other ministries' provincial officers. It is also doubtful whether CSFP should pay the salaries and other emoluments of ministerial cadres. On the other hand, more vehicles, drivers and vehicle operation cost , as well a higher training budget should be budgeted. (lumping it with pedagogic tools, promotion and seminaries).

Annex 1. Map and Global Statistics on Cambodia's Provinces
Annex 2. Data on Wood Flows to Phnm Penh, Energy Balances and Calorific Values of Fuels
Annex 3. Persons Contacted and Interviews
Annex 4. Reference Data Sheet
Annex 5. Monitoring System and Communication Strategy
Annex 6 Bibliography
Annex 7 Stove Test Coefficients from Mali on HighPower and LowPower phase,

3. Dissemination Strategies

3.1. Marketing
It will assist and promote the agents and agencies involved in the market approach, and prepare communication support for customers, retailers and and other traders. The marketing department should also create more public awareness, prepare a funding-strategy (aiming at long-term funding autonomy) and contact and acquire new financing partners,

3.2. Extension (non-market)
It will identify, contract and train long-term partners to take over the non-market approach for auto-constructed stoves, perhaps within a small-business training program. It will compare costs and benefits - and dissemination numbers - of that approach with the market approach.

4. ICE Support

4.1. Information (see 2.2 and Table 10)

4.2. Publicity (see 3.1. and 3.2.)

4.3. Training : the training division will prepare a training plan and training course curricula. conduct training courses and recycle trainers and extension agents.

5. Project Extension Second Phase

In our view it is presently not only too early to extend the project to 10 provinces but also not warranted in terms of maximl impact. We suggest therefore a step-by-step approach, namely, instead of formally involving more provinces into the project, concentrate on reinforcing the links between the producers and middlemen traders in Kompong Chnnang and the urban markets a) in Phnom Penh, b) along the major road axis K.Ch. to Sihanoukville [47]- and c) along the axis to Siem Reap, by a number of targeted actions on major energy users such as small energy-dependent enterprises, and reinforcing links with credit agencies, while developing a reinforced marketing and monitoring network and training provincial staff of Energy, Forestry and Environment Departments (in demonstration, training and impact monitoring).

The proposed co-operation with WeNetCam needs longer preparation and WeNetCam should prove its capacity by pointing a qualified and motivated coordinator for whom the resources necessary should be contracted through ARECOP and RWEDP.

The above recommendations imply an increase of personnel, with each of the 3 sections (R&D, M&E, ICE) employing at least 3 agents, with the M&E section ensuring overall co-ordination. In order to ensure the relative operational autonomy of each section, each should have logistic support in terms of office space, office equipement, transport equipment and operation budget. We will not go into detail on the proposed budget but limit ourselves to a number of remarks: the international and national personnel are sufficient to man the above-mentioned sections; but the number of provincial extension agents (vulgarisateurs) can be reduced from 24 to 6 - as the project should only extend to 3 provinces in addition to Phnom Penh instead of 10 - and that partner agents should not be fully be paid by CSFP, as it will work through partner NGO's and their extension agents, but rather provide training support and daily allowances for MIME and

[47] and in the prov.capitals of Kompong Speu, Kandal, Takeo, and eventually Prey Veng

In Table 10 the recommendations are summarized.

1. Objective-Planning	Priority	Indicators - Remarks
integrate project in national objectives	++	PPM [46] covers at least 2 NEAP or
	++	ADB objectives.
establish priority hierarchy (logframe)	+	Primary & Secondary actions clearly defined.
elaborate annual plans of operation	+	a PO contains activities, agents & resources and timing
2. Technology and Data		
establish an R&D section within CFSP	+	responsible activities below, with
improve the Siam & Kpg.Chhnang Lao	++	budget and personnel resources
increase efficiency/durability of all stoves	++	larger combustion chambers;
	+	fire in closed gas kilns,
increase cost-effectiveness of all stoves	++	reduce losses & production-cost
test LPG and Kerosene stoves	++	test report on available models
test solutions for SSE f.bakers, restos,	+	data on stoves produced & sold
laundries, brick-makers		WBT, CCT, KPF and emissions and
establish systematic M-&-E system	+++	costs for all stove models.
establish precise data on fuel consumption	++	social, economic, financial benef
establish household and enterprise budgets	+	
establish impact and cost-benefit analyses	+	
3. Dissemination Strategies		
concentrate on markets with max impact study	+++	urban areas K.Ch.,P.P., Knd,K.S.
the stoves' retail markets	++	data on retailers' sales + activities
elaborate specific marketing plans for	+++	1 marketing plan for each produ-
products, producers and target groups	+++	cer, each product and market
study the small enterprise market in P.P.	++	data on no.of businesses and on fuel consumption
develop a marketing section withinCFSP	++	responsible for activities under 3&4
develop CSFP into a consumer-info agency	++	
train/support NGO/MIME agents on stoves	+++	
4. ICE Support		
Bundle information one stoves	++	one single reference document
Communication tools:		comprising all technical data
systematize publicity material	+	1 brochure for each stove
elaborate material on correct stove use	+	
develop a training section within CSFP	++	budget, personnel, work plan
develop and document training modules	++	1 module for each trg. course
elaborate training module for stove users	++	1 leaflet of user info on each stove
develop a methodology for demonstrations		training guide & data sheet for demos
5. Project Extension		
reinforce market links between P.P. & K.Ch	+++	assist retailers to sell stoves in P.P.
develop the HH and SSE markets in P.P.	+++	study solutions to increase P.P. sales
establish PO with partners for Kandal, Takeo,	++	at least 1 partner per province assists
K.Speu		private agents to produce + market energy solutions

[46] Project Planning Matrix

Biodiversity and Protected Areas: similarly, CFSP could assist to improve management practices in protected areas,and conserve biodiversity(e.g.preserve dipterocarps).

Energy Development: CFSP should play a role in the strategic framework to improve environmental management and cooperate closely with the responsive agencies.(sepcially with regard to development of substitution alternatives). Government believes that hydro-electric power development will meet much of future energy demand, however, electricity will be far drom accessible to the ordinary user especially for cooking. CFSP can contribute to MIME's plans for a sustainable use of biomass, and also to training for MIME (and MoE and MoA) staff in the resource-scarce provinces.

The priorities of other major donors are : (ADB, EU) Rural Development, (WB, UN) Better Natural Resource Management. [45]

The project has the potential to build on and improve the skills of the rural and urban population (as producers of energy-saving devices), to create jobs, to increase incomes (for stoves' producers, consumers and retailers) and to reduce energy costs for small business and households, and reduce extraction of natural resources.

We suggest to mould the objective hierarchy of the project into the priority context of the country and the major donors focussing on the benefits to micro-enterprises and households, while downplaying the environmental advantages, as long as logging by military personnel continues, or the project be placed into a strong community forest component with the potential of supplying fuelwood. It could also focus on small-scale industry promotion with emphasis on energy cost reduction, and thereby strengthen the private sector.

2. Technology and Reference Data

2.1. Research and Development

It will continuously refine and test the energy-saving solutions, elaborate test protocols and prepare new stove models and improve production techniques for the market, in view of reducing the cost of energy especially for the poorer sectors of society. It will also prepare, update, and edit the information material on improved stove models. Particular emphasis should be given to testing firing of ceramic stoves in the gas kilns which have been installed by GTZ-PRASAC in Kompong Chhnang in order to assess the improvements in durability. The introduction of vaulted brick kilns with separate fuel and combustion chambers could also be part of a long-term productivity improvement strategy.

2.2. Monitoring and Evaluation.

It will collect data on dissemination of stoves and feed-back user criticism to the research section; elaborate market studies, and assess progress and success of the market approach, and the impact of fuel-saving on the regional and global energy balance. It will distribute and publish the technical information on imporved stove models and prepare the periodic project progress reports. It will develop a curricum for a consumer-information agency to counsel the general public on the energy-saving solutions

[45] ibid. p.66

The project has prepared a five page proposal suggesting the extension of project activities to 10 provinces with the help of organisations - projects and NGO - which are labelled 'partners' and form part of an informal network WeNet Cam. Yet those partnerships are still very lose and informal and clear commitments by the partners have not been obtained. Specific lines of action need to be defined and planned jointly, so that respective contributions in terms of personnel, office space and eventually funds should be negotiated and laid down in partnership contracts.

