferences in terms of shape and/or colours. At the same time, fuel preference (wood, charcoal, kerosene, gas) and budget for stoves and fuel were surveyed. This was done during stove demonstration meetings where they could express their preferences for a stove out of a number of improved stove models presented to them. The expected economy of the improved stoves, as established in the laboratory tests, was explained and they could indicate what would be an acceptable price for the improved stove.

In all countries household surveys were done to establish an inventory of kitchen utensils and to determine the most frequently cooked meals. This latter data enabled technicians to develop improved stoves adapted to local kitchen equipment and culinary habits, and to

make estimations on fuel savings in laboratory situations, based on the preparation of a local "standard meal".

1.6.1 Communication: Awareness-raising on background problems

Improved stove projects carried out demonstration and information activities to raise awareness about the fuel crisis and its background, about the existence of improved stoves and their role to reduce the pressure on woodfuel resources.

The stove demonstrations were organized in neighbourhoods and villages and during manifestations like fairs, independence days, etc. They were organized in cooperation and coordination with women organizations and/or local governmental or non-governmental organizations. Project teams also gave demonstrations at markets and other places where many people would assemble. In order to get more attention and improve the awareness raising effect, theatre groups and *griots* (traditional African story tellers) were often involved.

During the sessions, improved stoves were presented as a solution to the problem: Meals were prepared on traditional and improved stoves and the difference in fuel consumption and needed cooking time was shown. Explanations were given about the functioning of the improved stoves, and the differences with traditional stoves, on how and why they economize on fuel, time and money, etc. Other advantages of the improved stoves like safety and comfort were also brought to the attention of the potential consumers. The prize of the improved stoves was discussed and the principle of the pay-back period explained.

Apart from the public demonstrations, awareness of the fuel problem was increased by information campaigns at schools, nurseries, nutrition centres, and through mass media.

1.6.2 Sales promotion and distribution

Improved stove projects supported the marketing of the stoves by a series of sales promotion activities, through mass media and in demonstration and promotion campaigns. The principal goal of these was to create a demand for the improved stoves and inform the public where to buy them. Distribution of the stoves generally was left to market forces through the existing production system and commercial channels. The basic idea was that if a demand is created and made sure the availability of the product, market forces will act and a commercially viable system will install itself.

Sales of the improved stoves were promoted on television, radio and in the local press. In these spots and advertisements emphasis was laid on the same items as during the demonstrations: economy, safety and comfort, how to use the stove and when a stove must be replaced. These promotion campaigns were held periodically, typically once a year, with a duration of two to three months. TV spots featured once or twice a week, radio spots daily. Radio spots were also emitted in local languages. For a number of projects these sales promotion campaigns were developed with the assistance of professional agencies.

During promotion meetings at markets etc. T-shirts, stickers, leaflets, posters and alike were handed out. The existence of improved stoves was also brought to the attention of the public through billboards and signposts at selling points.

Some projects intervened to improve the distribution of the stoves by installing selling points in neighbourhoods far from the production sites and giving credits to wholesalers and detailers.

In some cases, interested households were offered credits to purchase an improved stove through their employer. The credits ware refunded through salary deductions.

1.6.3 Monitoring: consumer acceptance and satisfaction

Surveys were done to assess the acceptance of the stoves, before the start of the dissemination as well as during the course of the projects. In a number of cases the reactions of the users led to the development of new models like the MultiMarmite in Niger and the Mixte models in Burkina Faso, but in general the consumers seemed to be satisfied with their stoves.
Users agreed upon that improved stoves reduce fuel consumption and improve comfort because of a reduction in cooking time and time to gather fuel, lower smoke levels, and lower hazards to injuries through burning. They are well adapted to the culinary habits.

On the other hand it was noticed that comfort was reduced because of dirtier pans and the smaller amounts of charcoal remaining for ironing.

1.7 Pricing policies and taxation

Pricing policies and taxation that interfere in improved woodstove projects, are those on wood fuel, on the stoves and on substitution fuels, i.e. alternative fuels. In this case, it is useful to make a distinction between urban and rural markets environments.

1.7.1 Urban markets environment

The price of improved stoves is substantially higher than the price of the traditional stoves, due to higher material and labour costs. The projects, in concertation with the artisans, calculated an advisory retail price, taking into account the labour costs, the costs of primary material and a profit for the manufacturer. In some cases a profit for a wholesaler or a retailer were added.

Table 4 gives an indication of the prices of traditional and improved stoves in the reviewed countries. The price difference between the improved stove and traditional stoves should be compensated, in an economic sense, by the value of the woodfuel saved through the use of the stoves.

Table 4 Price indications for traditional and improved woodstoves, and of woodfuel, in reviewed countries

Country	Stove model	price	US $	year	source
Traditional stoves					
Senegal	3 stone fire	self constr.	self constr.		Jorez, 1991
Niger (Niamey)	Foyer Malgache	F 225	$ 0.76	1991	GTZ, 1994
Improved stoves					
Senegal	3 PA	self constr.	self constr.		Jorez, 1991
Senegal	Sakkanal mono-marmite	F 1250-2000	$ 4.20-6.72		Jorez, 1991
Senegal	Sakkanal multi-marmite				Jorez, 1991
Senegal	Diambar 1 (Jiko)	F 1350-3000	$ 2.50-5.70	1993	Mission data
Senegal	Diambar 2 (Jiko)	F 1250-2500	$ 2.40-4.80	1993	Mission data
Burkina Faso	Ouaga Mètallique	F 750	$ 2.50	1991	GTZ, 1994
Mali (Bamako)	Teliman	F 825	$ 2.75	1991	GTZ, 1994
Niger (Niamey)	Mal Sauki	F 700	$ 2.35	1991	GTZ, 1994
Niger (Niamey)	Multimarmite	F 1500	$ 5.00	1993	Mission data
Gambia	Nofly	D 45	$ 4.70	1991	Bialy, 1991
Fuelprices	*Fuel*	*Price*	*US/100kg*	*year*	*source*
Senegal	charcoal	F 40/kg	$ 13.40	1993	Mission data
Burkina Faso	firewood	F 24/kg	$ 8.10	1991	GTZ, 1994
Mali (Bamako)	firewood	F 20/kg	$ 6.70	1991	GTZ, 1994
Niger (Niamey)	firewood	F 20/kg	$ 6.70	1991	GTZ, 1994
Gambia	firewood	D 10/ 15 kg	$ 7.00	1991	Bialy, 1991

F = F.CFA (F.CFA 100 = US $ 0.3360 (level August 1991, (GTZ, 1994))
D = Dalasis (Gambia) = D 9.52 = US $ 1.00

In this respect the price of the wood also plays an important role. Wood still is relatively cheap in the reviewed countries, and the price is generally left over to demand and supply mechanisms. Firewood is, certainly in urban areas, a so called informal commercialized good, and governments have not been able to impact on it's price because, in general, the urban population has easy access to plant cover in order to extract wood.

In rural areas, the situation is even more difficult, since firewood is considered as a freely available good. Only in those situations that people spend a substantial part of their time on the collection of wood, they are interested to save wood, and improved stoves appear to be successful. If not, the dissemination of the stoves has proven to be a difficult and cumbersome process, not only in the reviewed countries (Barnes *et al*, 1993).

Supply management alternatives, varying from natural resource management to afforestation, all have considerable consequences for firewood costs:

- Natural forest management is estimated on 60-120% over the market price (with an average of 80%) of firewood, taking into account costs for the installation of firebreaks and payment of guards, as well as transport and marketing costs (GTZ, 1994).
- Firewood, cultivated and commercialized in afforestation projects, would cause firewood prices to rise approximately 275% in Ouagadougou and 335% in Bamako. (GTZ, 1994).

In paragraph 1.4.4, some remarks were made on the fuel economy reached by the introduction of improved stoves: Laboratory experiments showed 30% fuel economy of the improved stove over the traditional stove, resulting in a pay-back period for the extra investment to be two to four weeks. If the fuel economy realized in practice is lower than 30%, as field-tests show, the pay-back period will of course be longer. Fig. 16 shows increasing economy, expressed as the pay back period, for decreasing fuel economy from 30% to 5% for a typical situation for the reviewed countries, considering actual average firewood and woodstove prices.

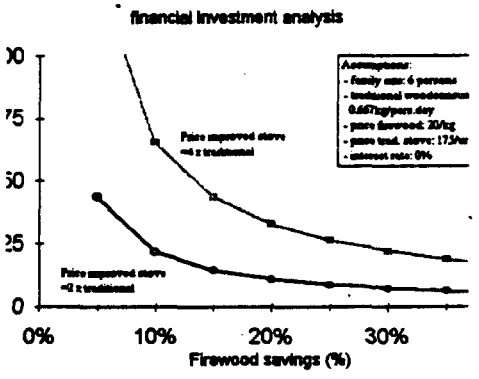

Fig. 14 Payback period of improved woodstoves related to firewood savings

1.7.2 Rural areas

In rural areas, the construction of the improved stoves was mainly based on self-construction: the persons who requested the construction of an improved stove had to supply the materials, being clay, sand and stones, themselves. For the construction of the stove they were assisted by the village masons trained by the project. The housewives had to pay for this service, but costs were limited. After the construction of the stove, which was a training session for the housewife as well, the beneficiary was expected to be able to maintain her stove and to construct a new one when necessary. Because generally fuel is gathered directly and not purchased, the pay-back principle was not applied to the rural areas.

1.7.3 Taxation policies

Stoves were not taxed in any of the projects reviewed; Subsidies were not applied either, except for the Kayes project. In this latter project, stove prices, varying from F.CFA 800 to 2900, were considered too high by the population. During promotional sales, stoves were subsidized to cost F.CFA 250 to 1450. After re-establishing the normal, commercially viable price, sales virtually stopped.

Wood and charcoal are taxed as far as they are commercially traded, but the tax level is low and the level of control is such that paying tax can easily be avoided. The trading of wood and charcoal is an informal business and wood merchants are very ambulant. The price of the wood and charcoal only reflects labour and transport costs and the profit margins for the traders, the wood itself is not paid for. Sometimes a small price has to be paid for the concession to cut wood, but these sums do not reflect the costs involved in reforestation, forest maintenance and protection.

Afforestation projects, that pretended to commercially cultivate firewood, have failed because they were not able to compete with the cheap wood brought to the market by the informal sector.

Only the PEII programme in Niger has an integrated supply side project, PEII - ED - Volet Offre, that tries to control the wood supply to Niamey by efficient control at the city limits and a taxation system that favours fuelwood that comes from less endangered areas. Part of the tax is imposed at village level, thus making the fuelwood trade, forest management and control of direct interest to the rural population.

1.8 Gender issues

Gender roles did not play a specifically distinguished role in most of the Sahelian stove projects. Generally, they have been limited to the perception of the woman as client, as the buyer of the woodstove who, in order to be willing to buy a woodstove, was to be convinced of it's usefulness. Therefore, women participated in demonstration and promotion activities, as well as in surveys to determine whether the stoves were accepted.

During stove research and development the controlled cooking tests were performed by women and their observations and suggestions have much contributed to the modifications and adaptations of the stoves. Test series of improved stoves were given to households and again the observations of the users were used to improve the stoves and to make them better adapted to local culinary habits.
Stove demonstration sessions organized during the marketing studies involved groups of 50 to 60 housewives that could give their opinion on the stoves presented. At these demonstrations the stoves were used by female demonstrators of the project to prepare meals and the housewives were invited to participate.
During stove demonstration and sales manifestations discussions with housewives about the merits of the stoves provided some feedback to the projects.

On the other hand, with the exception of two projects, improvement of the conditions of women was not an explicit objective. Woodstove projects generally were set-up for ecological and energetic reasons, not to improve the health and living conditions of women. On the level of discussions and project preparations, initiatives exists to explicitly integrate these social objectives into the woodstove projects in Sahelian countries.

No information could be obtained whether women, or women's organizations, participated with the formulation of the projects and were involved in project set-up and organization of the reviewed projects. New projects have a tendency to involve beneficiaries, and specially women, more actively in the definition of their activities (Hedon, 1994).

In only one case a woman formed part of the project staff, while all projects contracted female promoters.

1.9 Evaluation

When evaluating improved stove projects, the question whether they were successful should be answered considering the following aspects:

- *Effectiveness, or: have the projects achieved their targets*
- *Efficiency, or: judged on a rational basis, what have been the costs at which the final result is achieved*
- *Sustainability, or: what are the (expected) results on the long term.*

1.9.1 Project effectiveness

In the cases where project goals were set in terms of numbers of stoves to be disseminated, the effectiveness of the project should be easy to evaluate if adequate monitoring would have been performed. In practice, however, substantial problems were encountered on monitoring. In the case of some major projects, no data were recorded on the amounts of disseminated stoves (See annex 2).

Table 5 Targets vs achievements

	Number of stoves	
Project	Target	Result
WS1	?	97,000
WS2	120,000	182,000
WS3	125,000	32,000 + ?
WS6	?	5,000
WS7	40,000	40,000
WS8	500,000	36,000

The number of stoves disseminated by the projects does not reflect the penetration rate achieved with improved stoves, as the average service life of improved woodstoves is estimated by the consultant on 1 to 3 year, although some projects claim service lifetimes of 2-4 years (GTZ, 1994)). Therefore, it can be expected that a very substantial part of the stoves sold at project start are already lost by the time the project finishes. None of the projects evaluated the number of stoves actually in use, neither on the average service life time through field tests or surveys, and no data are available on the number of persons who replace their improved stove after stove break-down.

In other cases the project goals were set in qualitative terms like "put into place a potent system for the production and dissemination of improved stoves",or "improve the living and women's working conditions" or "reduce the pressure on wood resources through the introduction of improved stoves". No verifiable quantitative targets were set, and it is evident that adequate determination of the project's effectiveness is virtually impossible. At the same time, these projects did not realize efforts to quantify the effects of the developed activities.

In all cases, except one, the people interviewed for this evaluation, stated that they regarded their project as successful because the goals set were met and the users gave enthusiastic reactions during the surveys. The one exception was the Kayes project in Mali where only a very small number of stoves was disseminated because of organizational and personnel

reasons, and "les evénements du mars 1991", the outburst of violence that came with the political changes in Mali. In Kayes much of the project hardware was destroyed during these outbursts, and the project was terminated.

1.9.2 Project efficiency

Concerning project efficiency, a Mali project claimed success on the total amount of fuel economized (GTZ, 1994). Based on the total number of stoves disseminated and assuming they are "properly used", was calculated that the total value of all fuel saved exceeded the total project budget (assuming shadow prices for the saved fuelwood).

Another parameter often used as an indication for project efficiency is the total amount of project costs per disseminated stove. Fig. 15 shows a simple analysis of targets and obtained quantitative results vs. project budgets. Costs varied from $8 to over $40 per stove.[5] In some cases, program costs per stove were very high, and were a multiple of the cost of a stove. A separate observation should be made on project WS3; After a successful start, when project targets were surpassed, stove dissemination stagnated during the second phase. Of the 100,000 stoves foreseen, only a non-quantified small number was distributed. The project was not able to compete with the an other type of improved stove, which was inferior from the fuel economy point of view, but which was preferred by the Mali women for reasons of cooking convenience (Gajo, 1993).

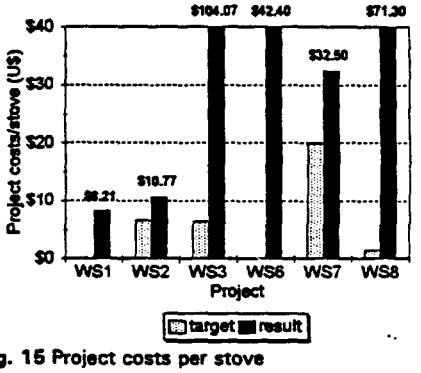

Fig. 15 Project costs per stove

1.9.3 Project sustainability

Most projects reviewed have ended last year or some years ago. The DNAS/GTZ project in Mali and the Energie II project in Niger are in a transition phase, but on a low level, using the remaining funds from the previous phase. They have issued an application for funds to continue and are awaiting the final decision. If the DNAS/GTZ project will be continued, it will be on a smaller scale and more focused on follow-up on the created stove production and dissemination system than on initiating new activities to disseminate improved stoves. Only in Mali a new domestic energy strategy program is scheduled to start, prepared by the "Unité de Pilotage de la Stratégie Energie Domestique" (UPS), comparable with the Energy II program in Niger.