Without further quantification of results and activities by indicators the proposal appears vague and unrealistic. Moreover, in view of the aforesaid and the implicit focus by CFSP on Phnom Penh, and in view of the basic principles for stoves dissemination and in view of the resource constraints - especially in terms of human resources - the project should not mechanically replicate its previous activities in a number of provinces, but should take account of the most important energy markets in terms of location - considering the dynamic interaction between certain provinces and areas - and in terms of the most relevant i.e. ligneous energy-consuming sectors.(see recommendations V.3).

CHAPTER V. Recommendations

1. Objective- Planning

In order to orient the project planning process, we suggest that the project proposal be placed within the National Development Context and its objectives, and thereby gain new partners.

The project situates itself within the following priorities of the country, its government and donors : poverty reduction, job and income creation, womens' promotion [43]and reducing the degradation of the natural resources, especially forests, and the environment.

According to Asian Development Bank the Country Priorities are:[44]

Development of the Rural Economy
promote agri-business, enhance rural productivity, use of labor-intensive techniques in rural production, counter environmental degradation by implementing NEAP

Human Resource Development
improve sanitation and health

Private Sector Development
lower dependence on wood for fuel, decrease energy costs
encourage expansion of rural credit through licensed microfinbance institutions.

The **National Environmental Action Plan** sets the following priorities which cover the objectives of the CFSP:
Forest Policy and Environmental Sustainability (residents have to manage their forest resources in an sustainable manner): - CSFP could develop modules which - with the help of Improved Technology - would make a significant contribution to sustained management;

[43] according to the Cambodia Socio Economic Survey, p. 7 Table 3, due to the civil war, the percentage of female-headed households is 26% of households in Phnom Penh. This could be a special target group of CSFP.
[44] ADB, Country Operational Strategy Cambodia, Enabling Socioeconomic Renaissance, July 2000, pp.v-vii

CFSP attending the ADB meeting in Cambodia and with the Ministry of Mine and Energy to attact the support for the second phase and emphasis was placed on NGO involvement in ICP‘s within the energy plan.

CHAPTER IV. Project Proposal for a Second Phase

The project has prepared a five page proposal suggesting the extension of project activities to 10 provinces with the help of organisations - projects and NGO - which are labelled 'partners' and form part of an informal network, WeNet Cam. The three major axes of this proposal are:
- support of the National Wood Energy Network
- continuation of experimentation in household energy, approaching other sectors
- medium-term pilot activities in community forestry to evaluate impact of ICS.

The National Wood Energy Network is yet in its beginning stage and the partnerships still informal so that clearer commitments by the partners have to be obtained. For each axis, specific lines of action have not been defined or planned , so that respective contributions in terms of personnel, office space and eventually funds are known or could be negotiated and laid down in partnership contracts.

Further detail and quantification of objectives, results, activities and indicators is necessary for a proposal to fund a second phase.

In view of the aforesaid and the implicit focus by CFSP on Phnom Penh, and in view of the basic principles for stoves dissemination and in view of the resource constraints - especially in terms of human resources - the project should not mechanically replicate its previous activities in a number of provinces, but take into account the most important energy markets in terms of location - considering the dynamic interaction between certain provinces and areas - and in terms of the most relevant energy-consuming sectors.(see recommendations VI.5.3).

The material is for the most part destined for the technician or extention worker: end users, retailers and donors can find little information of particular interest for them. Similar manuals should be prepared for the other stove types and for those special interest group.

Many training courses and sessions were held for technicians,extension workers and producers without proper documentation. We feel that the training inputs (personnel and costs) and outputs should have been recorded in a more formal manner, and that in future training plans be established to permit M & E. The training curriculum and budget should be laid down, like done in the manuals for Samaki. Especially for turning the non-market approach into a market approach business as well as technical training is an essential component likely to contribute much to the spread of stove technology.

More training materials should be prepared for the final users.

The most appropriate way to transmit messages and information to various target groups can only be established through marketing strategies and plans: while not easy to assess, the effect of each support instrument should be measured (for example we think that billboards and FM radio messages are more cost-effective means than TV to reach the general customer).

Other support given by the project includes: info meetings, demonstrations, credit, transport, technician services, but again most quantitative information on those still needs to be compiled and documented.

WEnNetCam

WeNetCam is the Wood Energy Network of Cambodia. It has been set-up early beginning of year 2000 by CFSP and CEDAC (Centre d'Etudess et de Development Agricole Cambodgien), a local NGO based in Phnom Penh. The WeNetCom is partly supported by ARECOP (Asia Regional Cookstove Program in Asia) based in Indonesia. The aim of this network is

1. To raise awareness on wood-energy and improved cookstove issues with different tools and actions address to:
   - the direct ICS beneficiaries (potential users, small-scale industries, stove producers, middlemen, etc),
   - the promoters (NGOs staff, extension workers, governmental institutions,)
   - the decision makers (policy makers, donors)
2. To strengthen the communication and information transfers among the members at a national as well as international level.
3. To involve more organizations in ICS dissemination
4. To encourage and support ICS dissemination strategies and actions
5. Tos upport R&D about the ICS and wood energy issues
6. To be sustainable, opened and independent forum.

CFSP and CEDAC have done well in attracting members and initiating some information exchange at the national level, distributing brochures, training manuals on CD, postures, comics and some ARECOP's materials.

Information exchange about ICS work at the international level needs to be developed. The members should be exposed with the support from CFSP and CEDAC.

CHAPTER III. Support Material and Services

Support necessary for Stove Dissemination can be differentiated according to:

- Information Material

The general studies A-D and the Internal Evaluation Reports mentioned above on technical performance and economic benefits of stoves to consumers are part of such information material for donors, producers and the general public. The same with the reports on Stove Testing and Dissemination Strategies. While quite detailed in some respects, they lack some essential information. As mentioned under I. 5-6, the results need further confirmation by tests and studies, and documentation in a separate reference publication;

- Communication or Publicity Material,

We understand by "communication" the 'wrapping' of a message in a special 'package' and transmission via specialized channels to special target groups.

Among these we háve
- a logo for project documentation and as sticker on vehicles
- t-shirts to project staff and extension agents[41]
- banderoles publicizing the Twin Stove at the wholesale depots;
- posters publicizing and describing the advantages of the Lao bucket, posted at producers;
- TV spots on the Twin stove and Lao bucket (not shown to us - the conference room at CEDAC being each time occupied)
- a cartoon book on the different stove types.
- a general brochure (bilingual) on the program
- a general website (under development)

(from all of the above [42]specific quantitative information - e.g. on savings, cost and pricing - is absent; we feel that potential buyers should be given precise information on what to expect before they buy and use each stove, in handouts or brochures. Traders should be targeted with special information e.g. on costs and profit margins).

the experience with the Twin Stove has shown the need for user-training, on the correct use and handling of the stove - for example with big pots or one pot. This material could come in the form of brochures - to be distributed through the retailers - or TV programs.

As for the stoves distributed through the market, either producers or traders should on the long run produce info and communication material - i.e. the investment into marketing cost should be borne by the beneficiaries, with the project should only give technical assistance.

- Education or Training Material

- for Samaki (training manual on CD for stove-builders and trainers)
- for Palm Sugar (training manual on CD for stove builders and trainers).

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[41] we feel they should be revised, because showing only a tree they do not express the idea of fuelwood-saving
[42] except the poster for the Lao which mentions 30% savings of charcoal

A non-market approach has been chosen for the auto-constructed Samaki and institutional and palm sugar stoves. Technicians and extension agents trained by the project have during most of 1999 and 2000 constructed 333 Samaki in 23 villages, of which 95 (29%) were constructed by the population itself in 5 (22%) villages (and 138 palm sugar stoves[40] in 20 villages, and 7 large stoves in institutions e.g. orphanages, schools, hospitals, pagodas).

In our view, the project has gone into early mass-diffusion for the larger stoves - at a considerable use of project resources - without first building a few models and evaluating them thoroughly, and then plan on a dissemination strategy. The readiness of end users to construct such stoves themselves varies considerably between localities and the assumption that future users will do auto-construction has not been verified. Thus, it is yet unclear whether this approach is or can be made sustainable, for example, if auto-construction can in the future be taken over by agents (agencies) in the target areas, whether the non-market approach is viable and can be developed into a market-approach. So far, few end users have built their own stove, nor mass training sessions held for them.

Strategy Selection Criteria: Apart from sustainability there is the cost (or opportunity cost) issue: While the results of a non-market approach can be much better controlled and monitored, the total numbers of stoves distributed may be much less than those distributed via the market. And the costs incurred in constructing the stoves are much higher than those involved in getting the market to do the distribution - construction cost is $ 12.65 for the subsidy and $ 4.46 for the non-subsidized owner-built Samaki - and such resources may be better employed for strengthening the market networks. A comparative study of costs per stove in the two systems may yield interesting results. How many stoves can be diffused in a year at a given cost through the market network as compared to the nonmarket network?

Non-market approaches are valid if solutions through the market cannot be achieved. Chances that Cambodian state agencies or NGO's can provide the necessary assistance until the target groups are capable to help themselves are slim, given the limited state resources. While we are of the opinion that the overall environmental objective - of reducing deforestation and pollution, merits public subsidy, we insist that efforts be made to integrate the construction of self-built stoves (and the training of trainers) into a market approach (with decreasing subsidies), for example an energy-saving program for small-enterprises. The service could either be privatized with private agents or NGO extension workers being trained to provide construction services against payment. In our view the Samaki, PSS and institutional stoves should be contracted out to either private, NGO or state agents, and no longer be executed by the project itself, which could thereby contribute to creation of independent entrepreneurs and employment generation.

[40] by PRASAC 18, 21 by Lutheran Worldwide Services, and 99 by CONCERN. This project needs special evaluation.

Here, impact should be estimated under various assumptions: let's say, assume that 30% (or 50%) of urban households of Cambodia introduce improved stoves in their homes over the next 10 years, how much fuel can be saved, how many stoves have to be continually produced (considering replacement requirements) in order to satisfy the market; how many producers need to be trained, how much raw material needs to be available etc. This can then be used to estimate the ecological impact (e.g. in tons of charcoal reduced and number of trees saved). Similarly, for any industry, assuming that 50% of the units introduce fuel-saving equipment, what is required in terms of equipment and investment cost, and what savings in money and time and fuelwood will be made. Similarly for the producers of such equipment, what will the additional income from a new line of production. Such reflections and calculations still need to be elaborated by CFSP before it can estimate the impact of future actions.

CHAPTER II. Dissemination Strategies

The project has experimented with 2 strategies, a market strategy, and a non-market strategy.

Market approach.

As most models have been too new on the market, we will only be able to draw tentative conclusions here.The CFSP strategy has initially assumed that the existing distribution network and marketing channels for the Siam and Kompong Chhnang would serve the dissemination of the improved models. One could assume that any new stove introduced into the product range of pottery product would be integrated into the existing network.

But the Twin, which has been distributed by project and produced by 20 producers in the Kpg.Chnang province, has only reached the pottery wholesale-depots, but not the transporters-retailers who sell the Siam and Lao Kg.Chnang in and outside the province.

No specific monitoring has been done on the 500 Twin stoves distributed by the project, and the 500 others sold in the 4 pilot areas,[39] but we have evidence that no more Twin stoves were sold since then in the pilot areas. We do not know who buys the Twin which the wholesalers take from the potters and stock at their own expense, but the retailers do not. In view of the underlying assumption, direct distribution by project to end consumers was correct for the sake of promotion. But the dissemination assumption does not seem to hold. Neither has the Twin so far been integrated into the existing retail circuits, not have those stoves which are accepted by the retailers been further improved. **More information on the obstacles to the Twin - which is a foreign introduction - at the retail level and perhaps greater marketing efforts are needed.**

When focussing on the charcoal-using Lao bucket, which is produced in P.P. and sold there by retailers, the CFSP began targetting Phnom Penh instead the Kompong Chhnang market. Even though the new Lao bucket was only introduced in december 1999 by training 2 (old) Lao-producing workshops in P.P. which seem to sell about 100 per month as against 3-400 traditional Lao. The marketing strategy, that traditional Lao sellers will also sell the new Lao seems to work although yet timidly. For us the main restrictions are the high price (14,000 as against 7000 R per unit) and the absence of a range of models. **In the case of the new Lao, more work with the retailers and the market network is needed to explore the obstacles.**

[39] very limited information from one village indicates that none of the households to whom the Twin Stove was distirbuted in 1998, has bought a new one, mainly because this stove can not be obtained in the villages since the retailers don't send it there, even though Siam and Lao Kg.Ch. are.

- i.e. cost of improved stove (purchaser price) and cost of fuel per meal or product, compared with the traditional method.
- number of jobs created for trading and producing the equipment (man-days required to produce the).

Conservation of wood fuel energy may bring substantial other **individual** benefits to the **consumers**, among which there are :
- savings in terms of household budget from reduced spending on woodfuel;
- savings in time e.g. for cooking and collecting wood with social consequences for women;
- number of jobs created in retail (of woodfuel-saving equipments)
- health benefits in terms of reduced smoke pollution by cooking fumes and reduced burns.

Benefits to **producers** include:
- additional incomes from new customers and orders
- cost savings from more efficient technology (e.g. kilns)
- jobs created
- technological advances (know-how)

7. Social aspects (acceptability, adoption)

For fast and high adotpion rates of technological innovations such as stoves their acceptability is necessary. The internal evaluations contain interesting reasons for the acceptance or non - acceptance of the new stoves, the Twin and the Samaki. 69 % of sample users accept the Twin, but 28% are not too sure how to use the Twin, and therefore keep their traditional stoves alongside. The readiness for auto-construction of Samaki seems to be very variable from village to viillage: as compared to 238 CFSP-built Samaki in 23 villages, 95 Samaki were built independently in 5 villages, while 12% of villages refuse the building of another.

8. Aggregate or macro-analysis

Establishing an Energy Balance [38]

Supply and demand and deficit projections and fixation of quantitative targets.
Contrasting estimated demand (or consumption) with supply we can estimate actual and future deficits based on projections of demand and supply trends over say 5 to 10 years. Only if (and where) these expected deficits are likely to be large does it make "ecological" and economic sense to plan measures to bring supply in line with demand, and we can estimate the collective benefits, i.e. benefits for the province or the country as a whole

By introducing realistic assumptions on the number of consumers who will introduce the improved technolgoy (fuel-saving stoves or other equipment) , and target a certain number of the population, we can not only calculate the financial and other economic benefits as a whole, but can also fix other strategic targets, namely the capacities needed to introduce and produce the required number of equipments. Models and calculations of this kind have not been yet produced by CFSP.

9. Benefits and impact estimates,

[38] see in Annex I the list of provinces with the energy balance estimates by ADB

is quite high. In fact, these calculations should be made per meal (by taking the average number of meal cooked on each stove e.g. in restaurants or institutions).

Some calculations on the economics of the stoves follow

Table 8 Fuelwood Savings from introducing Twin Stove in Kompong Chhnang.

HH wood consumption per year in kg	Wood saved by using Twin (18%) in kg	Unit cost of wood R/kg	Cost of fuel wood (in R)	Savings (in R)	Payback period ***
5256 *	946	200	1.051.200	189216	12 days
3504 **	631		700.800	126200	8 days

* according to CFSP , ** ccording to MIME, *** Stove cost = 4000 R or 1 USD

considering that everyday 2.6 kg or 520 R are saved (CFSP figure), the stove can be acquired after 7.7 days of saving (based on 365 days of stove use). Based on MIME figures the respective ffigures would be: 1.73 kg or 346 R and 11.6 days.

Table 9 Savings from introducing New Lao

HH Charcoal consumption per year (in kg)	Charcoal saved by using new Lao (15%) in kg	Unit cost of charcoal (R/kg)	Annual Cost of charcoal	Saving	Payback period
503	75	450	226350	33952	161 days*

* Stove cost 15,000 R, daily savings 93 R

We see that given the low fuel economy and the high price, the economic cost of the new Lao seem extremely high compared to other stoves.

We have not computed here savings from introducing Samaki are, given the uncertainty about the 35% efficiency figure, the cost of installation by project staff and the lack of data on annual fuel consumption by such a stove.