[5] In comparison: Barnes a.o. mention program costs per stove *in run* from less than $2 (in China) to just over $4 a stove (in India)

For the stove programs that have ended, there are still officials at department level who do some follow-up work, but in practice this is not effective because of a lack of political interest and priority, and consequently deficiency of financial means. For these projects only a very limited impression exists of the actual status and monitoring data on stove sales and performance are not recorded any more.

As soon as projects have come to an end and the activities to promote improved stoves have stopped or continue only on a low level, the tendency is that sales numbers of improved metal stoves decrease and construction of 3PA stoves declines, until both seem to stabilize on a low but constant level. There are no hard numbers on this phenomena, especially not for the rural ares, because no project had programmed follow-up monitoring activities. But the little data available gives enough indication. For instance:

- in Niamey now the sales of Maï Sauki stoves are at 400 per month, while they were around 1000 stoves per month during the project. Sales rate for Maï Sauki to traditional stoves is estimated to be 1 to 6.
- in Mali sales numbers of metal stoves have gone down, even during project intervention, from 900 to 250 stoves per month.
  Sales of 2000 stoves per month are claimed however for an improved stove that is not promoted by the project(!) and preferred by the consumers, the "foyer à trois barres" (Gajo, 1993). The fuel saving capacity of this improved stove, however, is doubtful. It is a *Ouaga Métallique* with a different pan support system that allows for the use of smaller pans, leading to increased heat losses and a reduced fuel economy.
- in Gambia 60% of a control group of 3PA users was still using the stove after 2 years. During this period the project was still active.
- in Senegal the market share of the Sakkanal stove is estimated at a stable 10%.

On the other hand, in Bamako the penetration rate of improved stoves is 65%, but one has to keep in mind that in Mali the possession of an improved stove is obliged by law. Nevertheless the utilisation rate of improved stoves was estimated on 63%. (Gajo, 1993).

In the other countries, improved stoves are still on the market, but their share is small and limited to a hard core of improved stove users: those households that appreciated the advantages the improved stove can bring, like reduction in cooking time and fuel costs, giving them the motivation to replace the old improved stove with a new one.

Now it is clear that improved stoves don't sell themselves automatically and that users don't always replace the improved stove by a new one, after breakdown. In the next paragraph an attempt will be done to investigate the reasons for this phenomenon.

1.9.4 Factors affecting consumers satisfaction and project sustainability

Improved stoves were bought because the user expected certain benefits from them. What benefits could be expected was extensively explained in the demonstrations and publicity

campaigns. Main items were economy of fuel and time, comfort and the environmental gains.
If one or more of the promised benefits does not show in the daily use, the customer feels deceived and will not buy a new improved stove.

So the fact that improved stoves often are not replaced by new improved stoves can be explained by:

- disappointing fuel economy
- disappointing reduction in cooking time
- relatively high price compared to traditional stove
- disappointing increase in comfort

These disappointments lead to a low motivation to buy a new improved stove.
Environmental arguments to buy a new improved stove are not so important and less so to the urban population as to the rural population.

Fuel economy

The promised fuel economy of around 30%, was based on tests done under controlled and favourable conditions. There is no doubt that this level of economy can be realized, but then the fire needs a lot of attention. This may not be the case in the daily practice of a household.

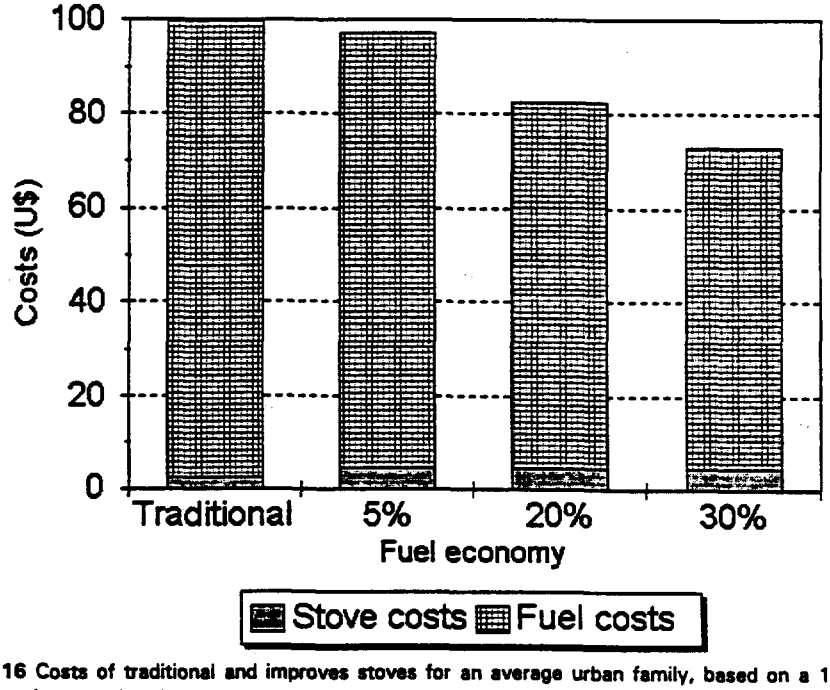

Fig. 16 Costs of traditional and improves stoves for an average urban family, based on a 1 year economic stove duration

Hardly any measurements have been done to verify the fuel economy realized in practice, most results come from surveys. The latest measurements done in Niger show economies of only 7%. Why should the situation in the other countries be so much different and better?

If fuel economy of improved stoves is really only somewhere between 5% and 10%, one of the main advantages for the households disappears: hardly any money or time to collect fuel is saved. And the small savings that might be realized are hard to appreciate, because most of the poorer families buy their fuel on a day to day basis (see Fig. 16). With fuel-economies of 5 to 10%, the pay-back period, as far as it was understood and served as a motivation for the improved stove, looses all meaning.

During cooking, improved stoves need a lot of attention to realize the potential fuel economy. If the same attention is given to a traditional stove or three stone fire, then an important fuel economy is possible. But still the comparative laboratory cooking test results stand: with maximal attention given to the traditional as well as to the improved stove, fuel economies of over 30% are possible. In practice 25% fuel economy should be possible and is realized in some cases (ref Rwanda, Niger some cases, Mali (GTZ, 1994)), probably in the group of families that keep buying improved stoves.
The technology of improved wood and charcoal cook stoves is not (yet) on a level where the user can leave the stove unattended for some time like for gas or kerosene stoves. The wood needs to be pushed in, the door needs to be closed, new fuel needs to be added, etc. Maybe on this point the expectations of the customers were also to high.
Besides, the efforts of most projects did not aim at the improvement of cooking techniques. A clear lesson learned from the Sahelian experience is, that the introduction and dissemination of improved stoves should be accompanied with a strategy to introduce fuel-saving cooking techniques.

Cooking time

No complaints have been recorded about the quickness of the improved stoves and this was also not to be expected. The power and efficiency of the improved stoves are higher than those of the traditional stoves, resulting in shorter times to bring the contents of the pan to the boil. This suggests that the time saving feature of the improved stove technology worked as expected.

High price compared to traditional stove

Improved stoves have to be purchased from the daily household budget, which is managed by the housewife (this in contradiction with kerosene or gas stoves which are considered a technological innovation compared to the traditional stove and therefore normally are paid for by the man). To buy a new improved stove, that costs twice as much as the traditional stove, the housewives must be really motivated. If the performance of the first improved stove has not been as good as expected, the motivation to buy a new one will be low. And even if she goes to the market to buy a new improved stove, she might change her mind on the spot because at the market she is confronted with a number of other articles she also

needs. So if the motivation to buy a new improved stove is low, she might change her mind, buy a traditional stove and use the remaining money for other necessary items. It was for this reason that several projects have created stove selling points in the neighbourhoods. In Niger, for instance, selling points were installed in the neighbourhoods during the first phase of the project. At the end of this first phase these selling points were liquidated, followed by an immediate drop in the number of stoves sold.

In this respect the price of the wood also plays an important role. Wood still is relatively cheap, and the price certainly does not represent the economic value. Basically the market price of fuelwood is composed of labour and transport costs and profit. Sometimes a little tax is included, but the control on fuelwood is so poor that paying the tax can easily be avoided. In general, the shadow price of firewood is two to three times the market price, as reflected to the costs of wood produced through sustainable natural forest management or afforestation (see paragraph 1.7.1). At the same time, higher woodprices would stimulate the sales of improved stoves. Several projects have noticed an increase in stove sales when fuel prices went up.
Of course fuel prices should not be raised to promote improved stoves, but because they should reflect the economic value and to stimulate it's rational use.

Convenience

It is doubtful if improved stoves add much to the convenience of the housewife other than in reducing the quantity of fuel needed and reducing the cooking time.
Improved stoves use the same fuel as the traditional stoves and advantages and disadvantages of the fuel do not change with the use of an improved stove. If the old stove produced smoke, the improved one will (with the exception of the few cases where stoves with chimneys were introduced). Improved stoves maybe a little easier to light and less messy because the ashes stay inside the stove, but ignition still needs some effort and ashes need to be removed. In this aspect only gas and, to a lesser extend kerosene, offer a real improvement in comfort.
The closed improved stoves offer a lower risk to direct burns from fire.
Often quoted disadvantages of improved stoves, related to users' convenience, are that they don't provide light and that they give dirtier pans, there is no remaining charcoal for ironing and it accommodates only one size of pan. Maybe be the closed improved stoves offer a lower risk to direct burns from fire, but the urban metal stoves still get very hot, hot enough to get burned, and this high temperature of the stove body is not obvious, especially not to children.

1.9.5 Lessons learned

1 Better marketing studies are needed before project starts, parting from the needs of the beneficiary population: What is it that the housewives want to improve their situation? Maybe they would not put improved stoves on the first place. An integrated approach is needed to improve the kitchen as a whole, considering energy and health aspects, and life conditions. More coordination with water and nutrition and health and urbanization and possible other projects.

2 During cooking, improved stoves need a lot of attention to realize their potential fuel economy. If not, the firewood saving effect of the use of improved stoves to reduce firewood demand are disappointing, on micro- as well as on a macro level.
But still the comparative laboratory cooking test results stand: with maximal attention given to the traditional as well as to the improved stove, fuel economies of over 30% are possible. The aspect of "proper stove use" has to be taken into account seriously when planning improved woodstove projects. Specific activities should be defined, aimed at the adoption of fuel-saving cooking techniques at multiple levels and through multiple activities, such as school lessons, demonstrations, nutrition programs, through women organizations, water and sanitation projects, etc.

3 At the same time, the introduction of fuel saving cooking techniques to traditional stove users can also reduce their firewood consumption, albeit to a lesser extend than in combination with improved stoves: If adequate attention is given to a traditional stove or three stone fire, an important fuel economy is possible.

4 The technology of improved wood and charcoal cook stoves is not (yet) on a level where the user can leave the stove unattended for some time like for gas or kerosene stoves. The wood needs to be pushed in, the door needs to be closed, new fuel needs to be added, etc. It is possible that on this point the expectations of the users were too high. Up to now, little research has been done on improved wood stoves that need less attention. One way is to cut the wood in small pieces and have closed stoves with separated primary and secondary air supplies. In principle charcoal stoves need less attention then wood stoves because the fuel is already in small pieces and only primary air is needed. But one can not say that improved charcoal stoves are a bigger success than improved woodstoves, so there are apparently more hidden factors that influence customers behaviour.

5 Fuel economy achieved by the use of improved woodstoves, has not been of sufficient interest to provoke a permanent switch to these cooking devices for the major part of the urban an rural population. As soon as project activities stop, the dissemination rate of improved stoves reduces. An important factor is, that the market price of woodfuel does not reflect it's economic value, and is relatively cheap compared to other fuels. In some situations an increase of the sales of improved stoves was actually recorded when fuelprices rose, such as in Senegal, upon the rise of charcoal prices. On the other hand, however, it might be that this enthusiasm for

improved stove might be a first and temporal reaction of the market to higher fuelprices.

6 Better monitoring and evaluation systems are needed. What happens to stoves, how do they perform in practice, and what do users think of them? This study shows that lacking or failing monitoring systems frustrate the improvement of projects.

7 Improved stove projects should be integrated in an overall household energy policy of a country, which should develop a clear policy towards the reduction of firewood consumptions for the different segments in the energy market. Demand and supply-side interventions should be integrated, while woodsaving activities should be coordinated with substitution activities, as shown in Fig. 1. Domestic energy consumers should have a range of possibilities to reduce wood fuel consumption.

8 Stove projects should be well planned, and phased from the beginning. An example, with the enumeration of some crucial project elements, is given in Fig. 17.

1 Project preparation	
Objective	Formulate a woodstove project integrated in overall policies to reduce firewood consumption, on energy, forestry, urbanization and nutrition
Strategies	(participative) investigations, studies and project formulations
Principle activities	• Assessment of objectives, strategy, tasks and (differentiated) consumer markets for traditional and modern energy sources; • Adaptation of models to local conditions, based on field experience; • Create awareness on the necessity to reduce firewood consumption; • Investigate possibilities for legislative, taxation and control measures, on forest management, firewood commerce and stimulation of firewood economizing activities; • Formulation of second phase.
2 Production and dissemination of woodstoves	
Objective	Introduce improved woodstoves and efficient cooking habits
Strategies	Stimulation of commercial production, educational activities, community mobilization, sales promotion, monitoring, evaluation, legislation
Principle activities	• Set-up of a local commercial production capacity; • Introduction of stoves in the local market; • Promotion of educational activities on economic cooking techniques and correct woodstove use towards housewives, seeking integration with existing projects on health, gender, housing and/or education. Development of educational materials; • Introduction pricing and taxation measures towards traditional and substitution fuels; • Permanent monitoring of production and marketing, firewood sales data, deforestation rate, etc; • Improvements on introduced models based on monitoring results; • Formulation of third phase.
3 Follow up	
Objective	Guarantee sustainability of introduced measures
Strategies	Sales promotion, monitoring, evaluation Stimulation of commercial production (limited)
Principal activities	• sales promotion: booster campaigns, making use of monitoring results; • monitoring: x monitor production and sales data; x monitor effects of pricing and taxation policies; x monitor reduction of overall firewood consumption data; x monitor consumer satisfaction (for at least 2-3 product service life cycles); • follow-up: x stimulate technical improvements on woodstoves; x stimulate activities that promote reduction of firewood consumption.

Fig. 17 Possible program cycle for improved woodstove projects

1.10 Conclusions on wood- and charcoal stoves

1 Wood and charcoal stove programs have played an important role in the efforts of governments of Sahelian countries in their struggle against deforestation; the reduction of the domestic energy demand is a key element in a broader strategy to reduce the demand of woody fuels, which is one of the principal causes of wood cutting in forests close to the urban centra;

2 On one hand, woodstove and charcoal stove programs in the reviewed countries have been successful: the goals set were met or even surpassed, and (ex-) project staff members were positive about the results of the projects they were managing;

3 In urban areas local craftsmen were taught and motivated to produce improved stoves based on a standardized design (*Ouaga Métallique* stove). Project activities were limited to the training of the craftsmen and promotion of the stoves (demonstration, publicity, social promotion). Production and commercialization was left to market forces.

4 In rural areas more simple improved three-stove (3 Pierres Améliorés), which was recommended at the international CILSS/FSSTD seminar of Ouagadougou (1984). Dissemination was based on self-construction by rural women, accompanied by trained (local) craftsmen /women.

5 After almost ten years of project activities in the reviewed countries, the impression exists that the overall effect of the introduction of improved stoves has not been as expected, although the number of stoves to be disseminated in almost all projects were reached.

6 The observed dissatisfaction has two principal aspects:
   a. the impression exists that the replacement rate of improved woodstoves is low;
   b. after ceasing project activities, sales of improved stoves generally decline, giving the impression of limited project sustainability.

low replacement rate

7 In order to explain this general feeling of dissatisfaction, a closer look should be taken at the objectives and the targets of the reviewed project. These generally part from the supposition that the introduction and dissemination of improved woodstoves would generate the desired wood-saving effect. Wood fuel economies were determined in the laboratory, and the desired overall wood-saving effect was supposed to be the product of the dissemination of a certain number of stoves, based on market forces.

8 This rather technical analysis assumed a snow-ball effect to be generated once a certain number of woodstoves would be introduced. Consumers would automatically be convinced of the usefulness of the improved stoves, and would want to have one. In practice, however, this snow-ball effect did not occur.

9 Reasons are the higher price of the improved stoves, and the limited consumer satisfaction with stove performance.

10 Surveys and field performance tests indicate that fuel savings in practice are much lower than, based on laboratory experiments, could be expected; The mission is of opinion that these limited fuel savings are due to the dissemination strategies, which failed to include the promotion of improved of cooking techniques. Laboratory tests have already shown that maximum fuel economy can only be reached when the stoves are used properly. Similarly, it has been shown that also with traditional stoves, improving cooking techniques may also save fuel (*the Bussmann diamond*, Fig. 12), albeit to a lesser extend than with improved stoves.

11 At the same time, many improved woodstove users did not find sufficient incentives to save firewood, due to it's market price, which does not reflect it's economic value.

12 Due to the incomplete dissemination strategy, consumers saved less wood than they had expected, causing longer pay-back periods. In an optimal situation, the extra-investment for an improved stove may be recovered within a few days or weeks; whereas with improper stove use this period may rise to a few months. This longer period is far beyond the investment horizon of the average member of the target-group and is, according to the mission, the most important reason why only a limited number of improved stove users replace their stove by a new improved stove.

13 At the same time, the situation of the Sahelian countries and of the project's target groups has deteriorated, rather than improved: the lowest strata of the Sahelian urban societies have found themselves in the deprived situation of decreasing purchase power. At present, investment decisions that go beyond daily basic needs such as food and fuel, are postponed. In our opinion the choice between traditional and improved woodstoves suffers from this situation.

14 The fact that the implied monitoring and evaluation procedures failed to register consumers dissatisfaction, puts a questionmark at these activities and their methodology. The fact that up to now no data are available on penetration of improved stoves in the woodstove market, nor on the replacement rates of improved woodstoves, or on it's causes, suggests incomplete and/or inadequate monitoring.

15 Additionally it should be mentioned that monitoring of the reviewed projects leaved much to be desired. In general no field data were available even the most elementary data needed to evaluate project performance, i.e. woodstove sales, number of craftsmen trained and/or active, or saved firewood.

limited project sustainability

16 Limited project sustainability, resulting in rapidly declining sales rates of improved woodstoves can partly be explained from the ceasing promotion when projects stop. Continuation of promotion activities, including demonstrations, publicity and environmental awareness activities, appear to be of crucial importance for lasting high sales rates.

1.11 Recommendations on wood- and charcoal stoves

1 Woodstove programs should be integrated in overall programs that combat the ecological disaster developing in the Sahelian zone. These programs should contain elements on supplying, saving and substitution of traditional (wood) fuels.

2 Programs should have a clear linkage to related policy-areas, such as forestation, public housing, health, water and sanitation, social welfare, education, etc.

3 On an intraregional level, an active exchange of information should be promoted. Periodical meetings on the exchange of information and experience can contribute to this. Efforts developed in one country should not be seen isolated form other countries.

4 Programs should from the beginning be carried out in clearly distinguished phases. Suggestions for such an approach is given in Fig. 17;

5 The program set-up should take the following factors into consideration:

a. Reducing firewood demand should be the overall objective. All other objectives should be derived from this main project goal;

b. Strategy should contain a differentiation towards target groups:
- lowest income groups: fuelwood saving through energy saving cooking techniques;
- low income groups: cooking techniques and improved stoves
- low-middle income groups: introduction of improved stoves and kerosene as a substitution fuel
- middle and high-income groups: LPG as a substitution fuel.

c. Development of improved stoves should be based on the knowledge present at the target groups. Endusers should participate in project priority assessment and the (technical) development of improved stoves;

d. dissemination of improved stoves and substitution fuels should be accompanied by an extensive information and awareness campaign on their correct use;

e. adequate monitoring systems should be set up, which permit a continuous evaluation of it's results and impacts, all over the chain of firewood commercialization and consumption;

f. sales and taxation policies on firewood, charcoal, substitution fuels and stoves;

g. a follow-up phase, providing funds to continue publicity, monitoring and evaluation activities, as well as continuation of promotion activities through a limited number of channels (schools, churches).

6 In order to avoid duplication of efforts, promotion of improved cooking techniques should be executed through existing programs on education, nutrition, health, women, credit funds, water and sanitation, social reforestation, etc, through schools, churches and projects. In order to provoke the desired mobilization, the energy project's activities should aim at training and motivation of promoters, teachers and other staff of these organizations.

2 THE SAHELIAN REGIONAL BUTANE GAS PROGRAM

2.1 Program Context

2.1.1 General background

Most of the Sahelian countries have worked on the dissemination of improved wood fuel cooking stoves since the late seventies or early eighties, often supported by the CILSS and external funding. Only Senegal, Cape Verde and Mauritania started to promote the use of substitution fuels, concentrating on butane gas, in the same period.

From the mid eighties, when the Sahelian countries were confronted by ever increasing urban populations, the woodstove programs in each of the countries adopted a wider strategy to reduce wood fuel consumption. In this strategy, substitution played an important role.

Under these circumstances, the Sahelian Regional Butane Gas Program (PRG) was initiated. The financing agreement was signed in February 1989 and regional project activities commenced in January 1990 (Djimrangar, 1994). National activities started in 1990 (Niger), in 1991 (Burkina Faso, Chad, Gambia, Mali, and Senegal), in 1992 (Mauritania and Guineee-Bissau and even as late as 1993 (Cape Verde).

With this program, favourable conditions were to be created for the introduction and penetration of butane gas at the level of middle- and high-income groups in the big cities, offering them a broad range of equipment, well adapted to the cooking habits of the local population and at a competitive price. The participating countries were to organize awareness raising and information campaigns and promotion activities.

2.1.2 Program funding and donor coordination

The Sahelian Regional Butane Gas Program (PRG) was financed by the Commission of the European Communities (CEC) and coordinated by the CILSS, based in Ouagadougou.
Funds were put at the disposal of the national governments of the CILSS member countries to be spent at their choice on equipment (gas bottles, burners and supports) and/or fuel (butane gas). Equipment and fuel were to made available to the urban population in cooperation with the gas importing petroleum companies: Shell, Total, Mobil and smaller local companies.

The participating countries were left quite free in the way they choose to use the funds. It was used to arrange the import of substantial quantities of gas bottles and burners and/or to subsidize this equipment and/or to subsidize the gas itself. Loans were provided to the petroleum companies in the form of capital or equipment (gas bottles). The petroleum companies took care of the (re)filling of the gas bottles and the sale of the gas bottles and other equipment. These loans, over one year, with a modest interest of 2.5%, were returned to the project in monthly terms, and formed a revolving fund. In the case of gas subsidies the money did not flow back to the project and eventually the government of the country

concerned had to find its own funding to maintain the subsidy. Generally this was done by increasing the tax on other petroleum products, such as gasoline and diesel fuel.
About 17% of the program funds were used for the regional program coordinator, based in Ouagadougou.

? shows the breakdown of program funds allocated to each country and gives a brief explanation of the objectives.

Table 6 Project's quantitative targets per country

Country	Targets consumption (t/yr)	stoves	Budget (F.CFA)
Burkina Faso	4,000	30,500	270,640,000
Gambia	1,400	4,800	206,353,000
Mali	2,040	48,000	312,047,000
Niger	1,700	15,000	324,000,000
Senegal	50,000	-	382,415,000

The contributions of the local governments were usually in kind and consisted of the provision of personnel (usually the national program coordinator and support staff), office space and facilities, the cooperation of governmental organizations like research institutes, and the assistance of improved stove projects to demonstration and promotion activities.

2.1.3 Program management and supervision

The overall program was coordinated by CILSS through a regional program manager based in Ouagadougou, whose responsibilities included:
- to assure program coordination and monitoring;
- to provide technical assistance to the national programs;
- to promote exchange of information and experience;
- to organize the annual regional CILSS meetings; and
- to prepare and distribute the annual reports.

At the national level the program was executed by the National Coordinator, assisted by a secretary and a small team of promotors.

During the annual meetings, national program coordinators, the regional program coordinator and representatives of the donor (CEC) discussed the progress of the activities and coordinated joint promotion activities. As another way of liaison, the regional coordinator had the possibility to visit each country up to two times annually.

2.1.4 Regional program objectives and targets

The project document described as the overall objective of the program the effective utilisation of butane gas at both the national and regional level. The secondary objective was to promote the use of butane gas as cooking fuel in urban centres in order to stop the progressive exploitation of firewood, a practice that gradually destroys the semi-urban forests.

The following targets were set in 1990:

- Evaluate the gas promotion activities in each of the member states and supervise the coherence between the national programs;
- Supervise the establishment of the national program structures;
- Establish activity plans in each member state which are coherent and take into account the interest of all parties involved;
- Establish a system for the exchange of information between the national and regional coordinators;
- Acquisition of fuel trucks for land-locked member states to reduce the transport cost component in the butane gas price.
- Contribute to the training of national program coordinators

To realize the objectives and tasks, the national coordinator was to develop activities in the following fields:

- Consumers information and promotion
- Support the establishment of a gas fund;
- Support the production of pan supports;
- Provision of gas transport means;
- Technical and financial assistance to program execution;

The quantative targets per country were set in numbers of gas stoves to be disseminated and in an increase in tons of gas to be sold compared to a reference year. These quantative targets are also summarized in Table 6.

2.2 Institutional framework: actors and roles

The national coordinator was to initiate the project activities, like making the financial arrangements with the private sector and organizing the promotional activities.

In all countries the program was executed in close collaboration with the oil and gas importing petroleum companies like Shell, Total, Mobil and smaller local companies. These companies arrange the import of gas, the filling of the bottles, and the import and retailing of the equipment. Imports were/are done in concertation with the national government/coordinator.
An important aspect of the activities of the private companies is the control of safety. At the filling plants the bottles are checked and fixed ore taken out of circulation.

The manufacture of the supports was done by local workshops. These workshops were trained to manufacture the supports according to the specifications of the petroleum companies who were responsible for the design of the supports.

2.3 Stove technology

Gas stoves

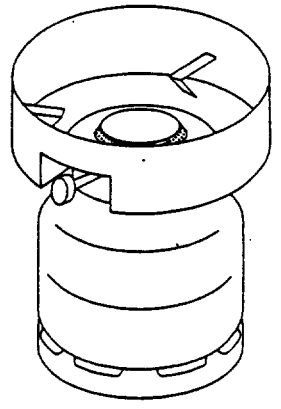

Fig. 18 Gas bottle with pan support

The gas stoves introduced use gas bottles of 3 and 6 kg, with a burner screwed directly on the bottle. The small 3 kg bottle with burner is placed in a supporting structure to assure the stability during cooking. The bigger 6 kg bottle offers enough stability from itself and the pan support is fixed directly on the bottle, see Fig. 18, which shows a 6 kg bottle with the Nopalé (Senegal) or Gateli (Mali) pan support. In this way a simple, safe and cheap construction is assured, without hoses and pressure reducers. Two types of gas burners are used, the Primus burner that is marketed by Total and the Camping Gaz burner that is sold by Shell. Both burners can be used on 3 and 6 kg bottles. In Gambia a copy of the Primus burner is used that appears of the same quality but costs half the price of the Primus burner.

The one exception is Burkina Faso where an important number of small, two burner gas-ranges were marketed, that are connected to the gas bottle by means of a pressure reducer and a hose. The advantage of this system is, that they can be used with a 6 kg as well as with a 12.5 kg bottle.

Efficiency and fuel consumption

In general the gas stoves are developed and tested by the petroleum companies, but efficiency numbers are not known. In some cases the stoves have also been tested by the local stove laboratories, using waterboiling and controlled cooking tests. No results are known, but the results were said to be satisfactorily.
In Niger, Mali and Senegal gas stoves were tested by the consultant during ESMAP Household Energy Studies. P_{max} varied from 3 kW for the Camping Gaz burner to 7 kW for the Primus burner. In a number of cases the performance of the gas stoves could be improved by reducing the height of the pan over the burner. The tests also showed that the Camping Gaz burner was difficult to control in the low power range, resulting in unnecessary high fuel consumption (Bussmann and Visser, 1986; Visser, 1988). In Senegal the Camping Gaz burner has been replaced by an improved model.

Stoves have not been field tested, although there is a consumer feed-back during the stove demonstrations. In some cases this has led to adaptations of the stoves. In general stoves are well accepted and appreciated for their convenience and cleanness. Stoves were well adapted to local habits.

2.4 Marketing and dissemination

Market studies were not always done: In some countries the number of potential customers was estimated by adding up the number of civil servants, employees of semi-statal enterprises and officials of private companies. In general, the marketing studies showed that the people was interested in butane gas because of its ease of use and cleanliness, but they were afraid of gas and thought it to be too expensive.

The butane gas was promoted through demonstrations in quarters, neighbourhoods and marketplaces, through promotion spots on radio and television, through advertisements in newspapers and through billboards. At the demonstrations promotional material was distributed like posters, stickers, T-shirts, calendars and leaflets. Themes of the promotion campaigns were the comfort of use and the struggle against desertification: awareness about the woodfuel crisis and its background and the role butane gas stoves can play to reduce the pressure on woodfuel resources was stressed in the demonstration sessions.

Goal of the promotion and demonstrations was to create a demand for the gas stoves, and leave the actual distribution to the market. The sale of equipment was also promoted through the creation of credit systems for people with steady jobs, like civil-servants, employees of semi-statal enterprises, officials of private houses and militaries. Payment was arranged through the employer.

Household equipment was sold at selling points of the petroleum companies like gas stations, but also through a system of wholesalers and retailers. The empty bottles were returned through the same channels for checking and refilling.

2.5 Pricing policies and taxation

The manufacture of the locally made supports was organized through the petroleum companies and were sold without profit. The complete set of equipment (burner, bottle and support) received a 5000 F.CFA subsidy except for Gambia and Senegal. The price of the gas bottle was more a deposit because it was around 50% of the real value of the bottle, which was between 10.000 and 12.000 F.CFA. The costs of this outstanding capital were recovered through a supplement in the gas price.
At the filling stations the gas bottles were/are checked for damage. Often they can be repaired, sometimes they have to be discarded. Actual percentage of discarded bottles in Senegal for instance is around 2%. These costs are also recovered through a supplement in the gas price. Table 7 gives an indication of price structure of the bottles, burners and supports before the F.CFA devaluation.

It was not possible to get a detailed picture of the gas prices in all five countries. In most countries tax and customs rights on the gas are low. Gas is sold at around 250 F.CFA/kg. Of the countries reviewed Mali, Senegal and Niger subsidize the gas. Senegal subsidies up to 50%, resulting in a consumers price of 125 F.CFA/kg and in Niger and Mali the gas is subsidized at around 50 F.CFA/kg to keep the consumer price at 240 F.CFA/kg. In Mali the gas price after devaluation has risen to 500 F.CFA. Subsidy has gone up to 220 F.CFA/kg,

Table 7 Indication of equipment prices (before the F.CFA devaluation)

	Niger (F.CFA)	Burkina Faso (F.CFA)	Mali (F.CFA)	Gambia (Dalasi)	Senegal (F.CFA)
6 kg equipment					
bottle	8,000	3,000	4,000	196	3,000
burner	2,500	2,500	2,500	16	2,500
support	4,500	5,000	5,500	206	2,000
total	15,000	10,500	12,000	418	7,500
subsidy	5,000	5,000	5,000	0	0
cons.price	10,000	5,500	7,000	418	7,500
3 kg equipment					
bottle	6,000	2500	4,000	123	2,500
burner	2,000	2,000	2,000	16	2,000
support	4,000	4,000	4,000	164	2,000
total	12,000	8,500	10,000	303	6,500
subsidy	5,000	5,000	5,000	0	0
cons.price	7,000	3,500	5,000	303	6,500

leaving the consumer price at 280 F.CFA/kg. These subsidies are paid from the program fonds or from supplementary taxes on the other oil products like diesel oil and gas oil.