More economic and financial analysis at Household (Consumer) or Workshop (Producer) is needed. In order to calculate these benefits, other benchmark data on cost and benefits are needed, at the household and the industrial unit (enterprise) level.

On the Cost side

actual cost of preparing a meal, or another product, and percentage of fuel cost in meal preparation.
- cost of the traditional stove (for wood and charcoal)
- cost of the fuel
- cost of food and ingredients

On the Benefit side

- savings from introducing fuel-saving equipment interms of less money spent on fuel

imperfect: the kilns are open to the top[37] and at the loading gate. While the use of rice-husk is ecological, it does not permit to attain temperatures as high as with wood, and therefore products are more fragile. While the local clay is relative free from impurities, it is still not homogeneous. Preparation of the clay still - as in most traditional pottery - involves the inclusion of pounded ceramics to make it more heat resistant and thereby implies greater thickness. Improvement of the firing process would on the long run also have to entail changes in the clay preparation.

6. Economics of ICS

At micro-level (e.g. for consumers or producers) almost no data for an economic evaluation exist. Therefore we have calculated in Table 4, based on the Conversion Factors above, the cost of useful heat in Rial (1 USD = 4000 R).

Table 7 Cost of Useful Heat

Stove Type	R/unit of Fuel	Fuel Cost (R/MJ)	Useful Heat (R/MJ)
3- Stones	200	13.79	137.9
Siam	200	13.79	91.9
Twin	200	13.79	72.6
Samaki	200	13.79	39.4
Lao Kompong Chng	200	13.79	86.2
old Lao bucket	450	15.52	64.7
new Lao bucket	450	15.52	53.3
Kerosene wick	1800	50.99	110.8
Kerosene pressure	1800	50.99	98.1
LPG stove	2280	50.38	79.9
Electricity hotplate	650	180.55	273.7
Trad.Institut. stove	200	13.79	51.1
Imprvd Institut. stove	200	13.79	32.2
Palm Sugar Kiln trad.	200	13.79	65.0
Palm Sugar Kiln impr	200	13.79	33.6

If fuel has to be purchased, the new Lao seems to be the most economical of the wood stoves; the Twin seems gain not to have much advantage over the Siam. For the Samaki we have reason to believe that the 35% efficiency as recorded by CFSP is overly optimistic. The low cost of useful heat should be verified by a larger number of performance tests. This holds true for the other stoves for quantity-cooking as well. We note that LPG - which is not subsidized in Cambodia - is quite competitive with wood and the traditional and improved stoves.

The above analysis includes only price of the fuel and not purchase cost of the stove itself, which could shift the relationship somewhat since the initial investment for institutional stoves

[36] unfortunately we have no data on damage during transport, during our field visit, several of the distributed Twin stoves were cracked or broken and no longer used. More exact data are needed on this.

[37] The kiln itself is 4 walls of bricks with no roof; the kiln site is, however, covered with a corrugated iron roof which protects the essential firing process from rain but does not from occasional temperature shock from wind , especially during the rainy season.

In terms of rapidity the Twin saves only 5 min compared to Siam and 3-Stone model. The new Lao bucket saves only 3 min over the old Lao. The test-cooking confirms the results from the WBT, namely that the improved stoves are not vastly superior to the existing stoves (which are however already much improved over the 3-stone fireplace);the 'traditional Cambodian' stove is therefore quite advanced compared to stoves in other countries.

Monetary fuel-savings as result of the cooking tests were not calculated by the CFSP but we have made our own calculations (see 6. ICS) [35]

Field Cooking Tests (Kitchen Performance Tests)

They are to be done in users' household to determine the relative performance of presently used and improved stoves. Here they were not done under comparable conditions (e..g. same family sizes, same foods) as required by standard cooking test procedures (see S.Baldwin, Biomass Stoves, Princeton N.J., 1987 VITA).

From the project's different test results we can not know presently the relative performance of traditional and new stoves: For example, in the WBT the Twin saves 40 per cent of fuel compared to the 3-Stone; but during CCT the efficiency of the Twin was only 19 per cent.
The Samaki, on the other hand, with a 35% efficiency, saved only 10% of fuelwood compred to the 3-Stone during KPT (or 29% when all pig food cooking was included).

This clearly shows the need for a sufficient number of test to give **significant results.**

Demonstrations

THe report on dissemination strategies states that some 12 demonstrations were held in the villages before target groups - and with the Department of Womens' Affair as partner. Some 351 people were in attendance. But there is neither published information on the methodology of the demonstration (whether they compared trditional with improved stoves or only presented the imporved stoves) nor on the results (no.of men and women, reaction, fuelwood consumption or savings) or other results. In a project, advantage should always be taken of demonstrations to obtain more data under field conditions e.g. like in CCT. Therefore, a clear methodology for Demonstrations should be established through standard data sheets and a training manual which enables the demonstrations to be exploited like CCT or kitchen test results.

Other technical advantages and disadvantages.

Fuelwood or monetary savings are only two parameters opting for or against the adoption of improved stoves compred to the 2 stone stove. There are others: health and hygienic benefits, comfort, convenience e.g. portability, rapidity , durability. All these should be taken into account and assessed during user surveys.

In terms of durability we found that breakage rate of Siam and Twin is high a) during firing around 10%, b) during transportation and c) during utilization.[36] The firing process is

[35] (the kg of wood costs 200 R in Kompong Chnang and 300 or up to 400 R for high grade in Phnom Penh; charcoal in Phnom Penh is 500 R)

Palm Sugar Kiln impr	FW	41	14.5 MJ/kg

Controlled Cooking Tests (CCT)

CCT are used to test performance of stoves under real actual cooking conditions.
Wood consumption and fuel-savings per day per family should be obtained from numerous replications under different conditions (dry season, rainy season, morning, evening, with and without wind); the differences between replications are sometimes surprisingly great. The number of 5 replications seems insufficient; here we get only an indication that stoves save fuel but not the quantitative savings under different test conditions. As with WBT, data from the different cooking exercises were lumped together into an aggregate - so we feel they are not really comparable - instead no individual test data with means and standard deviations and description of conditions were recorded in the stove-testing report.

Table 6 CCT conducted in 1998 (Source: CFSP, Stove Testing)

Stove Type	Tot.wgt.food	Tot.fuel used	Tot.test time hrs, min	power (kw)	Specific fuel cons.kg
3-Stone	11.84	4.43	3.42 min	11.1	0.37
Siam	12.26	4.79	3.52 min	7.5	0.39
Lao Kp.Ch.	12.38	3.11	3.35 min	7.9	0.25
Trad.Lao	12.16	2.66	3.39	4.0	0.22
Cast iron	12.54	2.90	3.43	4.6	0.23
Twin	12.44	2.72	2.19	21 ?	0.22

Specific fuel consumption is the kg of fuelwood used for cooking one kg of food.

In order to get an idea of the Performance and Fuel Economy under real conditions - i.e. cooking the same local meal and the same quantity on different stoves - we asked the project to set up 4 tests in Kompong Chhnaang, but unfortunately for lack of time only one could be done. It gives however some indication of the performance of the stoves relative to the traditional 3-stone-stove. [34] In our test, under the supervisions of the project's animatrices, a meal of .8 kg of rice, .3 kg of vegetables, and .3 kg of meat were prepared with 1.5 l water; final weight of food was around 2 kg (1.94 - 2.19 kg)

Cooking Test Specific Consumption (in kg) for 2 kg Rice and Sauce (own calculation)					
	3-stones (ref)	Siam	Twin Stove	old Lao	new Lao
wood	1.60	1.080	.880		
charcoal				.480	.410

computing for 1 kg of food we obtain the following specific consumptions of wood: .8, .5, .44, and for charcoal .24 and .205. Compared to the Three-stone model the Twin saves 37% of wood, and the Siam saves 32,5%; compared to the Siam, the Twin stove saves only 18 %.
The new Lao bucket saves 11% of charcoal compared to the old Lao bucket.
The fuel-economy thus is relative to the 3-Stone: Siam 32.5, Twin 37%; Twin over Siam 18%

[34] For more quantitative data see 6.