2.6 Program evaluation in the 5 RPTES sample-countries

The introduction of butane gas as a household fuel has definitely been a success in Senegal, where introduction already started in 1974 with the 3kg bottle and the Blip stove. Gas consumption increased with the introduction of the 6 kg bottle and the Nopalé stove in 1983, but the major increas was achieved in 1987 with a new price structure for gas resulting in considerably lower prices. At this moment, the yearly growth of the gas sales is around 22%. (Shell Senegal. 1994).

In other countries butane gas was only introduced on a large scale as a substitution fuel for the urban households with the CILSS program. Since this program only ended in december 1993, it is still to early to judge if the program was a success or not, even though the number of stoves to be disseminated was not realized. Main reasons for this are a regular shortage of available equipment and, sometimes, gas.

The consumption of gas has increased, but not to the extend it was planned. In Niger and Mali, where gas is subsidized through the project, the wealthier part of the population (that already used the gas) has also profited from the CILSS funds, despite the original goals of the program.

A weak point in the whole program was the difference in pricing policy in the different countries. In some countries gas was subsidized, in others it wasn't, resulting in large price

differences between countries and sometimes within a country. Prizes for equipment also varied from one country to another due to different subsidizing policies. These differences are hard to explain for a regional program. Apparently governments are not willing to coordinate pricing policies, which makes it difficult to believe that, in a next phase of the gas program, the CILSS countries can commonly realize gas import and equipment production activities.

In the same way as in the first part of this study, evaluation of the projects can be presented on three aspects:

- Effectivity, or: have the projects achieved their targets
- Efficiency, or: judged on a rational basis, what have been the costs at which the final result is achieved;
- Sustainability, or: what are the (expected) results on the long term.

2.6.1 Targets vs achievements

butane gas market penetration

Targets of the programs were set in rather quantitative terms, on gas fuel importation and stove dissemination. Table 8 and Table 9 summarize these targets as wel as the quantities of gas and numbers of stoves sold.

Table 8 LPG import data (1987-1993)

	Gas Sales					Goal	Realized	
Country	1987 (t)	1990 (t)	1991 (t)	1992 (t)	1993 (t)	1992 (t)	1992 (%)	1993 (%)
Niger	480	556	613	670	700	4,000	39	41
Burkina	1230	2151	2519	2886	3495	1,400	72	87
Mali	670	834	1136	1441	1800	2,040	71	88
Gambia	450	800	1084	1366	1800	1,700	98	129
Senegal	18100	32111	36306	40500	45000	50,000	81	90

Table 8 shows the butane gas consumption data for 1987 to 1993, as compared to the quantitative targets set for the year 1992 (1991 data are obtained trough interpolation). Data show that only in Gambia sales targets were met. In Burkina Faso, Senegal and Mali reasonable results were obtained.

Table 9 presents the targets and achieved sales of gas stoves, 3 kg and 6 kg together. Results are poor, below 50% of the target sales, except for Niger where 67% of the targeted number was sold.

Table 9 Stove sales data (1992-1993)

Country	Stoves sold 1992	Stoves sold 1993	Goal 1992	Realized 1992 (%)	Realized 1993 (%)
Niger	6,871	10,123	15,000	46	67
Burkina	10,000	14,378	30,500	33	47
Mali	9,460	16.666	48,000	20	35

Inter fuel substitution and woodfuel savings impacts

Assuming that gas is exclusively used as a cooking fuel, the increase in butane gas sales in a country can be an indicator for the effectiveness of the project.

Data on butane gas consumption in the project target group (low and middle class income households) from before project start were not available, so an absolute estimation of the project impact, inter fuel substitution and woodfuel savings cannot be made. However, for the purpose of estimation, a zero consumption rate for this group of households before 1990 on 3 kg and 6 kg bottles may be assumed for all countries except Senegal, where butane gas started to penetrate the market since the early eighties. This means we assume that before 1990 al the gas was consumed by "rich" households that have never even used wood.

Fuelwood savings can be estimated based on a butane gas-woodfuel equivalent of 6 kg firewood per kg butane, assuming wood heating value of 17 MJ/kg and gas 45 MJ/kg and 50% energy savings compared to traditional wood fuel stoves.

Table 10 Estimation of woodfuel substitution

Country	Gas consumption increase (tonnes) 1992	Gas consumption increase (tonnes) 1993	Fuelwood savings (tonnes) 1992	Fuelwood savings (tonnes) 1993
Niger	114	144	684	864
Burkina	735	1,344	4,410	8,064
Mali	607	966	3,642	5,796
Gambia	566	1,000	3,396	6,000

*) *Based on daily consumption of 0.7 kg firewood/pers.day and 6 persons per family*

Based on this, woodsavings can be calculated (see Table 10). Calculated in this way, wood substitution is much lower than estimated by Madon (1994)

2.6.2 Program efficiency

An indicator which could permit some comparison between the efficiency of a substitution program like PRG with other programs that aim at the reduction of fuelwood demand, could be the amount of program costs, compared to the amount of firewood saved.
Table 11 calculates this indicator for the five programs. The indicators obtained for Burkina Faso, Mali and Gambia show an average program cost of U$ 78.- per ton firewood saved. Fig. 15 on page 19 shows the program costs for the dissemination of woodstoves, which is between U$ 8 and U$ 40/stove. Comparing this number with the case of gas substitution,

Table 11 Program costs referred to wood equivalent

country	Budget		Gas consumption increase	Program costs	
	(F.CFA)	(US$)	1990-1993 (t)	gas (US$/t)	wood eq. (US$/t)*
Niger	270,640	902,133	315	2,864	477
Burkina F	206,353	687,843	2,447	281	47
Mali	312,047	1,040,156	1,877	554	92
Gambia	324,000	1,080,000	1,852	583	97
Senegal	382,415	1,274,716	25,473	50	8
Total	1,495,455	4,984,848	31,964	572	95

* Expressed as US$/ ton firewood saved, based on 1 ton gas 6 ton wood.

and assuming that the improved woodstove would save aprox. 200 kg/year[6], some idea can be obtained on the relation of costs and effects:

- for gas substitution, program costs a approximately U$ 62.- per ton firewood saved;
- for improved woodstoves, program costs lie between U$ 40 and U$ 240.- per ton firewood saved.

The Senegal case showed that, once the penetration of gas passes a certain level, gas importations raised very quickly. Over the last few years, the increase of gas consumption has been over 20% per year. The Senegal case also indicates that once the market share of gas passes a certain level, the costs per ton of fuelwood saved can decrease enormously and the cost effectiveness of gas substitution becomes much higher than that of an improved woodstove program.

2.6.3 Program sustainability

It is for certain that households are highly interested in butane gas as a household fuel, but it remains to be seen if the price level of equipment and gas is good enough and if the supply of gas is secure enough to realize continuously high penetration rates. The high price of the gas and the necessary equipment is the most serious threat for large scale dissemination under the poorer part of the population.

The duration of a three year project is far too short to reach the whole urban population in the Sahel. Only in Senegal, where gas was already introduced long before the start of the CILSS program, other cities outside the capital are effected by the butanisation. In the other countries it was but a start of a process that now risks to be frustrated by the recent devaluation.

* based on average firewood savings (25%), family size (7 persons), stove number (2 stoves/family) and fuelwood consumption (0.7 kg firewood/person.day)

The limited number of disseminated stoves is partly the result of a lack in infrastructure: disruptions in supply of gas and equipment. On the other hand the limited number of stoves disseminated does not justify large investments in an improved butane gas infrastructure like storage and bottling capacity; certainly not on a national level.

In the execution the program has been a strange mix of mandate by governments and petroleum companies, mainly because the funds were put at the disposal of the governments. But governments are not the right organisms to market a new product, however much this product may be of national interest. A more efficient way might be to contract the introduction of butane gas stoves directly out to the petroleum companies. For the actual program already they have done most of the work.

Despite of the remaining funds from the CILSS program that have come back to the governments as revolving funds, there is a need for supplementary funds to continue the gas dissemination program, especially in view of the recent devaluation of the F.CFA.
The program now has only touched the capital cities and some major town and should continue the dissemination of gas stoves in other town and then in rural areas.
The program should also be continued in the cities that have already attained a significant penetration of gas stoves, to promote a second gas stove to replace the wood/charcoal stove that is still in use next to the first gas stove.

In a continuing program the participating countries should combine their imports of equipment and gas, to achieve a lower price and to homogenize prices and price structures among the countries.

On the long run petroleum companies are basicly interested to sell gas. Side activities, such as the sales of household equipment, do not really have their concern. It might be a good idea to interest other private entrepreneurs to start the import, manufacture and sales of the equipment.

2.6.4 F.CFA devaluation

There exists no doubt that the devaluation will have a negative impact on the position of butane gas as a household fuel. Because fuel as well as equipment are imported goods, their prices will increase, probably by a 100%, having a devastating consequence for the dissemination of butane gas under the larger part of the population that have medium and lower incomes. In Senegal for instance, the deposit for a 6 kg gas bottle will go up from 3000 F.CFA to ±7000 F.CFA.
It is to be expected that this will bring butane gas out of reach for the initial target group, such as households with a regular income like government officials, laborers, militaries, etc. Only the rich top layer of the population, that already used gas already before PRG started, will be able to afford gas as a cooking fuel.
To counteract this development, prices should be kept as low as possible. This could be reached by:

- subsidies on gas and equipment, and tax reduction. Subsidies could be financed by increased taxes on other petroleum products, the system that is already used in some countries.
- prices can also partially be reduced by the regionally coordinated purchase of gas on the international market, in order to benefit from economy of scale. For bottles, burners and materials for the production of supports this could probably be arranged in the near future, since it only implies organizational activities. There seems to exist the will and determination to do so. Large scale importation of gas is not possible at the short term, since the required infrastructure is not available: storage facilities at port(s), land transport capacity, filling stations, etc.
- Cheaper equipment might become available if locally produced. Supports are already locally made, but bottles and burners are all imported.

2.7 Conclusions on the PRG

1 The introduction of Liquified Petroleum Gas, as a strategy to reduce wood fuel consumption in the urban areas of the reviewed countries, can be of interest for the population of a certain (middle and high-income) group. Gas is a relatively expensive fuel, and investment costs (bottles and gasstoves) and the costs of refills make it beyond reach of low-income groups;

2 Gas prices differ between the five countries: In Senegal, subsidies make operational costs for gas and wood cooking equal, while in the other four reviewed countries gas prices make cooking on gas twice as expensive as cooking on wood;

3 The introduction of liquid gas requires time: In Senegal, were gas was introduced to the urban population during the early eighties, a substantial part of domestic energy supply is covered. In the other countries, the introduction period of two-three years has been too short to reach a major cover of the population. On the other hand, even in countries like Niger and Mali, where only a small part of the population has switched to gas consumption, the effect on wood fuel demand is comparable to a major improved stove program;

4 The recent devaluation of the F.CFA may have a negative impact on the dissemination of butane gas as a cooking fuel: relative price gap between gas and firewood has increased, and investment in gas bottles and cookers, all imported, is now even further out of reach than before. In order to overcome this, a major effort should be done to establish the local production of gas bottles and burners.

3 THE NIGER KEROSENE "TCHIP" STOVE PROJECT

3.1 Introduction: Overview of improved kerosene stove programs in the RPTES sample-countries

In the UNDP/WB ESMAP Household Energy Surveys in the Sahelian countries, the feasibility of the introduction of kerosene as a substitute fuel for wood and charcoal was investigated. Of the five RPTES sample-countries these studies were carried out in Niger, Mali and Senegal. The studies concluded that in Niger and Mali an important part of the urban households was prepared to change over to kerosene as the principal cooking fuel.

In Niger a project to disseminate kerosene cooking stoves was actually implemented. The Project Energie II disseminated the "Tchip" kerosene stove, therefore the project is commonly known as the Tchip-project. The potential market share for kerosene stoves was estimated at 20 - 30% of urban households (Madon, 1993)

In Mali dissemination of kerosene stoves will be part of the new household energy strategy project prepared by the "Unité de Pilotage de la Stratégie Energie Domestique" (UPS). This project is expected to start shortly.

In Senegal kerosene stoves were received less positively. The Senegalese people considered kerosene stoves as being dirty, giving a kerosene smell to the food, and giving poor cooking performance. There are no explicit plans to disseminate kerosene stoves in Senegal.

3.2 Organization and management of the "Tchip" project

3.2.1 Funding and donor coordination

The Tchip kerosene stove project is part of the "Projet Energie II - Energie Domestique" (PEII-ED) project. It is funded by Denmark and the World Bank. The local input of the Niger government includes personnel and office space.

3.2.2 Institutional framework: actors and roles

The PEII-ED project has two main parts. "Volet Offre" is aimed at the rationalization of fuelwood supply, and "Volet Demande" is aimed at fuel substitution through kerosene stove dissemination.

The main activity of "Volet Demande" is the execution of the Tchip-project. In addition, it coordinates the activities of the GTZ funded Improved Woodstove Project and the CILSS Regional Butane Gas Program. Finally, it manages the publicity and promotion campaigns of the three projects.

The project director of "Volet Demande" is from the Department of Energy of the Ministry of Energy and Mining. He is assisted by a resident expatriate technical assistant. Further project staff consists of locally recruited administrators, secretaries, promoters, surveyors, drivers etc.

Several short term consultants assisted the project, providing technical assistance for the testing and production of the stove supports, with the importation of the burners from Indonesia, and with publicity.

The project aimed to turn the dissemination of the kerosene stove into a commercially viable and self-sustainable operation. Therefore the project cooperated with a local entrepreneur for the import, production and commercialization of the kerosene stoves.

3.2.3 Project objectives and targets

Based on the results of the Household Energy Survey a Household Energy Strategy was adopted with the following objectives:

- to limit the demand for firewood and to create a diversification of household energy fuels;
- to create a more precise, rational and controlled management of the wood fuel resources;
- to improve the planning capacity of the government in the field of domestic energy

In the framework of this Household Energy Strategy the PEII-ED project would concentrate its efforts on the 4 main cities of Niger, i.e. Niamey, Maradi, Zinder and Tahoua. These cities represent over 80% of the total urban population. Principle project targets were:

- to stabilize firewood demand at the 1989 level;
- to effectively control the woodfuel supply to the cities;
- to annually increase fuelwood supply from controlled forest exploitation, combined with the creation of rural woodfuel markets;
- to put in place a new pricing policy for fuelwood, together with new tax systems for fuelwood, which would assure economic production and consumption, reduce fraud and create substantial tax revenues;
- to create a permanent system of information and evaluation on stoves and fuels (sales rates, consumer acceptance, prices etc); and
- to attune forestry and energy policies and to improve the coordination of domestic energy.

More specifically for the stoves component, the target was to create a commercial viable and sustainable system for the dissemination of kerosene stoves. Over the 5 years of the project the target was to disseminate 80.000 stoves to the urban population in the cities of Niamey, Maradi, Zinder and Tahoua.

During missions of PEII-ED, Tchip-Import and BTG to Indonesia it appeared that only one factory could manufacture burners of the desired quality which were technically complying,

the Pendowo stove factory in Malang on Java that produces the Thomas Cup stove. The manufacturer's production capacity for export was limited to 1000 burners per month. The contract between the producer with Tchip-Import was agreed upon in December 1991 and signed in January/February 1992. The first money transfer to Pendowo arrived in Indonesia in March 1992 so the maximum number of kerosene stoves that could be disseminated over the remaining project duration was 20,000.
Before the import by Tchip-Import started, PEII-ED had imported 4000 burners for marketing purposes and to assure the availability of the product during the first publicity campaigns. Thus the total number of stoves that might be disseminated was around 24.000.

3.2.4 Stove selection criteria and technical parameters

Two basic types of kerosene stoves were tested: wick stoves and pressurized stoves.