The following tests were reported : Water-Boiling Tests (WBT), Controlled Cooking, Kitchen Performance Tests [33]

Laboratory Water Boiling Tests (WBT)

The performance of a stove is expressed in terms of heat utilization. WBT provides a quick comparison of the performance of different stoves - or of the same stove under different conditions. It is normally done for a high power (boiling) and low power (simmering) phase to give an energy output for each (measured in kw). The high power phase informs us of the heat transfer from fuel to the pot (or its contents), while the low power phase is necessary to simulate the energy-input for the remainder of the cooking procedure- e.g. simmering in boiling sauces or soups, or rice.

WBT were done for Siam, Twin, Lao Bucket, Samaki but only for High Power Phase and not for Low Power Phase; thus we have no combined Power Output in kW for the two phases. The relative efficiencies are shown in Table. The individual protocols of each test should be shown in the report, and not only the global results.

Table 4 WBT conducted in 1998 (Source CFSP, Stove Testing)

Stove Type	Potholes	kg fuel used	kg of water	min boiling	power (kw)	%efficiency
3-Stone	1	0.55	2	12	11.1	10
Siam	1	0.31	2	10	7.5	15
Lao Kp.Ch.	1	0.33	2	10	7.9	16
Trad.Lao	1	0.20	2	12	4.0	24
Cast iron	1	0.23	2	12	4.6	22
Twin	2	0.53	4	21	21 ?	19

The twin is not really comparable with the other stoves under these conditions, but must be compared and evaluated under conditions of cooking entire local meals to see total savings.

Table 5 Comparative Efficiency of Different Stove Types (own calculations)

Stove Type	Fuel Type	Efficiency (η%)	Conversion Factor
3- Stones	Fuelwood	10	14.5 MJ/kg
Siam	Fuelwood	15	14.5 MJ/kg
Twin	FW	19	14.5 MJ/kg
Samaki	FW	35	14.5 MJ/kg
Lao Kompong Chng	FW	16	14.5 MJ/kg
old Lao bucket	Charcoal	24	29 MJ/kg
new Lao bucket	Charcoal	29	29 MJ/kg
Kerosene wick	Kerosene	46	35.3 MJ/ltr
Kerosene pressure	Kerosene	52	35.5 MJ/ltr
LPG stove	Gas	63	45.26 MJ/kg
Electricity hotplate	Electricity	66	36 MJ/kwh
Trad.Institut. stove	FW	27	14.5 MJ/kg
Imprvd Institut. stove	FW	42	14.5 MJ/kg
Palm Sugar Kiln trad.	FW	21	14.5 MJ/kg

[33] from Stove Testing in Kompong Chhnang Province, CFSP /98/E/01

The local population has found an ingenious way of adapting different pot sizes to local stoves - of the same size - by using rings - which are also produced by potters and which reduce heat loss and permit adjustment to lower pot sizes (see photo).

As for the charcoal stove, another solution to the same problem - adjusting pot size to stove has been found: instead of rings people uses different sizes of stoves. The combustion chamber of the traditional Lao seems small and does not use heat optimally when too large a pot is being used with a small stove, and therefore a lot of energy is lost through the sides. The pot does not enter sufficiently low into the combustion chamber. While this can be compensated, for the old Lao, by using a larger size stove, this is not possible with the new Lao because so far there is only one size. It is imperative that before further marketing the most common pot sizes in use be identified, and an adequate range of stove sizes be introduced. We do not know, whether the problem of fish grilling is as crucial for the urban charcoal users as for the rural wood users.

The Samaki is to be used for food preparation in larger quantities at the household level, e.g. for the domestic animals and gatherings, if it can attain a large-scale diffusion. We have seen it used in our field trip for commercial food preparation by women who operated a local food stall to prepare lunch for local workers. In this quality it seemed to be appreciated since it reduced the need for buying fuelwood, with the quantities gathered from farm and homestead. In our view survey of the stoves diffused so far, of its field performance and quantitative impact and benefits is necessary- The internal evaluation report is concerned with questions on use [32]but not with economic questions.

We must say something about smoke: while generally undesirable - and while the measured levels of CO2 emissions exceeded the permitted levels in all stoves - in indoor kitchens, in rural households smoke emission is desired because it smokes and preserves wood - from which most houses are built, from termites - and food - especially rice stored in the attic - from humidity and rodents (chimneys to evacuate smoke therefore have to be optional and users have to be properly trained on when and not to use a chimney).

5. Fuelwoood and Charcoal Consumption (Test Results)

Stove Tests

Given their importance, for measuring consumption and savings of improved stove models and ultimately the potential impact of woodfuel-savings on the energy balance and economics, more data are needed, especially comparative - including the trditionl stoves - fuel consumption (cooking and field kitchen performance) tests under realistic cooking conditions, with evaluation of financial costs and benefits, so that not only impact on the woodfuel balance but also economic impact e.g. on household budgets, producer incomes ets. can be estimated. For dissemination it is important that the quantitative advantages of each stove be made clear to potential adopters.

[32] Such as such as "who built the stove, how long has it been used, is it used alone or with other stoves, will it be replaced, can it be rebuilt, is the user satisfied". 'Economic questions' concern the purpose, the operating cost, the monetary benefits e.g. number of meals sold, income earned or saved. There are no data on fuel consumption.

down into the combustion chamber and a chimney is used to evacuate smoke the design maximizes heat transfer, and reaches an efficiency of 35 to 48%, according to project staff. Here we have no evaluation report to inform us about the real fuel consumption, benefits or impact.

Palm Sugar Stoves. The traditional version has been improved by CFSP.The **traditional** model is a one-place fixed stove from mud intended for auto-construction by the user. The Wok which is used to heat the juice of the palm (Borassus aethiopus) to make the sugar crystallize sinks into the fire box (combustion chamber).[29] Estimated average efficiency is 22 %

The **improved model** is a two-place model from built with fired bricks and then plastered. A pottery liner chimney, and secondary air holes have been added for better draft. The stove is inclined so that the second pothole is lower than the first.[30] The estimated average efficiency is 41 per cent.

The underlying hypothesis that stove users will build their own stoves because they are practically at zero cost (see II. dissemination strategies) needs to be verified. Up to now most large -scale stoves have been installed by the project, and do not come at real cost to users who usually don't build without further encouragement. They are best for commercial users - like food sellers and palm sugar producers - who can recover the investment of paying professional stove builders (see Dissemination - non-market).

here photo 3

In a second phase, gas and kerosene stoves which have a high potential of replacing woodfuel by substitution and which are already widely used in urban areas, and also improved metal stoves (which have the potential of higher durability at moderate prices) should be tested.

4. Fuelwood management (cooking practices) on Improved Cookstoves

In rural Cambodia most poorer families prepare only rice and fish. A traditional stove like the Siam permits fish grilling on its front platform, and boiling of rice on the back pot rest. The Twin Stove does not preserve the same functionality as the Siam: while it permits two simultaneous cooking procedures, on the front and the rear fire, it only permits fish grilling with difficulty since the front platform is too small, according to the users, and the rear pot rest - which receives the exhaust fire, is more suitable for smoking than for grilling fish. nother inconvenience, according to users, is the impossibility of using large pots, and to cook in one pot only.[31] But the Twin is seen as very useful by those users who cook two dishes e.g. rice and sauce, or want to heat water because the temperature in the evacuation channel (2nd fire place) it always permits water boiling (for example for tea) or warming food (some users now boil water regularly for drinking, an important health side-effect). Also common is soup preparation, which needs lower temperature than boiling rice and is done on the 2nd pothole.

[29] Dimensions found were 120 x 100 x 50 cm, with a 80 cm diameter for the pothole, and 30 cm fuel gate.
[30] Dimensions are 240 x 100 x 70, with the height at second pothole only being 50 cm instead of 70.
[31] These could, however, be overcome with the help of rings and covers- see below. This points out the need for user-information and training, and the production of relevant training support.

charcoal stove. [25]The improved insulation considerably increases production cost for only a relatively small gain in efficiency (29%)and economy.

Picture F.04 Sheet Metal Stove

We have no data from CFSP on metal stoves as these have not been diffused by CFSP.

The **Samaki** is a two-place stove for larger pots. It was conceived for auto-construction by the end user from locally available - from rice fields - clayey loams.[26] The second pot hole can be equipped with a chimney to evacuate ait outside the kitchen. For the moment the project has trained some of its own personnel as stove-builders who have installed models in households in the test zones. The Samaki has an efficiency of 35% on average and is intended to replace not home cooking, but preparation of larger meals e.g. at festivals, family gathering or of food for animals, especially pigs.