Wick stoves use wicks to transport the kerosene from the fuel tank to the burner. In the burner the kerosene evaporates, the vapour mixes with air and the mixture burns with a blue flame. Power is controlled by rising or lowering the wicks. The power density of a wick burner is relatively low: a big burner is needed to reach a reasonable power level.

The pressurized burner uses a pump to pressurize the fuel tank. By this pressure the kerosene is transported to the burner. It is injected into the burner through a very small nozzle, forming a vapour jet. This jet entrains the combustion air and the mixture burns with a blue flame. Power is controlled by varying the pressure in the tank. To start evaporation the burner must be preheated. The power density of a pressurized burner is high: only a small burner is needed to reach a reasonable power level.

Gravity fed stoves, a variety of the pressurized stove where the pressure is not created by pumping but by putting the kerosene tank about two meters above the burner, were not considered. Except for the omission of the pumping they have the same disadvantages as the pressurized stoves (see below) with the added handicap of being difficult to transport.

Several models of wick and pressurized stoves were tested, using the water boiling tests and controlled cooking tests, described in chapter 1.4.1 and annex 6.

Because all the kerosene stove models originated from outside Africa, they had to be adapted to local utensils (pots and pans) and cooking habits. Adaptations involved only the supporting structure of the stove, not the burner itself. Testing showed that of the wick stoves only one, the Thomas Cup stove from Indonesia, was powerful enough to suit Sahelian cooking practices. The energy economy established in the tests was over 50% compared to the traditional woodstove, and it also offered a financial benefit of 10 to 20% because of reduced fuel consumption. Therefore this wick stove was chosen to be disseminated.

Wick stoves were preferred above pressurized based on the outcome of a marketing study (Madon and Matly, 1986). Consumers showed a clear preference for the wick stoves because they were easier to use and cheaper to buy. Pressurized stoves were not considered because of the pumping needed, the requirement for a second fuel (alcohol) to preheat the burner, the noise of the flame, and fear for the fuel container to rupture under pressure. A serious practical disadvantage of the pressurized stoves was that they proved to be very sensitive to contaminated fuel. Dirt in the fuel would clog the fine nozzle. Wick stoves are indifferent to contaminated fuel.

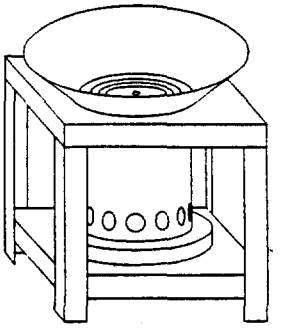

Fig. 19: TCHIP kerosene stove

The choice to disseminate a powerful wick stove as the vehicle for the substitution of fuelwood by kerosene introduced a couple of new aspects that were not encountered before in other (wood) stove projects. The burner of the stove had to be imported from overseas (Indonesia) and the support, that would be manufactured locally, had to be made within small tolerances so that burner and support would fit together without problem.

3.2.5 Market dissemination strategies and systems

The Tchip stoves were to be disseminated through an autonomous self-sustaining commercial system. Input from the project included, apart from initiating the import of burners and the manufacture of supports, publicity and promotion campaigns. The Tchip stoves were promoted through television and radio. Promotional material included T-shirts, stickers, leaflets, calendars and alike. The existence of the Tchip stove was also brought to the attention of the public through billboards and signposts at selling points and through stove demonstrations at markets and other highly frequented places.

Sales Points

About 35 sales point are set up in the 4 cities covered by the project. In addition to buying the stoves and spare parts like wicks, consumers can get information about their operation at these selling points customers. As discussed below, sales points gradually evolved into sales and service points.

After sales service and warranty

The project has installed service centres in each of the cities where the Tchip stoves are sold. Stoves were warranted and customers could get their stoves serviced (maintenance, wick replacement) at these service centres when handing in their warrantee coupons.
The stove service centres were separated from the stove sales points. Because customers tended to return to the shop were they had bought the stove once their warrantee had expired, shop keepers were also trained to service the wick stoves.

3.2.6 Pricing and taxation policy environment

Stoves

The market studies had shown that a price up to approximately 10,000 F.CFA was considered acceptable and would put the stoves within reach of consumers in the desired market segment (Matly, 1990).

The first stoves cost approximately 15,000 F.CFA because of the high transport cost of the imported burners and supports. The project has subsidized these stoves to make them available at a reasonable price. After optimizing sea transport from Indonesia (packing 1100 instead of 600 burners per container) and the localization of support manufacturing, production costs went down. The price structure of the Tchip stove (before devaluation of the F.CFA) is shown in Table 12 (Madon, 1993).

Table 12 Tchip stove - price structure

Item	F.CFA
Burner (Indonesia)	2.975
Packing and local transport Indonesia	180
Sea transport and insurance	900
Surface transport Africa	670
Margin exporter	445
Stove support	2.853
Margin Tchip-Import	1.700
Margin wholesaler	600
Margin retailer	1.600
Sales price	11.923

Fuel

Kerosene prices in Niger have varied considerably over the last years, due to the unofficial kerosene imports (smuggle) from Nigeria. In April 1993 kerosene was priced at approximately 65 F.CFA/l in the south of the country, near to the Nigerian border (PEII-ED, 1993). With the official price fixed at 105 F.CFA/l the official kerosene traders in that region were forced to close down.

Due to fuel price increases in Nigeria and better border control at the Niger side, informal kerosene prices have gone up to around 150 F.CFA/l by the end of 1993.

After the recent devaluation the official price remained fixed at 105 F.CFA/l, but the availability of kerosene at the official fuel stations was limited. Madon (1994) expects the kerosene price to increase to approximately 200 F.CFA/l. At this price level, a subsidy of

100 F.CFA/l is still required for the kerosene that is sold through the official channels. This level of subsidy is not sustainable and kerosene prices are likely to increase substantially.

3.2.7 Project operation

Import and Production cycle

Of the two main components of the stove, the burner is imported from Indonesia and the supporting structure is locally made.

For the import of the burners a contract was signed between Tchip-Import and the Indonesian manufacturer, Pendowo. The contract arranged for the manufacture of lots of 6000 burners at a fixed price, to be produced and shipped at a rate of 1000 burners per month. Per batch of 6000 an advance payment of 30% was to be paid to pre-finance the necessary primary materials. The remaining 70% was payable after each shipment of 1,000 burners. An Indonesian consultant was hired to represent Tchip-Import and to take care of the payments, the quality control and shipment of the stoves and to liaise between Tchip and Pendowo. The local consultant would order each batch of 1,000 burners after receiving the funds for burners, packing and transport.

Burners were shipped to Cotonou (Benin) where they were received by the clearing agent representing Tchip-Import. Tchip-Import arranged the surface transport from Cotonou to Niamey.

Because the imported burners must fit in the locally produced supports, these supports must be manufactured according to strict specifications. This necessitates industrial production with adequate machines and tools.

For the first batches of imported burners PEII-ED ordered test series of supports at local workshops in Niamey, Maradi, Tahoua and Zinder, but the quality of these supports was not sufficient. To be able to control quality and to be assured of a sufficient number of supports, Tchip-Import decided to start its own production of supports. For this purpose it has acquired a shed, machines and tools. The production capacity is sufficiently large for the production of the necessary supports and offers possibilities for the production of burners. To that effect Tchip-Import has recently installed a 80 tons hydraulic press.

3.3 Project evaluation

3.3.1 Targets and achievements

Stove dissemination and sustained consumer acceptance

By the end of the project 8000 kerosene stoves were disseminated, including the 4000 stoves imported by PEII-ED before the activities of Tchip-Import started. Therefore over a two years, Tchip-Import imported and marketed only 4000 stoves of the possible 20.000.
The single reason for this poor performance was the lack of adequate financial management by Tchip-Import. Except for the first payments, others were always too late and/or insufficient. Delays of several months were no exception, in spite of repeated promises of Tchip-Import that money would be transferred shortly ("before the end of this week"). The last batch of 1200 burners was never paid for by Tchip-Import and Pendowo consequently cancelled the contract.

To date, all the imported Tchip stoves have been sold without problems. Publicity campaigns have been successful, the Tchip stove is widely and well known, and there are sales points in every neighbourhood. The stove is a popular product but it is hard to forecast whether this demand is sustainable, as the period it has been on the market in sufficient numbers has been too short. The first negative consumer reactions, however, have been noted, concerning the (high) fuel consumption and the requirement to replace wicks frequently.

Interfuel substitution and woodfuel savings impact

The recent survey on fuel consumption in Niger has shown that families that have a Tchip stove use the stove together with their (improved) wood stove. These families economize 19% of fuelwood compared to those that exclusively use the traditional woodstove.
To stabilize woodfuel consumption in Niamey at the 1993 level, the total number of improved wood and kerosene and gas stoves should economize about 6000 tons of fuelwood. In total about 3900 tons were economized (PEII-ED, 1993), of which 2300 tons can be contributed to the use of Tchip stoves.

Consumer benefits

Main advantages of kerosene stoves as perceived by the user are the easiness of lighting, its power and its controllability. In addition it is a modern piece of equipment, improving the status of the households owning one.

Project sustainability

Project sustainability depends to a very large extent on the availability of burners. If they can no longer be imported from Indonesia, everything depends on the creation of local production facilities. Production of burners is technically not very complicated, but not an easy job either, especially under African conditions and without prior production experience.

Secondly, to keep the customer satisfied, the negative feedback should be taken into account: high kerosene consumption and rapid wear of the wicks. The high kerosene consumption can be taken care of by introducing a less powerful burner with only 24 wicks or by emphasizing the correct use of the Tchip stove with 36 wicks. Unfortunately the room for importing burners of any kind ceased after the connection with Pendowo ended so the option for a 24 wick stove becomes only materialises when the local production of burners can be realized.

The high kerosene consumption is most probably due to insufficient (if any) power reduction during the simmering phase of the cooking process (Ref. Annex 6). If this is the case, the introduction of a 24 wick burner will only cure this problem to a very limited extend. A better approach is to intensify and improve the training of the users of kerosene stoves.

Quick wear of the wicks is a maintenance problem: the wick length should be adjusted every day. If not done every day, the wick will burn and adjustment becomes difficult or impossible and wicks must be reinstalled for which special tools are needed. This problem can be overcome by improved training of the user or by installation of wicks with a glass fibre protection cover.

3.3.2 Lessons learned

Leaving the dissemination of kerosene stoves to a single entrepreneur has proven to be tricky. The entrepreneur involved, for whatever reason, did not fulfil his contractual obligations and has caused the import and dissemination of kerosene stoves to cease.

In the case of involvement of the private sector, a good and legally sound contract should be drawn up so that some level of control and correction is possible in case the entrepreneur shows to be unable to manage his business. Stove activities should be separated from other commercial activities in order to avoid priority problems.

It never became clear what caused the owner of Tchip-Import to delay and eventually cease the payments to Indonesia.

3.3.3 Expected impacts of the F.CFA devaluation

The devaluation of the F.CFA will have an important impact on the price of the Tchip stove. Madon (1993) estimates that after devaluation the stove will be priced at 18.000 F.CFA when burner import from Indonesia ceases, and at 13.000 F.CFA if the burner can be produced locally. The price of kerosene is also likely to increase. As discussed above it is not unlikely that it will reach 200 F.CFA/l shortly.

Both factors will probably cause the costs of cooking on kerosene to increase with 50 to 100%. As, in spite of the devaluation, fuelwood prices have hardly increased to date, the expected price increase will make kerosene less attractive and affordable.

3.4 Conclusions and policy recommendations

Conclusions

1 Kerosene stoves can cater to an important market niche in Niger. They are a popular product and all the imported stoves have been sold to date.

2 Publicity and promotional campaigns have been successful. Urban population knows about the Tchip stove and about its advantages.

3 A large number of sales and service points for the Tchip stove has been created.

4 Due to inadequate management of the entrepreneur in charge of the import from Indonesia, the number of burners imported was very low and import eventually ceased.

5 Local production facilities for supports of good quality were set up by the entrepreneur. A start was made to initiate local production of burners.

6 The first negative consumer comments have been noted concerning high fuel consumption and wear of wicks.

Recommendations

1. Every effort should be focused at making Tchip stoves available on the market again.
2. The reason for high fuel consumption and wear of wicks should be investigated and corrected.
   High kerosene consumption could be the result of incorrect use of the stove.
   Wear of wicks could be the result of a lack of daily maintenance.
   If both assumptions are true, the problems result from an inadequate training program on the functioning and use of the stove; the introduction of a less powerful burner will only partially remedy the high fuel consumption, and not the wear of wicks.

4 THE "CASAMANCE" IMPROVED KILN PROGRAM (SENEGAL)

4.1 Introduction

The available information on the Casamance kiln project is very limited. It was only on the afternoon of the last day of the mission in Senegal that I was able to have a short interview with Mr. N'Diaye, Coordinator of the Carbonization Projets at the Water, Forest, Hunting and Soil Conservation Department

4.1.1 Background

Charcoal is the key fuel for urban households in Senegal. Urban households use 85% of the total energy and over 90% of their cooking fuel in the form of charcoal. Charcoal is traditionally produced with an efficiency of 18-20%; thus, to make one kg of charcoal requires 5.0-5.5 kg of wood. Because of urban growth and the intensity of urban fuelwood consumption in the form of charcoal, cities are casting a growing "urban shadow" over the countryside, with charcoal makers cutting trees to supply urban demand.

Commercial wood-cutting and carbonization are regulated and only registered forest users are authorized to engage in these activities. The registered forest users employ charcoal makers, known as *sourghas*, to cut wood, build kilns, and supervise carbonization. The *sourghas* are primarily from the Peul tribe in the neighbouring Ghana. They are paid per sack and often receive an advance from their employer to meet basic needs. Because of their status as foreigners, their indebtness and the fact that administrative paperwork is handled by their employers, they are completely dependent on (and often exploited by) their patrons.

The Senegalese charcoal makers are known to be the best in West Africa (Esmap, 1989) Traditionally, they burn charcoal in very big earth mound kilns with an average size exceeding 200 stere. Carbonization takes 3 months or longer from initial loading to packing the last charcoal bag. The yield[7] (by weight) of their traditional earth-covered kilns approaches 18-20%. Each charcoal maker prepares an average of 2-3 kilns per season, each of which produces 10-20 tons of charcoal from 50-100 tons of wood. Total charcoal production in Senegal was estimated at 220,000 tons in 1988; thus the number of charcoal makers would exceed 5,000.

In principal, three methods can be applied to improve yields of traditional charcoal kilns: (1) using drier wood[8], (2) constructing larger kilns (which incur relatively lower heat

[7] Yield = ratio between charcoal weight (air-dry) and wood weight (air-dry)

[8] At lower moisture contents the carbonization efficiencies are higher, and *vice versa* at higher moisture contents. In theory, a 10% decrease in wood moisture content (expressed on wet basis, mcwb) will cause a 3.8% increase in the kiln charcoal yield. Drying wood for 30-45 days will in the dry season normally reduce the mcwb from around 40% to 20%, and in theory lead to 7.5% increase in charcoal yield. However, even charcoalers who have been demonstrated the potential to increase yields usually do not dry green wood prior to carbonization, *inter alia* because they cannot afford the large investment in working capital nor do they wish to take the risk of theft by fellow charcoalers.

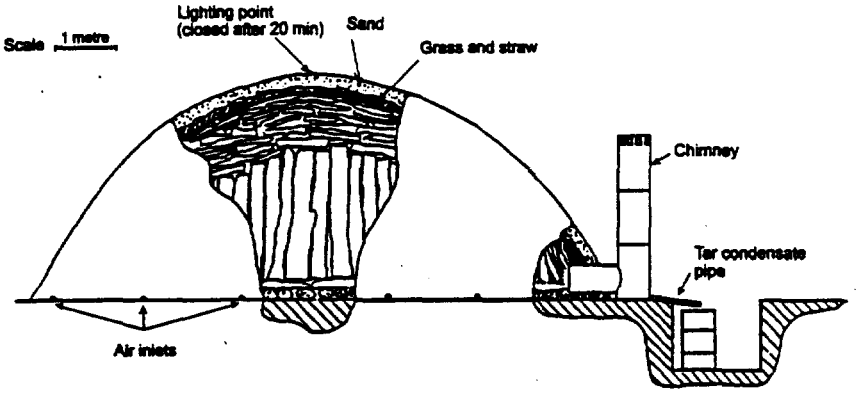

Fig. 20 The Casamance improved kiln

losses), and (3 improving process control. Preferably all methods are to be applied simultaneously. In Senegal, the last method was employed in a project funded by USAID which aimed at improving control of the carbonization process by disseminating the Casamance kiln developed by the US Peace Corps.