Traditional institutional stove. A one fireplace auto-constructed stove was found in pagodas where it is used for food preparation - rice, fish and soup - with cylindrical pots or the Wok for the monks' congregation. [27] The average efficiency of such stoves lies somewhere around 27 per cent.

here photo 2

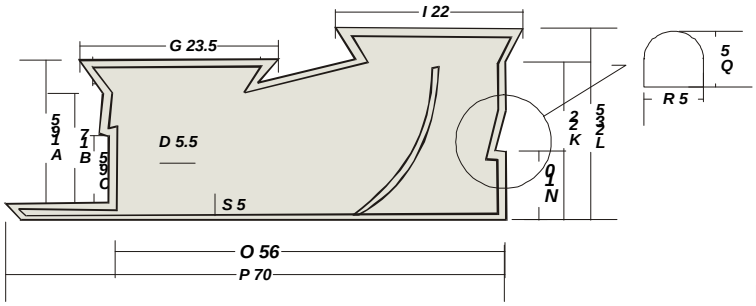
The **Improved Institutional stove** is a fixed two-place model from bricks intended for auto-construction. It has been built and installed by the CFSP in pagodas and orphanages, where it is used in food preparation by Wok or pots for the teachers and students.[28] As the Wok lowers

[25] Vertical height 28 cm, height of the combustion chamber from grate to top rim is 15 cm. The pot is an inverted cone which has a lower dimeter of 16 cm and a top inside diameter of 26.5 cm. The three pot rests define a gap of 1 cm. The vertical height of the pot rests, which are extended from the lower to the top ring, is 6.5 cm. The grate is incorporated and made from unfired mud mixed with clay and wood ash in a proportion of 2:1. The primary air inlet is 5 x 11 cm.

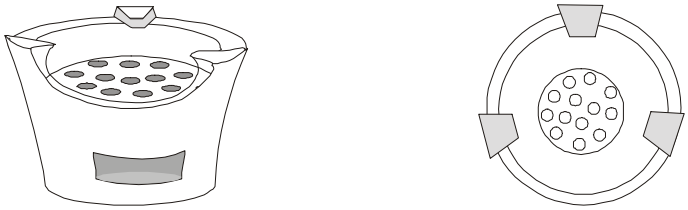
[26] To reduce crack formation, a 1:1 ratio of clay/soil is used to form a rectangular body of appr. 1:2:4 proportion of height, width and length. The pot holes are carved according to the size of the maximum pots - between 30 and 34 cm, with a distance of 60 cm between the outer edge of the holes. The fuel gate is 15 cm² and the air intake 10 cm².

[27] The dimensions were 38 cm height by 100 cm, with a 72 cm pothole and a 22 cm² fuel gate.

[28] The dimensions a 196 x 120 x 75 cm, see photo

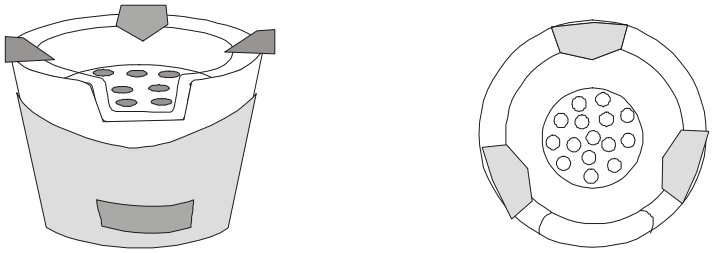


Picture 02. Twin Stove



Picture F.03 Lao Kompong Chhnang

The **Lao Kompong Chhnang** which seems a local development, a mixture between woodstove and charcoal stove, can be used with both, by introducing wood through the cut-out frontal rim, or placing charcoal on the grid. In rural areas it is second to the Siam in frequency of use. It is produced in five sizes. [23] There are no test data. Efficiency is about 16.



Picture F.04 Lao Bucket

The **Lao bucket** is a copy of the Thai bucket - or an improved Lao Kompong Chhnang - and exists traditionally in several different sizes (1 to 5 small, and 3 large sizes). It has a wide distribution among charcoal users, especially food stalls in the urban markets, but can also be used with wood. In Phnom Penh mobile food sellers even carry with them on trays balanced across their shoulders. The combustion chamber is smaller in diameter and height than the Lao Kompong Chhnang[24], its walls are thicker and the outside is covered with simple metal sheeting The producers have found a way by which the Lao bucket can be used with wood, by cutting out a front piece (see photo above, far right). The average efficiency is 24 per cent.

New Lao Bucket is a copy of the Thai Bucket and improved in comparison traditional bucket with regard to insulation (full metal bucket as outside liner, and clay-ash layer as insulator - contrary to the refractory clay liner of the Thay Bucket. So far producers have been trained to produce only one size model which reduces the versatility of the traditional model. It is a solid

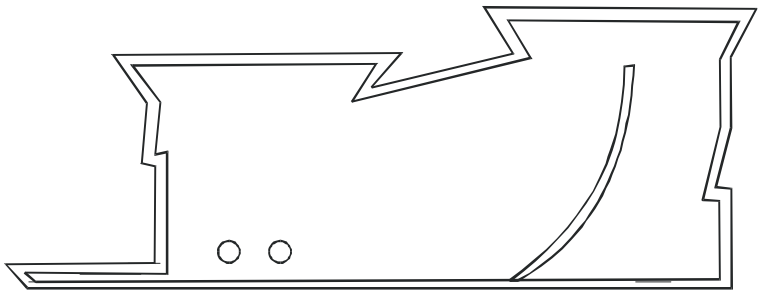
[23] Stove height of no.4 model is 28 cm, height of the combustion chamber is 8 cm, diameter is 27 to 31 cm. Three pot rests define a gap of 4 cm which is large. The primary air intake is 4 x 13 cm. A ceramic grate is incorporated.

[24] no.5 model is 28 cm high, and its combustion chamber 13 cm in diameter. The diameter of the pot ring is 21. The gap defined by the 3 pot rests and the chamber is 5.5 cm wide, too large (a gap should not exceed 1 cm for an optimal hot air flow). The primary air inlet is 5 x 11 cm. The stove is produced with a removable fuel entrance for fuelwood.

improved Lao bucket, traditional Lao bucket (for charcoal back, for wood in front)

The **Twin Stove** is a slightly modified version of the of the Indonesian SAE stove developed by YDD according to the GTZ Stoves Manual. It is a two-hole pottery liner with a 5 cm high 'lip' before the door [22] combines a frontal combustion chamber with a tunnel and a rear chimney where a lip diverts the smoke. The evading hot air can be used for further cooking. The average efficiency of the Twin is 19 per cent.

P01 Siam



[22] The size of the entrance is 18 x 10 cm. The front pothole has a 19 cm diameter, the rear is 16 cm. The tunnel connecting the two potholse tapers to a baffle. The gap between the baffle and the pot base is 5 cm. On each side of the firebox are two small holes for smoe evacuation.

three stoves were already produced by potters in Kompong Chhnang, namely the Siam Ceramic, Lao Kompong Chnam and the Lao Bucket (see photo 1, no. 1,2,3 from left to right) and have traditional distribution networks. [18]

Table 4 Stove Types in Cambodia

	Fuelwood Stoves	**Charcoal Stoves**
Traditional Models	0. Three - Stone Stove	
	1. Siam Ceramic	2. Lao Kompong Chnang
	Lao Kompong Chnang[19]	3. Lao Bucket (5 sizes)
Introduced by CFSP		
Improved Models (small)	4. Twin Stove (2 fireplaces)	5. new Lao Bucket (1 size)
(small and large)	6.Samaki Mudstove (2 places)	
(large)	7. Palm Sugar Stove (2 places)	
	8. Institutional Stove(2 places)	

The traditional **Three-Stone Stove is the model which should serve as the reference for all other developments.** In Cambodia, it consists of a shallow 20 cm deep circular pit, which is lined with three stones of 20 cm size. On the average this stove has about 10 per cent efficiency. [20]

We assume the **Siam** stove was developed for the rural house type with elevated bamboo or wood floors in which the 3-stone stove constitutes a fire risk The **stove** is a ceramic oval bowl with a flat bottom whose two ends are circular , one of which is the potrest above the combustion chamber the other one a 'lip' to for firewood or charcoal, which is widely used for fish grilling (with rice in traditional meals).[21] There are three different sizes of Siam on the market..The efficiency of a no.3 Siam is on average 15%.