The Casamance kiln is a modified version of the traditionally vertically stacked earth kiln and incorporates an external chimney with tar collector. The size of the kiln ranges between 30 and 100 m^3 capacity. The kiln is constructed by first placing a horizontal layer of medium sized wood (15 to 20 cm in diameter) dispersed radially on the ground. On top of the base layer small-sized wood pieces (7 to 10 cm in diameter) are placed in order to ensure good circulation of the gases during operation.

The metal chimney is made of three used barrels welded together. The bottoms of the barrels are opened partially by about 20 cm in order to cool and condense the hot gases into pyroligneous acid and wood tars, which are collected through a small opening at the base of the chimney. Approximately 3.3 litres per stere of wood is recovered. These by-products may be used as a replacement for imported creosote for the treatment of telephone poles or fences.

The carbonization yield (oven-dry basis) is estimated to be around 25%, depending on the type of moisture content of the wood, the timber's actual density and stacking density, etc. In the Senegalese situation this means a relative gain of 25% as compared with the traditional kiln.

4.1.2 Project objectives and targets

The objective of the project was to improve the yield of charcoal making in Senegal through the introduction of the Casamance kiln. The objective was to be achieved by the training of charcoalers in the use of the Casamance kiln.

4.1.3 Kiln selection criteria and technical parameters

The choice for the Casamance kiln was made after an evaluation of four different improved kilns during the "Projet d'amenagement de la forêt de Tabor" in the Casamance province in the south of Senegal. The four kiln type evaluated were:

- Casamance kiln
- metal kiln "Mark V"
- retort kiln
- mixed kiln "Metal and ditch"

The Casamance kiln was selected for two reasons:

- low investments costs compared to the other improved kilns; and
- charcoal yield was high compared to the traditional kiln. To produce 1000 kg of charcoal the wood input for the traditional kiln were claimed to be 13 stere of wood while the Casamance kiln needed 7 stere (1 stere = ± 450 kg [9]), signifying an efficiency improvement from 17 to 31%.

4.1.4 Project funding and donor coordination

The project was funded by USAID in two stages of 100 million F.CFA and 200 million F.CFA respectively. over a period of six years, 1980 - 1986.

After 1986 the Senegalese government continued the support of the charcoalers using the Casamance technology from its own resources by making available 60 million F.CFA over 1987 - 1990 (Budget Nationale d'Equipement) and 50 million F.CFA over 1989 - 1991 (Fond National de l'Energie). The money of these funds was exclusively to be used to buy tools for the charcoalers, like shovels, rakes, balances, chimneys, etc.

Table 13 Project funding in the different phases of the Casamance improved kiln program

Period	Donor	Funding	Program
1980-83	USAID	100 mF.CFA	Projet National de Carbonisation par la vulgarisation de la meule Casamance
1983-86	USAID	200 mF.CFA	
1987-90	Senegal	60 mF.CFA	Budget Nationale d'Equipement
1989-91	Senegal	50 mF.CFA	Fond National de l'Energie

[9] number quoted by mr. N'Diaye. Other sources mention values varying from 250 to 350 kg/stère

4.2 Project evaluation

4.2.1 Targets vs achievements

The project has trained about 700 charcoalers in the use of the Casamance kiln.

4.2.2 Fuelwood savings impact

No data are available to the mission how on much charcoal has been produced by the charcoalers trained in the use of the Casamance kiln, nor about the amount of wood saved.

4.2.3 Project sustainability

After the financial assistance of the "Fond National de l'Energie" has stopped, there is no follow up on the project, nor any systematic monitoring. It was estimated that 350 of the 700 charcoalers trained still use the Casamance kiln. There is no data as to what rate charcoalers have invested in new chimneys or other equipment.

4.2.4 Lessons learned

Measurements during project execution have shown that the Casamance kiln can give a higher charcoal yield, although the technique has less impact than originally estimated (Feinstein, 1991). But the amount of wood to cut is much higher than for a traditional kiln so the charcoalers need to organize and they need to invest in a chimney.

Apparently the investment is the bottleneck in the system: as long as there was financial assistance to buy chimneys and tools, charcoalers tended to keep using the Casamance kiln. But as soon as they needed to invest themselves in new equipment they returned to the traditional kiln. Whether the additional profits of the Casamance kiln weren't apparent enough to the charcoalers to make the investment for the chimney themselves or that the financial means were lacking is not clear.

It has proven difficult to organize the charcoalers in the Casamance kiln project and this lack of organization and structure has obstructed financing and training facilities, as well as project sustainability.
In order to overcome these problems some kind of organization could be introduced. In the "Projet d'amenagement de la forêt de Tabor", which formed the basis for the Casamance project, forest management groups were created. These groups had a certain stability and status, which enabled them to get credits from a bank, for instance for a chimney.

In the Casamance project, however, the project did not succeed in organizing the charcoalers, since the specific target population is from nomad origin (Peul). A second reason was that attempts to organize sourgas in collectives were discontinued due to lack of financing (Feinstein, 1991).

The implementation of the improved kilns might be more successful in the settings of more general programs (integrated rural development, or sustainable forest management programs), that also promote the organization of the target population.

Bibliography

General

CILSS: "Seminaire régional CILSS/France: Réunion des chercheurs Mansakonko". CILSS, Ouagadougou, June 1986.

CILSS: "The CILSS/UNFSSTD international seminar on research and dissemination strategies of improved stoves for the Sahelian region". CILSS, Ouagadougou, Nov. 1984.

Jorez, Jean-Philippe: "Guide technique de l'économie du bois de feu: L'expérience du Sahel". Lund Centre for Habitat Studies, Lund, Nov. 1991.

Madon, Gérard and Matly, Michel: "Conservation et substitution de l'energie a l'usage domestique". Consultancy report for the World Bank, Washington, July 1986.

Madon, Gerard: "Propositions pour une 2eme phase de mise en oeuvre de la strategie energie domestique" (Document provisoire). SEED, Paris, Jan. 1994.

Burkina Faso

Kabore, Marguerite "La promotion des foyers améliorés au Burkina Faso". Ministère de l'Environnement et du Tourisme (MET), Ouagadogou, date unknown

MET, "Rapport annuel d'activites (Janvier - Decembre 1986) - Projet UNSO/BKF/85/X03 - Appui à la construction et diffusion des foyers améliorés (phase II)". Ministère de l'Environnement et du Tourisme (MET), Ouagadogou, January 1987

MET, "Rapport sur la campagne de promotion des foyers améliorés (Bobo-Dioulasso 16 Juin - 15 Juillet 1987) - Projet UNSO/BKF/85/X03 - Appui à la construction et diffusion des foyers améliorés". Ministère de l'Environnement et du Tourisme (MET), Ouagadogou, 1987

MET, "Rapport d'activites 1987 - Projet UNSO/BKF/85/X03 - Appui à la construction et à la diffusion des foyers améliorés". Ministère de l'Environnement et du Tourisme (MET), Ouagadogou, January 1988

MET, "Projet UNSO/BKF/89/X03 Foyers Améliorés - Rapport Final". Ministere de l'Environnement et du Tourisme (MET), Ouagadogou, September 1993

MET, "Examen des politiques, stratégies et programmes du sous-secteur energétique traditionnel". Ministère de l'Environnement et du Tourisme (MET), Ouagadougou, February 1994

Saka, Parfait, "Evaluation à mi-parcours de la stratégie de production/diffusion des foyers améliorés à dolo dans la ville de Ouagadougou - Rapport Final". Ministère de l'Environnement et du Tourisme (MET), Ouagadougou, December 1993

SEGP, "Rapport d'evaluation de la stratégie test d'autonomisation de la production et de la commercialisation des foyers metalliques améliorés a Ouagadougou - Rapport Final". Consultancy report for Ministère de l'Environnement et du Tourisme, Ouagadougou, May 1993

Yameogo, Georges and Sawadogo, Armande, "Test de performances et etudes d'acceptabilité du foyer à gaz bugunana". Institut Burkinabe de l'Energie (IBE), Ouagadougou, January 1992

Gambia

Berthelsen, S. "UNSO/GAM/85/X01 Production and promotion of improved cooking stoves - Draft strategy paper for project reorientation 1990-1991/1992". UNSO, Banjul, May 1990

Bialy, Jan a.o. "The production and promotion of improved cooking stoves UNSO/GAM/85/X01 - Final report of the in-depth evaluation mission". Report for UNSO/UNDP, Edinburgh, June 1991

Bulow, Dorthe von, "The improved stoves project in the Gambia - Six-monthly progress report (November 1993 - May 1994)". For UNSO, Banjul, June 1984

DANIDA, "The improved cooking stoves project in the Gambia". Mission report from Danida/OPE/UNSO, Banjul, July 1984

MEPID, "Lomé III Regional Programme for the Sahel Countries - LPG project (national component for the Gambia) - Action Plan", Ministry of Economic Planning and Industrial Development (MEPID), Banjul, November 1989

RPTES, "Review of the traditional energy sector (RPTES) - Gambia Country Study (1st draft)". RPTES Gambia, Banjul, 1992

Mali

ABF/GTZ/ITDG, "Recommendations pour des Programmes Foyers Améliores en Milieu Rural - Elaboré par le colloque foyers améliorés". ABF/GTZ/ITDG, Bamako, November 1991

Gajo, Michael a.o.: "Projet foyers améliorés DNAS/GTZ (Herdverbreitung Mali) Mali. Rapport sur le contrôle de l'état d'avancement du projet". Consultancy report prepared for GTZ, Eschborn, April 1993.

Lo, Masse a.o. "Diffusion de foyers améliorés et intervention sur les filieres d'approvisionnement en bois-energie de la ville de Kayes, Mali (draft du rapport provisoire)". Report for UNSO/UNIFEM, Bamako, April 1993.

MSSPA, "Etude filiere foyers améliorés". Ministère de la Santé de la Solidarité et des Personnes Agées (MSSPA), Bamako, January 1994

RPTES: "Examen des politiques, strategies et programmes du secteur des energies traditionelles - Evaluation du secteur de l'energie traditionelle". RPTES Mali, Bamako, February 1994.

Visser, Piet: "Stoves and lamps for Mali". Consultancy report for the World Bank, Washington D.C., July 1989.

Niger

Aboubacar, Idi: personal communication. Niamey, 16 March 1994.

Bussmann, Paul and Visser, Piet: "Stoves for the UNSO/NER project". Consultancy report for the World Bank, Washington, July 1986.

Gajo, Michael a.o. "Rapport final du Projet Foyers Améliorés GTZ-PSE/BM/DE - Activités, Analyses, Recommendations". Ministère des Mines et de l'Energie, Niamey, January 1987

PEII - ED: "L'Indicateur energie domestique Niger". PEII-ED, Niamey, 2eme sem. 1993.

RPTES, "Examen des politiques, stratégies et programmes du secteur des energétique traditionnel - Evaluation du secteur de l'energie traditionelle". RPTES Niger, Niamey, February 1994

Tiémou, Issoufou: personal communication. Nimaey, 17 March 1994

UNDP/WB ESMAP, "Mid-term progress report - Niger: Improved Stoves Project.

UNDP/WB Energy Sector Management Assistance Programme, New York/Washington D.C., July 1986 (bilingual)

UNDP/WB ESMAP, "Activity Completion Report - Niger: Improved Stoves Project. UNDP/WB Energy Sector Management Assistance Programme, New York/Washington D.C., December 1987 (bilingual)

UNDP/WB/Biliteral Aid ESMAP, "La consummation de bois de feu a Niamey - Analyse et conseils méthodologiques pour les prochaines enquêtes". The World Bank, Washington D.C., 1988

Visser, Piet: "Aide-mémoire relative à la mission nr. 2 de l'expert technologique foyer. Avril-Mai 1990". Consultancy report for SEED-CTFT, Paris, May 1990.

Senegal

BTG, The charcoal industry in Liberia, for: UNIDO, Vienna, March 1990

BTG, An investigation of charcoal production, for: Ministry of Agriculture, Maputo, December 1990

Chatain, Elisabeth: "Diffusion massive de foyers améliorés: Contraintes et perspectives". UNDP, Dakar, May 1988.

ESMAP, Rwanda: Improved charcoal production techniques, for: WB/UNDP. Washington, February 1987

ESMAP, Senegal - Urban Household Energy Strategy, for: WP/UNDP. Washington, March 1989

FAO Forestry paper 41 - simple technologies for charcoal making, Rome, 1983

Feinstein, C; Plas, R. van der; Improving charcoaling efficiency in the traditonal rural sector, World Bank, Washington, July 1991

Foley, G. - Charcoal making in developing countries, for: Earthscan, London, Janaury 1986

Jambes, J.Pierre: "Diffusion de foyers ameliorés dans la region urbaine de Dakar". Report for Ministère de la Cooperation, Paris, February 1992

Jores, Jean-Philippe" "Evaluation du Programme de Diffusion de Foyers Ameliores au project PRBOVIL". Consultancy report for Ministere de l'environnement et de la protection de la nature, Dakar, January 1994.

Laura, Phillippe and Jambes, J.Pierre: "Diffusion de foyers ameliorés dans la agglomeration de Dakar". Report for Ministère de l'Industrie et de l'Artisanat, Dakar, Augustus 1990

Laura, Philippe: "Les combustibles domestiques au Sénégal - Consommations et pratiques des ménages", report for Ministère de l'Industrie, du Commerce et de l'Artisanat, Dakar, December 1992

MEMI/MEPN, "L'observatoire des combustibles domestiques - Numéro 3", Ministère de l'Energie, des Mines et de l'Industrie (MEMI) with Ministère de l'Environnement et de la Protection de la Nature (MEPN), November 1993

MICA, "Document préparatoire à la reunion sectorielle sur l'énergie - Annexe A: combustibles domestiques". Ministère de l'Industrie, du Commerce et de l'Artisanat (MICA), Dakar, October 1991

MICA, "Appui au secteur des combustibles domestiques - rapport d'activités Novembre 1990 à Décembre 1991. Report for Ministère de l'Industrie, du Commerce et de l'Artisanat (MICA), Dakar, 1992

MICA/MDRH, "L'observatoire des combustibles domestiques - Numéro 1", Ministère de l'Industrie, du Commerce et de l'Artisanat (MICA) with Ministère du Développement Rural et de l'Hydraulique (MDRH), July 1992

NRI- Charcoal production - a handbook, for: Commonwealth Science Council, London, November 1991

RPTES: "Etude du secteur des energies traditionelles". RPTES Sénégal, Dakar, February 1994

Annex 1: Terms of reference

AFRICA REGIONAL STUDY
Review of Policies in the Traditional Energy Sector (RPTES)

Terms of Reference

Biomass Technology Group - BTG
Improve Energy Technology Specialist

Short-Term Consultants

I. Project Objectives

1.1 The Energy Unit within the Africa Technical Department (located organizationally within the Division for Private Sector Development and Economics - AFTPS) has commissioned a regional review of the traditional energy sector in Sub-Saharan Africa with the following objectives:

(i) undertaking a retrospective evaluation of the objectives, scope and approach of the traditional energy sector work done to date and of its resulting policies, strategies, and programs on the evidence of stated public policy, its execution by agents in the public and private sector, and activities of external assistance agencies and organizations;

(ii) identifying the principal critical inter-sectorial linkages that influence the operation of the traditional energy sector in selected countries, and developing a conceptual framework and strategy for the sector within this enlarged operational context;

(iii) preparing a set of recommendations of new policy directions for the development of the traditional energy sector, and for the establishment of implementation priorities by national institutions and economic agents, complemented by appropriate instruments of external assistance;

(iv) identifying projects and/or programs and thus to arrive in the shortest possible time at operational results; and

(v) disseminating the operational results among the donor community at large.

1.2 Given the wide scope of the proposed review, it is being implemented by examining and evaluating the relevant sector activities in several phases:

(i) A summary overview of past activities in the traditional energy sector throughout Sub-Saharan Africa; this initial activity is aimed at sharpening the focus of the issues, preparing terms of reference and contracting external consulting assistance required in the next phase;

(ii) The policy review itself, to be carried out for a few reasonably homogeneous groups of sample countries and culminating in a synthesis of those results that are of broad significance for the Africa Region. The country selection is based on the perceived severity of actual sector problems, the extent of work already done, the

existence of complementary data bases in adjacent countries, the experience with alternative policy approaches in similar environments, etc. The initial execution Phase IIa will evaluate a group of five Sahelian countries comprising Senegal, Gambia, Mali, Niger and Burkina Faso.

1.3 The activities described above are being financed out of a trust fund provided by the Government of The Netherlands and administered by the World Bank. It is envisaged that, upon completion of Phase IIa, the policy review would continue with separate funding to cover other groups of representative sample countries (Phase IIb), with the objective of obtaining an operational overview and synthesis for all of Sub-Saharan Africa.

II. Bank Supervision

2.1 The Project supervision within the Bank is the responsibility of the Division for Private Sector Development and Economics within the Africa Technical Department (AFTPS). AFTPS assures the liaison with external Consultants through a full-time Task Manager whose functions include:

(i) Directing the day-to-day project implementation and integrating the contributions of consultants and African counterparts in the field in interim reports and consolidating the results in the final report;

(ii) Maintaining contact with public and private sector entities in the five countries (in cooperation with Bank Resident Missions);

(iii) Facilitating contacts between Consultants and Bank units concerned with the subject matter, specifically the Sector Operating Divisions (SOD's) in the Africa Region responsible for energy, the thematic teams in the Technical Department, the Divisions in central Vice-presidencies responsible for the development of Bank policy in the relevant subject areas and ESMAP staff; and

(iv) Facilitating contacts between Consultants and other bilateral and multilateral donors and aid organizations.

III. Scope of Consultant Services

3.1 Under the direction of the Task Manager, and in accordance with these Terms of Reference, the Consultants will provide the following services within their areas of expertise:

(i) Undertake a retrospective review of the principal improved stoves (woodfuels and petroleum fuels) and kilns programs that have been implemented in the RPTES country sample (Burkina Faso, Mali, Niger, The Gambia, Senegal) during the last 10 years. This review will take as a starting point the information already collected by RPTES' African counterpart teams and written up in the draft country reports presented at the Second RPTES Workshop held in February 1994. The field phase of the assignment will comprise a discussion of the results obtained thus far with the counterparts concerned, and the completion of the information base as necessary. When identifying and analyzing each

program/project, the Consultants will pay specific attention to the following aspects:

- project organization and management (source and amounts of external and local funding, length of activity, linkage to regional programs, modality of technical assistance including arrangements for training and technology transfer, national counterpart setup, activity supervision and evaluation procedures);

- the specific technologies (stoves and kilns) promoted and the rationale for the choices;

- proposed targets and actual achievements (stoves/kilns produced/imported, stoves/kilns disseminated, energy efficiency and/or energy savings (contrasting efficiency improvements inferred from laboratory tests with the likely results obtainable in the field);

- the market dissemination strategies used (consumer/user awareness & dissemination programs, pricing and taxation policies, promotion campaigns, etc.);

- current status of programs/projects and assessment of their sustainability (including a thorough evaluation of maintenance problems) upon termination of donor funding; and

- principal reasons for success or failure of program/project.

(ii) Based on the findings of item (i), above, identify and analyze the common sub-regional issues/themes that emerge at the sub-regional level (RPTES sample countries), paying special attention to:

- institutional aspects (including but not limited to financing, donor coordination, counterpart organization, management, gender roles, continuity, incentives for maximum private sector participation);

- pricing and taxation policy (as applied to fuels and cooking equipment);

- market dissemination strategy (including the relative merits of stove promotion in urban and rural areas);

- technology aspects (including tradeoffs among consumer acceptance, efficiency, convenience, etc.);

- the relative merits of butane and kerosene substitution for woodfuels (with special reference to the commercial operation of the "Tchip" stove factory in Niamey, Niger, the prospects for dissemination of this stove in other countries and especially Eastern Mali, and the advisability of promoting kerosene substitution in The Gambia).

- for the countries in the franc zone, the likely effects of the recent CFAF devaluation on the cost of cooking and the householders' choice of cooking equipment and fuels.

The issues listed under (ii) above, are a subset of a more general set of questions that was included in the RPTES application for financing as Appendix II, under the title "A Sampling of Policy-Related Questions". This Appendix is attached to these Terms of Reference as an information item that may assist the Consultants to place their contribution in the overall framework of the RPTES.

3.2 Implementation of Assignment. The Consultants will implement the assignment according to the following calendar:

(i) Interim report on item (i) at the end of the sixth (6th) week of the assignment.

(ii) Draft final report on items (i) and (ii) at the end of the twelfth (12th) week of the assignment.

Upon receiving the interim report from the Consultants, the Task Manager will provide comments within 5 working days. The Consultants will forward a final report on his assignment within 15 working days of receiving the comments from the Task Manager on the Draft final report.

3.3 Term of Assignment. In the execution of this assignment the Consultants will utilize a maximum of eleven (11) weeks within a maximum period of fifteen (15) weeks. This assignment will include, approximately, five (5) weeks of field work and six (6) weeks of desk work.

Annex 2: Summary of Improved Woodfuel Projects Reviewed

WS1

1 Country	Niger
2 Name	Projet Foyers Améliorés, phase I (urban) and II (urban and rural)
3 Current status	Stopped in december 1993, actually very limited activities in follow up phase on remaining project budget (until end 1995)
4 Donor(s)	World Bank and GTZ for phase I and GTZ for phase II
5 Donor Budget	90 million F.CFA for phase I and 744.000 DM for phase II
6 National Budget	Personnel, offices
7 Execution Period	phase I: 1985-1987, phase II: 1989-1993, interim period 1988
8 Expatriate Executing Agency	GTZ
9 National Executing Agency	Ministry of Energy and Mining, Direction of Energy
10 T.Assistance Modality	Resident T.A. for project management. Consultants for stove development and publicity.
11 Project linkage	Projet Energie II - energie Domestique - Volet Demande - Programme Régionale Gaz
12 Target population	urban and rural
13 Proposed Qualitative Objectives	Reduction of fuelwood demand (phase II) - good use of stoves - dissimination of stoves
14 Proposed Quantitative Targets	20.000 stoves in phase I,
15 Achieved Qualitative Objectives	Reduction of fuelwood demand (15-25% savings, based on extrapolation of data)
16 Achieved Quantitative Targets	40,000 stoves in phase I 45,000 (urban) and 12,000 (rural) in Phase II
17 Principal problems	Verification of wood savings Sustaining level of stove sales / sustaining sales structure
18 Lessons learned	Project should create sustainable retail system (phase I)

WS2

1 Country	Burkina Faso
2 Name	Projet Foyers Améliorés
3 Current status	completed
4 Donor(s)	Sweden, through UNSO
5 Donor Budget	US 238.000 for phase I, US 860.333 for phase II and US 2.416.440 for phase III. Phase III includes forestry actions.
6 National Budget	personnel, offices (± US 350,000 for phase III)
7 Execution Period	phase I: 1984-1986, phase II: 1986-1988, phase III: 1988-1992
8 Expatriate Executing Agency	-
9 National Executing Agency	Ministry of Environment and Tourism
10 T.Assistance Modality	Resident TA for project management and stove technology, through swedish consultancy firm
11 Project linkage	-
12 Target population	urban and rural
13 Proposed Qualitative Objectives	Phase I: stove development and pilot studies Phase II and III: reduce wood consumption by introduction and use of improved stoves Phase III: Develop forestry and agro-forestry actions with women
14 Proposed Quantitative Targets	120.000
15 Achieved Qualitative Objectives	Not evaluated
16 Achieved Quantitative Targets	52,000 stoves in phase II 130,000 stoves in phase III
17 Principal problems	No data on woord economy or market penetration, stoves in use, etc. Inadequate project preparation and insufficient project sustainability.
18 Lessons learned	Project was too much focused on stove promotion and distribution. Need for better project preparation to assure project sustainability.

WS3

1 Country	Mali
2 Name	Projet Foyers Améliorés
3 Current status	preparing phase III 3 years of continuing project work, 2 years of follow up activities.
4 Donor(s)	Germany (GTZ)
5 Donor Budget	phase I: 640.000.000 F.CFA; phase II: 640.000.000 F.CFA; phase III: 640.000.000 F.CFA (projected)
6 National Budget	personnel, office room
7 Execution Period	phase I: 1988-1991, phase II: 1991-1994, phase III: 1994-1998 (?)
8 Expatriate Executing Agency	GTZ
9 National Executing Agency	DNAS
10 T.Assistance Modality	Resident TA for project management Consultants for marketing
11 Project linkage	-
12 Target population	urban
13 Proposed Qualitative Objectives	phase II: Creation of a performant stove dissemination system
14 Proposed Quantitative Targets	phase I: 25.000
15 Achieved Qualitative Objectives	stove dissemination system in place
16 Achieved Quantitative Targets	phase I: 32.000 stoves phase II: no data available
17 Principal problems	stove sales down to 250/month
18 Lessons learned	continue reinforecement stove production and commercialization system

WS4

1 Country	Mali
2 Name	Projet Foyers Améliorés
3 Current status	finished
4 Donor(s)	USAID
5 Donor Budget	U$ 482.000
6 National Budget	CNESOLER facilities (office, laboratory, test facilities)
7 Execution Period	1986-1988
8 Expatriate Executing Agency	VITA
9 National Executing Agency	CNESOLER
10 T.Assistance Modality	Resident TA on stove technology
11 Project linkage	Volet Foyers Améliorés du Projet Energies Revouvables
12 Target population	Urban
13 Proposed Qualitative Objectives	Development of urban metal stove models; Dissemination of stoves in Bamako; Training of craftsmen on stove production
14 Proposed Quantitative Targets	-
15 Achieved Qualitative Objectives	Development of the multi-marmite trois barres metal stove model; Craftsmen trained, clients satisfied
16 Achieved Quantitative Targets	Stove dissimination number unknown.
17 Principal problems	Stoves used with too small pans. Inadequate pan supports.
18 Lessons learned	Stoves should only adapt to one pot size

WS5

1 Country	Mali
2 Name	Volet Foyers Améliorés du Projet Energies Renouvables
3 Current status	finished
4 Donor(s)	USAID
5 Donor Budget	U$ 4,000,000 for the complete project. Budget for stove-component is not known
6 National Budget	CNESOLER facilities (office, laboratory, test facilities)
7 Execution Period	1980-1985
8 Expatriate Executing Agency	AID
9 National Executing Agency	CNESOLER
10 T.Assistance Modality	Resident TA on stove development and management
11 Project linkage	
12 Target population	Rural
13 Proposed Qualitative Objectives	Development and large scale dissimination of heavy stoves in rural areas
14 Proposed Quantitative Targets	
15 Achieved Qualitative Objectives	Development of a number of wood stove models, principally heavy stoves with 2 or 3 holes; development of 3PA
16 Achieved Quantitative Targets	Number of stoves developed and dissiminated unknown
17 Principal problems	
18 Lessons learned	Need for a portable metal stove

WS6

1 Country	Mali
2 Name	Volet Foyers Améliorés du Projet Pilote de Foyers Améliorés et Forestière dans la ville de Kayes
3 Current status	Finished
4 Donor(s)	Norway through UNSO and UNIFEM
5 Donor Budget	US 212,000 for Volet Foyers; US 530,000 for total project
6 National Budget	Personnel and offices, estimated at 12 million F.CFA
7 Execution Period	1988-1991
8 Expatriate Executing Agency	-
9 National Executing Agency	Ministère des Eaux et Forêts
10 T.Assistance Modality	Incidental (short term) TA when needed
11 Project linkage	
12 Target population	
13 Proposed Qualitative Objectives	Improve conditions of women through the introduction of improved stoves. Reduce pressure on wood fuel through improved stoves.
14 Proposed Quantitative Targets	
15 Achieved Qualitative Objectives	Proposed objectives have not been reached
16 Achieved Quantitative Targets	5,000 stoves 20 craftsmen trained in stove production
17 Principal problems	Poor execution: lack of experts, disagreement between staff members, regular short of funds due to combersome UNSO approval procedures for releasing funds
18 Lessons learned	

WS7

1 Country	Gambia
2 Name	Gambia UNSO Stove Project
3 Current status	stopped in june 1991, limited activities on remaining project budget
4 Donor(s)	Denmark through UNSO
5 Donor Budget	U$ 1,300.000
6 National Budget	Personnel, offices, test facilities
7 Execution Period	1982-1991, in 2 phases (1982-1985; 1985-1991) and several prolongations
8 Expatriate Executing Agency	UNDP
9 National Executing Agency	DCD: Directorate of Community Development; Ministry of Economic Planning and Industrial Development
10 T.Assistance Modality	Resident TA on project management Consultant on stove technology
11 Project linkage	-
12 Target population	urban and rural
13 Proposed Qualitative Objectives	phase I: Research and development, technical and social stove dissimination, persue Banjul declaration phase II: Improve daily life of women and children
14 Proposed Quantitative Targets	
15 Achieved Qualitative Objectives	Noflie I and II stoves Pottery stove developped
16 Achieved Quantitative Targets	40,000 stoves dissiminated
17 Principal problems	Noflie too expensive, ceramic stoves to fragile. Project interruption in 1989
18 Lessons learned	Project should be continued in order to maintain the momentum initiated by the project

WS8

1 Country	Senegal
2 Name	Projet Foyers Améliorés CERER
3 Current status	finished
4 Donor(s)	Denmark through UNSO, USAID and OPEC
5 Donor Budget	700 mln F.CFA
6 National Budget	70 mln F.CFA
7 Execution Period	1980-1988
8 Expatriate Executing Agency	-
9 National Executing Agency	CERER
10 T.Assistance Modality	Peace Corps Volunteers
11 Project linkage	Precoba and Probovil reforestation projects Chodak (Chomage Dakar), employment project
12 Target population	urban and rural
13 Proposed Qualitative Objectives	-
14 Proposed Quantitative Targets	500,000 stoves and 10,000 stoves masons in the rural zone, between 1980-1984
15 Achieved Qualitative Objectives	-
16 Achieved Quantitative Targets	rural: 12.000 (1980-'84) and 24,000 (1984-'88), all in rural zones 7,500 female masons trained
17 Principal problems	self-construction is difficult; Quick deterioration of 3PA, not transportable. Stoves no priority of women.
18 Lessons learned	

WS9

1 Country	Senegal
2 Name	Projet Fouers Améliorés ATI
3 Current status	near the end, for the time being no finance for prolongation
4 Donor(s)	USAID
5 Donor Budget	U$ 340,000
6 National Budget	0?
7 Execution Period	1991-1994
8 Expatriate Executing Agency	
9 National Executing Agency	ATI
10 T.Assistance Modality	
11 Project linkage	
12 Target population	
13 Proposed Qualitative Objectives	
14 Proposed Quantitative Targets	7.900
15 Achieved Qualitative Objectives	
16 Achieved Quantitative Targets	
17 Principal problems	
18 Lessons learned	

Annex 3: Summary of Improved LPG Stove Projects Reviewed

PRG1

1 Country	Niger
2 Name	Programme Regionale Gaz
3 Current status	Stopped in December 1993. Limited follow-up activities for two years
4 Donor(s)	EC, through CILSS
5 Donor Budget	F.CFA 324,000,000
6 National Budget	Project coordinator, office Tax reduction on gas
7 Execution Period	1990-1993
8 Expatriate Executing Agency	-
9 National Executing Agency	Direction d'Energie
10 T.Assistance Modality	-
11 Project linkage	CILSS Regional Program. PEII-DE, Petrol companies
12 Target population	urban, capital
13 Proposed Qualitative Objectives	Promote the use of Butane gas as a household cooking fuel in urban areas
14 Proposed Quantitative Targets	20,000 stoves 1,700 tons gas (1992)
15 Achieved Qualitative Objectives	Promotion has brought gas stoves under the attention of an important part of the urban population
16 Achieved Quantitative Targets	12,000 stoves
17 Principal problems	Gas imports are exclusively from Nigeria, which is considered vulnerable; Informal gas imports from Nigeria; Reglar supply interruptions; Since the project has ended, sales of stoves have declined due to the retraction of subsidies on stoves;
18 Lessons learned	3 years program is too short; Need of reliable gas supply; Subsidized gas is mainly used by rich users.