The **Sawdust stove** constitutes a further development of the Siam in direction of a closed combustion chamber - sawdust is compacted by pounding in the combustion chamber before starting a slow carbonization process - but which is no longer produced due to the scarcity of sawdust, as many sawmills have closed in the area. There are no test data on the sawdust stove, but we assume efficiency is situated between the Siam and Lao Kompong Chhnang. It would have been logical to further adapt and improve the Siam in that direction, as it is widely known and used.

Photo 1from left to right: Twin Stove, Siam, Lao Kpg.Chhnang (front), Sawdust stove (back),

[18] from the producers of ceramic stoves, to wholesale depots in Kpg.Chnang, and from there to transporters to the markets in Phnom Penh and other urban centers; from there to retailers in markets and from there to final consumers. The Lao bucket is produced in factory-like production facilities in Phnom Penh and delivered to retailers on order;

[19] the Kompong Chnang is conceived with a grid, for use with charcoal, but it is widely also used with wood .

[20] efficiency η is the Amount of heat which goes into the pot (or food to be cooked) as a percentage of Gross Heat Input.

[21] The length of the 'lip' is up to 32 cm, its height appr. 14 cm, so that wood or charcoal placed on it slants downward into the combustion chamber. The latter's diameter is 18 cm. The diameter of the pot ring is 32 cm and the gap between the chamber and the pot rests is 5 cm, in our opinion too high .

C Selection of Pilot Zones

The objective was to test dissemination strategies and study the impact of improved cookstoves on the reducing deforestation, i..e. whether fuelwood collection from forest areas would be reduced after the use of improved stoves. The study contains data on 2 Pilot Areas at 2 locations each on families, fuelwood consumption, woodfuel resources and a tentative demand-supply analysis for one pilot area.

However, the impact on forest stands could not be studied, as the study area was awarded to a plantation concessionnaire and clear-felled. Therefore, the second objective of testing dissemination approaches, was not reached because following the free distribution of 500 stoves, and the sale of another 500 at highly subsidized prices, there were no alternative dissemination methods and no data on stoves sold through other channels in the Pilot Zones were collected.

D Internal Evaluations of 3 Major Stoves

Evaluated in separate reports were the SAE Twin stove, the mud stove Samaki (photo 2), a Palm Sugar Stove (photo 3). The reports contain description of physical characteristics, dissemination results, publicity support, user appreciation from questionnaire. (see under 7.) a discussion of the test methodology but no test results. Tests should have been made **before** the introduction of the stoves to the public, and several months **after** introduction in the field, as part of overall M & E, but we have no evidence that this was done.

A similar internal evaluation report for the Lao bucket (comparison old and new) has not been found (according to project staff it is in preparation) All basic reference data from the evaluation reports should be presented in one summary volume.

3. Woodstove Technology and Stove Models.

The daily preparation of food on **three-stone hearths** has remained unchanged over thousands of years and a majority of the Cambodian rural population still uses that mosel. With the change of time and through migrations pottery-liner stoves were introduced. It should be recognized that these models do represent progress and they should be understood before dealing with "improvements."

It has to be appreciated that CFSP has identified and concentrated on local technology - namely the models produced by an existing pottery industry in Kompong Chhnang. Since Emphasis has been on Conservation rather than on Substitution of Woodfuel, only woodfuel-saving stoves have been introduced and tested, even though metal (sheet metal and cast iron) stoves exist in the market of the capital. Given the existence of pottery models, CFSP should have tried to improve those [17]but chose instead to introduce a model from abroad.

Consistent with its choice of project area, CFSP has implanted the project in a traditional pottery production zone, with a view of improving existing models. It is our understanding that

[17] (Note that ceramic stoves have a higher heat storage capacity than metal stoves,(even this has not been tested , see some test data from Mali in Annex 7).

Insert3

Annually 474 300 tons or 790 440 cubicmeters of wood are extracted by the province, of which 49.500 t are exported, and 644 473 consumed as local firewood, and 96,000 t used by other industry. Methodology: estimated no. of households, monthly consumption, yearly consumption.

Domestic consumption: 14.4 kg/hh/day, or 14.4 steres per year, or 2.57 kg per person/day (5.6 hh average (or MIME 9.6 kg/hh/day or 1.7 per person per day).

This should have been multiplied with the total number of persons (or households)/per province (Population is not even mentioned in the report but we have taken figures from the Socio-Economic Survey report to make our own estimate) to estimate total Demand.:

Actual Consumption

	Population Province Kpg Chhnang	consumption per day/per hh.	consumption per day/person	Total annual consumption: CFSP estimate	Total estd. consumption: MIME estimate
1995	365953	14.4 (9.6mime)	2.57 (1.7)	940499 kg/day	622121 kg/day
1997	390171			1002739	663290 kg/day
1997	75924 families	1093305 (728870)			
1995	Annual	Consumption		343.282	227.074
1997	Annual	Consumption		366.000	242.100

Demand Projections from 1995 to 2002

Kompong Chhnang Province Population			Daily Personal Consumption	Yearly Personal Consumption	Deficits '000 tons
	Total	per psn.cons.	in tons	in tons	supply - demand
1995	365953	2.57	940.49921	343282.212	306 - 343 = 37
1997	390171	2.57	1002.73947	365999.907	306- 366 = 60
2000	415991.694	2.57	1069.09865	390221.008	306 - 390 = 84
2002	443521.149	2.57	1139.84935	416045.014	306 - 416 = 90
growth.p.a*	3.31 %				

Table 4 of report contains Inventory, stock, yield per hectare, Total yield in 1998 is 766 000 tons of which 80 % is considered exploitable; but sustainable supply is given as only 306 000 tons, or 510 000 cubic meters. It is not quite clear why less than 50% are sustainable, whereas in table 4 actual production is given as 474 300 tons.

Comments on the Difference in Table 17
Demand p.a. 474 kt Supply 306 kt ; Deficit 168 kt (and not 171 as in the Report). (demand 1997 366 kt, which is 108 kt less than the estimated one, or 242.kt (MIME), or 232 000 t. The Deficit then in 1998 would be only 60 kt. CFSP Trend Analysis shows increasing gaps between supply and demand and a deficit of 505 000 tons in 2015. but it could be much less if the household consumption coefficient is lower than assumed by CFSP.
(However demand increase from Phnom Penh has not been taken into account).

2. Fuel Wood Consumption and Balance

B The Woodfuel Flow Study in the Kompong Chhnang Province contains data on consumption and supply of fuelwood, as well as on trade flows, sufficient to enable us calculate an energy-balance (without Phnom Penh) (see Analysis in Insert 3). However, a number of unanswered questions remain. For example, why is sustainable supply estimated at only 306 000 t when total yield in 1998 is estimated at 766 000 tons ? Which daily consumption coefficient should be retained, the lower one of 1.7 kg by MIME or the higher one of 2.57 kg by CFSP? The latter consumption estimate derives from the socio-economic study which gives 1.22 stere/month, (this amounts to 14.4 kg/day/family or 2.57 kg per person, or or 5.27 tons/year). Interview data are howeverusually higher than direct measures.

The respective consumption figures for Phnom Penh [15] are much lower than either CFSP or MIME figures, namely .56 kg daily per person (or 3.55 kg per household). Does this difference come from the fact that rural households also boil food for pigs ? Even taking this into account, a difference of two kilograms seems high. For the purpose of estimating woodfuel demand and a balance a reliable coefficient is very important, and the above differences need to be reconciled.

Insert 2 Average Fuel Consumption

	households (FAO)	CFSP	MIME	services	industry
firewood	0.56	2.57	1.7	567 (all units)	37.6 tons/day (all units)
charcoal	0.36			10865	756

in kg/day per person (FAO household average is 3.55 kg[16] vs. 14.4 kg from CSFP)

In Phnom Penh 39% of households use wood as main cooking fuel, and 39% use charcoal already with rising tendency; main charcoal users among the services are restaurants, but laundries (for ironing) come in second; industry uses large quantities of wood (bakeries), which increases to 75,000 tons p.a. if brick kilns are included. There is urgent need to develop a strategy for alternative energies and technologies for urban use e.g. gas or diesel burners.