PRG2

1 Country	Burkina Faso
2 Name	Programme Regional Gaz
3 Current status	Finished. Subsidy on equuipment continues on remaining budget
4 Donor(s)	EC through CILSS
5 Donor Budget	F.CFA 270.640.000
6 National Budget	National project coordinator and offices. Gas subsidy
7 Execution Period	1991-1993
8 Expatriate Executing Agency	-
9 National Executing Agency	Direction d'Energie
10 T.Assistance Modality	-
11 Project linkage	CILSS, Petrol Companies
12 Target population	urban, capital
13 Proposed Qualitative Objectives	Promote the use of Butane gas as a household cooking fuel in urban areas
14 Proposed Quantitative Targets	8,000 - 32,000 stoves / year 1,100 - 3,500 tons gas / year
15 Achieved Qualitative Objectives	Promotion has brought gas stoves under the attention of an important part of the urban population
16 Achieved Quantitative Targets	14,378 households reached 2,800 (1992) and 3,400 (1993) tons of gas imported
17 Principal problems	Shortage of equipment: bottles, burners. Initially: lack of promotion Lack of engagement of the petrol companies
18 Lessons learned	

PRG3

1 Country	Mali
2 Name	Programme Regional Gaz
3 Current status	Finished. Continuation by the gouvernment
4 Donor(s)	EC through CILSS
5 Donor Budget	F.CFA 400,000,000
6 National Budget	Project coordinator, offices
7 Execution Period	1991-1993
8 Expatriate Executing Agency	-
9 National Executing Agency	Direction Nationale de l'Hidraulique et de l'Energie
10 T.Assistance Modality	-
11 Project linkage	CILSS regional programme; Petrol companies
12 Target population	urban, capital
13 Proposed Qualitative Objectives	Promote the use of Butane gas as a household cooking fuel in urban areas
14 Proposed Quantitative Targets	48,000 stoves sold (1992) 2,000 tons gas imported (1992)
15 Achieved Qualitative Objectives	Promotion has brought gas stoves under the attention of an important part of the urban population
16 Achieved Quantitative Targets	1.441 (1992) and 1,800 (1993) tons of gas imported
17 Principal problems	Shortage of equipment and gas Petrol companies were not interested in the distribution of equipment (bottles, burner, support)
18 Lessons learned	

PRG4

1 Country	Gambia
2 Name	National Gas Program
3 Current status	just started
4 Donor(s)	EC through CILSS
5 Donor Budget	ECU 860,000 (10,000,000 Dalasi)
6 National Budget	0?
7 Execution Period	1991-? Effective program start in 1993. End date not yed determined.
8 Expatriate Executing Agency	-
9 National Executing Agency	Ministry of Trade and Industry and Employment
10 T.Assistance Modality	-
11 Project linkage	CILSS regional programme; Petrol companies
12 Target population	urban, capital
13 Proposed Qualitative Objectives	Promote the use of Butane gas as a household cooking fuel in urban areas
14 Proposed Quantitative Targets	4,800 stoves 1,400 tons of gas (1992)
15 Achieved Qualitative Objectives	too early
16 Achieved Quantitative Targets	too early 1,500 (1992) and 1800 (1993) tons
17 Principal problems	No bulk storage for gas. Dependent of Senegal for import. Lack of bottles. Costs of equipment.
18 Lessons learned	Gambia needs LPG terminal

PRG5

1 Country	Senegal
2 Name	Programme National Gaz
3 Current status	stopped; Activities fully commercialized and taken over by Shell and Total
4 Donor(s)	EC through CILSS
5 Donor Budget	F.CFA 382,415,000
6 National Budget	0?
7 Execution Period	1991-1993
8 Expatriate Executing Agency	-
9 National Executing Agency	Ministère de l'Energie, des Minies et de l'Industrie
10 T.Assistance Modality	-
11 Project linkage	CILSS regional programme; Petrol companies
12 Target population	urban
13 Proposed Qualitative Objectives	Promote the use of Butane gas as a household cooking fuel in urban areas
14 Proposed Quantitative Targets	50,000 tons of gas (1992)
15 Achieved Qualitative Objectives	Promotion has brought gas stoves under the attention of an important part of the urban population
16 Achieved Quantitative Targets	Increased gas sales (22%/year) 40,500 tons (1992) and 45,000 tons (1993)
17 Principal problems	Shortage of bottles, due to exportation
18 Lessons learned	Harmonization with neighbour countries. Monitoring system should be improved

Annex 4: Summary of Improved Kerosene Stove Projects Reviewed

1 Country	Niger
2 Name	Projet Energie II, Volet Demande, Foyers à pétrole
3 Current status	Completed. Second phase proposed
4 Donor(s)	Denmark
5 Donor Budget	US$ 2.3m (???)
6 National Budget	???
7 Execution Period	1989 - 1993
8 Expatriate Executing Agency	World Bank
9 National Executing Agency	Department of Energy, Ministry of Mines and Energy
10 T.Assistance Modality	Resident T.A. project coordinator Short term T.A. stove fabrication experts
11 Project linkage	GTZ Projet Foyers Améliorés, PRG
12 Target population	Urban
13 Proposed Qualitative Objectives	To limit fuelwood demand through fuel substitution
14 Proposed Quantitative Targets	To stabilize fuelwood demand in 1993, thus saving 6000 tonnes of fuelwood
15 Achieved Qualitative Objectives	Approximately 2300 tonnes of fuelwood saved in 1993
16 Achieved Quantitative Targets	8000 stoves (in 5 years)
17 Principal problems	import of burners, financial problems, lack of control over entrepreneurs, higher fuel and wick consumption than expected
18 Lessons learned	solid contract with private sector

Annex 5: Summary of Improved Kiln Projects Reviewed

1 Country	Senegal
2 Name	Projet d'Aménagement de la Forêt de Tabor
3 Current status	finished
4 Donor(s)	PNUD/FAO/UNSO
5 Donor Budget	U$ 1,000,000
6 National Budget	?
7 Execution Period	1978-1986
8 Expatriate Executing Agency	-
9 National Executing Agency	Direction des Eaux, Forêts, Chasses et Conservation des Sols
10 T.Assistance Modality	?
11 Project linkage	?
12 Target population	?
13 Proposed Qualitative Objectives	Forest maintenance and upgrading; Thinnings to be carbonized. Test of carbonization kilns
14 Proposed Quantitative Targets	-
15 Achieved Qualitative Objectives	Forest upgrades; Experience was gained with four types of kilns.
16 Achieved Quantitative Targets	
17 Principal problems	
18 Lessons learned	The Casamançaise kiln was found to be best adapted to Senegalese conditions.

1 Country	Senegal
2 Name	Projet National de la Vulgarisation de la Meule Casamançaise
3 Current status	finished
4 Donor(s)	USAID
5 Donor Budget	F.CFA 300,000,000
6 National Budget	0?
7 Execution Period	1980-1986
8 Expatriate Executing Agency	?
9 National Executing Agency	Direction des Eaux, Forêts, Chasses et Conservation des Sols
10 T.Assistance Modality	-
11 Project linkage	-
12 Target population	-
13 Proposed Qualitative Objectives	Improve efficiency of charcoal production by the introduction of Casamançaise kiln
14 Proposed Quantitative Targets	
15 Achieved Qualitative Objectives	
16 Achieved Quantitative Targets	700 charcoal makers trained
17 Principal problems	
18 Lessons learned	

1 Country	Senegal
2 Name	Budget National d'Equipement / Fonds Nationale d'Energie
3 Current status	finished
4 Donor(s)	
5 Donor Budget	
6 National Budget	F.CFA 60,000,000 / 50,000,000
7 Execution Period	1987-1990 / 1989-1991
8 Expatriate Executing Agency	
9 National Executing Agency	Direction des Eaux, Forêts, Chasses et Conservation des Sols
10 T.Assistance Modality	
11 Project linkage	
12 Target population	
13 Proposed Qualitative Objectives	Financial support to trained charcoal makers to buy equipment: chimneys, spades, wicks, rakes, balances
14 Proposed Quantitative Targets	
15 Achieved Qualitative Objectives	
16 Achieved Quantitative Targets	
17 Principal problems	Rate of organization of charcoal makers is low. Difficult arrangements for lowns, etc.
18 Lessons learned	

Annex 6: Testing procedures for woodstoves

With the introduction of improved stoves the need arose to test stoves in order to establish and verify fuel consumption. At first stove testing concentrated on the determination of the maximum efficiency of the stoves while later it was realized that the ability of a stove to give a low simmering powers was even more important to realize a low fuel consumption. (Prasad, 198?).
Many different test procedures have been in use by different organisations until in 1984 the proposed international standards were agreed upon. For the Sahel these standards were slightly adapted to local circumstances and agreed upon in the meeting of Sahelian stove researchers in the Gambia (Mansakonko) in 1986 (CILSS, 1986). The standard includes water boiling tests and controlled cooking tests.

Water boiling tests.

In the waterboiling tests the following stove parameters are determined:

P_{max} the maximum power of the stove
E_{max} the stove efficiency at the maximum power
P_{min} the minimum power of the stove
E_{min} the stove efficiency at minimum power

P_{max} is the power at which the maximum amount of fuel is burnt while maintaining a constant fuelbed, while

P_{min} is the power at which the water in the pan just continues to boil. It is clear that both definitions are not very exact, but skilled testers arrive at reproducible results.

Efficiency is the ratio of the heat transferred to the pan and the heat generated by the combustion proces.

Waterboiling tests are used in the laboratory for research and development work on stoves. The results are mainly of technical interest but they give important indications as to what can be expected of a stove under real cooking conditions. This can be illustrated as follows.

The cooking proces needs different heat inputs to the pan over varying periods of time: the power regime. The simplest power regime is like for the preparation of patatoes or rice or beans. The content of the pan must be brought to the boil and then the food must be kept simmering to make it edible. Simmering time is food dependent, and cannot be shortened by increasing the heat input to the pan. The limiting factor is the 100 °C boiling temperature of the water. In pressure cookers, where the operational temperature is 120 °C, simmering time is reduced to half the time needed at 100 °C. The maximum power and efficiency determine the time and fuel consumption to bring the content of the cooking pot to the boil. A combination of a high P_{max} and a high E_{max} give short boiling times at a low fuel consumption. The minimal power determines the fuel consumption for the simmering phase of the cooking proces. The efficiency at minimum power is less

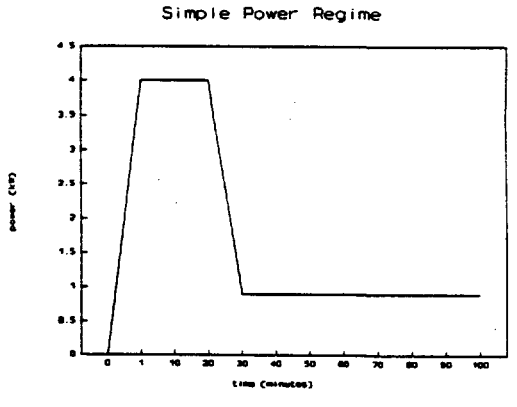

Fig. 21 Example of simple power regime

important. The following table illustrates the equal importance of E_{max} as well as P_{min} on the fuel consumption. The table is calculated for a pan with 5 kg of water equivalent of food. A simmering time of 40 minutes is assumed. The table shows that if E_{max} is improved from 35% to 45%, cooking time is reduced by 4 minutes and fuel consumption by 11%. In case for the same stove P_{min} can be reduced from 2 kW to 1 kW, cooking time remains the same but fuel consumption is reduced by 25 %.
When the simmering time is shorter the influence of P_{min} decreases, when longer it increases.

Table 32 Fuel consumption for different stoves

Exp	P_{max} (kW)	E_{max} (%)	P_{min} (kW)	E_{min} (%)	time to boil (min)	fuel to boil (g)	time to simmer (min)	fuel to simmer (g)	total time (min)	total fuel (g)	econ. (%)
1	4	35	2	25	20	282	40	282	60	565	
2	4	45	2	25	16	220	40	282	56	502	11
3	4	35	2	25	20	282	40	282	60	565	
4	4	35	1	25	20	282	40	141	60	424	25

In order to obtain reliable results, each test must be repeated at least three times and the outcomes averaged. Because of the standardization of waterboiling tests, the results from different locations can be used for stove comparison.

Controlled cooking tests.

The controlled cooking tests serve to determine the fuel consumption of a stove for the preparation of a standard meal. The standard meal is the local main dish for which the quantities of the ingredients are fixed: for each test the same amount of water, rice, meat, vegetables etc. is used. Experienced cooks prepare the meals on the traditional stove and on the different improved stoves. The quantity of fuel used is measured. The results are presented in terms of fuel economy compared to the traditional stove. To get reliable results each test must at least be repeated three times and the outcomes averaged. The results of controlled cooking tests from different locations are not comparable because the standard meal (ingredients and quantities) may be different and the traditional stove may be a different one.

To be able to compare stoves that use different fuels, like charcoal, gas or kerosene, the fuel consumption can be expresed in terms of energy (Joules). Comparison to the traditional stove can then also be done in terms of energy and is called the energy economy.

When the power regime for the preparation of the standard meal is known, the theoretical fuel consumption can be calculated using the power and efficiency results from the waterboiling tests.

Annex 7: List of interviewed persons

Niger

MOUSSA Mahamane	National Coordinator RPTES; Head of Unit for New and Renewable Energy, Energy Department
Kiri TOUNAOU	Director a.i. Energie II - Energie Domestique, Volet Demande
Idi ABOUBACAR	Coordinator Improved Stoves Project, Phase II
Issoufou TIEMOU	National Coordinator of CILSS Regional Gas Program
Idrissa MADOUGOU	Managing Director TCHIP-IMPORT
Francis MODY	Program Officer World Bank Resident Mission

Burkina Faso.

Saïdou OUIMINGA	National Coordinator RPTES; Director of Energy Department
Zalle DAOUDA	Head of the Energy Economy Unit, Forestry Department
Richard Ngabaroum DJIMRANGAR	Regional Coordinator of CILSS Regional Gas Program
Godefroy THIOMBIANO	Head Research Programs "Institut Burkinabé de l'Energie"
Mm. OUEDRAOGO	Action Sociale, Ministry of Health
Célestin Bépio BADO	Project Officer World Bank Resident Mission

Mali.

Ismael TOURE	National Coordinator RPTES; Hydrology and Energy Departement
Mahamadou SIDIBE	Director of Hydrology and Energy Departement
Amadou TANDIA	National Coordinator of CILSS Regional Gas Program; Head of Energy Division, Hydrology and Energy Departement
Cheick SANOGO	Head of the Domestic Energy Unit, Hydrology and Energy Departement
Hamadi KONANDJI	Head of the Lignouos Fuels Unit, Department of Water and Forests
Oumou CAMARA	Coordinatrice Improved Stoves Project DNAS/GTZ
Samaké TOURE	Head Promotion Improved Soves Project DNAS/GTZ
Mohammed TOURE	Sociologist DNAS
Mahamane Bilaly TOURE	Head of Wind-energie and Bio-conversion Unit, CNSOLER
Kalfa SANOGO	Program Officer UNSO, UNDP Resident Mission

Gambia.

Omar SALLAH	National Coordinator RPTES; Director of the Gambia Renewable Energy Centre
Abdou TOURAY	Assistant Director of Community Development
Amadou LOWE	National Coordinator of CILSS Regional Gas Program
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Leo GRUBER	Managing Director Escapag Gambia Ltd.

Senegal

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Kory DIONE	Former Improved Stove Specialist CERER
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Mr. DIKKER-HUPKES	Director General Shell Senegal
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