Table1 Distribution of Households by Type of Cooking Fuel Used, SocioEconomic Survey 99

Type of Fuel	Phnom Penh(HH)	Other Urban	Rural	Total Cambodia
Firewood	67.735	184.379	1.656.938	1.909.052
Charcoal	67.362	24.170	14.506	106.039
LPG	31.621	3.588	1.158	36.367
Kerosene	5.873	983	19.375	26.232
Electricity (private+public)	940	440	3.207	4.580
None		85	287	372
Other	284	633	9.593	10.511
Total No. of Households	173.815	214.272	1.705.065	2.093.152

[15] from Woodfuel Flow Study of Phnom Penh, FAO - RWEDP GCP/RAS/154 NET, Bangkok December 1998. This study states p.12, "the figures shown in the table give different information from different sources, which highlights the need for a good information base which can be continually and consistently updated for energy planning." The variation among estimates is indeed great and only highlights the need for further empirical studies of daily energy consumption,, especially in the SSE sector.

[16] or 4.71 bundles per hh; 1 bundle = .754 kg (1 stere = 795 bundles or 600 kg)

1997 Population by	Province				
	Surface Area km²	Forest Area	Pct.of Total	Population	Density
1.Banteay Meanchey	714.1	280	39.4	577,777	87
2.Battambang	1278	487.6	38.3	816 035	68
3.Kampot	539.3	203	37.8	557 065	108
4.Kandal	383.8	1.7	.4	1 075 122	301
5.Koh Kong	1548.5	886	57.3	132 106	12
6.Kompong Cham	940	315	33.6	1 608 914	164
7.Kompong Chhnang	541	121	22.3	417 693	76
8.Kompong Speu	685.8	340.3	49.7	598 882	85
9.Kompong Thom	1300.8	652.1	50.2	569 060	41
10.Kratie	1200.1	1060	88.4	263 175	24
11.Krong Kaeb	incl in Kampot				
12.Krong Pailin	incl. in Battambang				
13.Krong Prean Sihanu	498	68.7	13.8	155 690	179
14.Mondol Kiri	1348	1276	94.7	32 407	2
15.Oddar Meanchey	includ. in Siem Reap				
16.Preah Vienear	1345.8	1073	80	119 261	9
17.Prey Veng	468	4.1	.9	946 042	194
18.Pursat	1237.5	726	58.7	360 445	28
19.Ratanak Kiri	1189.5	1030.8	86.7	94 243	9
20.Siem Reap	1628.6	934.9	57.4	764 443	68
21.Svay Rieng	280	12.	4.7	478 252	161
22.Stung Treng	1189.3	933	78.5	81 074	7
23.Takeo	339.3	6.1	1.9	790 168	222
Phnom Penh	5503	190	3.5	999 804	3448
				11437 656	64

The surrounding provinces, like Kpg.Speu, Siem Reap, Battambang show similar characteristics, whereas the southern provinces like Kandal, Takeo, Svey Rieng, Prey Veng and Krong Preah Sihanouk are more populated, little forested and generally poorer. Phnom Penh is altogether different.

1. General Features of the Study Area

Four Studies labelled A to D below were the Basis for the reference data collection:
A. General Socio-Economic Study of the Intervention Area, Kompong Chhnang Province.

A. contains data by district on ethnicity, demography, religion, educational level, health status, sanitation, water supply, land ownership and housing conditions; income by source and type of expenditure. One finding is that only 28 % of households in the sample buy fuelwood, whereas 72% collect wood. 45 per cent of the former spend between 5 to 10,000 Riel ($1.2-2.5) monthly on fuelwood, or 2.5 - 5% of monthly income. The section that deals with the types and numbers of stoves used, establishes that 80% of households already use a traditional pottery stove, the Siam, and only 11% the 3-stone-stove. **This makes the province less than ideal for improved stoves technology, as most households have little monetary incentive to save woodfuel and already use an improved technology.** Contrasting with a great detail on stove placement and cooking arrangements, the report contains no data on the fuel consumption of the stoves found. The 14.4 kg average of daily household wood consumption seems to come from interviews rather than from measurements, and may be overestimated.[14]

[14] see Insert 2

CHAPTER I. Woodfuel-Saving Technology and Elaboration of Reference Data

The purpose of the project was to elaborate reference data. This report summarizes these data s they are scattered over many project reports; many data however were not avilable from the project and had to be compiled by us , they are presented in inserts.

Justification of Project Area Selection

If the province of Kompong Chhnang was chosen to establish reference data for a country-wide stoves' dissemination strategy, then we have to ask how representative it is for the country. No selection criteria were contained in the reports available to us, yet choice of area need be thematized if strategy dictates that stoves projects should intervene where impact and sustainability are likely to be the greatest. From interviews with the project staff it seems that choice was motivated by practical considerations, the strongest of these being that the project implementation agencies, GERES and YYD, had previously worked in Kompong Chhnang in the context of rural development programs, and therefore had privileged knowledge of the province. **More importantly, however, Kompong Chnang is the center of the country's pottery industry where local producers already manufacture two widely accepted stove models which are distributed nation-wide and reach Phnom Penh and other markets.** While this is crucial for the development of a production capacity and of markets and distribution networks, **these conditions may not necessarily be found in other project extension areas, and the same approach may not be replicated there.**

In terms of geography, topography, language, ethnic groups, occupational patterns, and infrastructure the province of K. Chnang appears to be typical and representative of many other provinces except for the more mountainous northwest and northeast. But in terms of vegetation, forest cover, population density and average incomes Kompong Chhnang province differs from other provinces.

Quite different socio-economic structures prevail in Phnom Penh, the major absorption area for woodfuel - and pottery stoves - , which has no own supply base (and to a minor extent Sihanoukville and the floodplain of Tonle Sap and Siem Reap). Woodfuel demand and potential fuel savings from interventions with improved stoves need to be further documented for these areas in order to justify intervention there.The interaction between the Phnom Penh market and K.Ch. have not been studied but the province is a major supplier of ligneous fuel for the capital.[13]

Insert 1

[13] an FAO-RWEDP Study on Woodfuel Flow of Phnom Penh provides data for model-making of the inter-action between the Kompong Chhnang and the Phnom Penh markets.

2. allow the diffusion of those knowledges on Kompong Chnang province throughout the country
3. valorize the correlation of fuelwood economy to deforestation reduction to balance supply and demand.

The formulation of **Specific objectives** was as follows -
1. new stoves users. economic aspects of reduction of fuelwood expenses;
awareness on the necessity to reduce deforestation and the existing methods to facilitate.
Indicators were defined as a) tests to measure reduction of fuelwood consumption; social and economic survey to know the impact on the users' level..
2. new producers of fuel-saving stoves manufacturers: provide new alternative of income sources; provide new knowledges ; support production.
Indicators : establishment of new stoves production units; ability to apply the knowledge to maintain high quality of the stove.
3. NGO'S and government staff members: information on project knowledges; training of staff members on integrated approaches. **Indicators:** ability to participate to the orientations of the project; interest to extend the project in a broad sense; sollicitation of external and local managers of the project to diffuse the approach.

Like in all reports, sometimes it is difficult to understand the English formulation. -

ii.2. Results and Activities were defined as follows:
year 1: prediffusion of 500 SAE improved stoves and 10 big capacity stoves
2. Analysis of Social and Energy problems in the province and the strategy made by GERES and YDD before launching the project.
3. Develop a strategy to reduce fuelwood on the area and define a specific area for observation purpose.
4. Test various tools and practices
5. Train Cambodian technicians
6. Global evaluation of the action
7. Elaboration of a strategy for a finest diffusion based on the results of the evaluation
8. prediffusion of 500 improved cookstoves and 10 big-capacity stoves
9. Implication of various stoves to replicate the diffusion at K.Chn. and national scale
10. Elaboration of practical guides for animators., constructors and managers in charge of
11. Assistance to manufacturers to make their activities last
12. Promotion of tools and practices by media
13. Assess the impact of the programme in the area and make necessary improvements to enable replication of the approach at national level.

Irrespectively of the slight variations in objectives from one document to another, this Evaluation will concentrate on the following TOR and comprise 5 chapters: I. Elaboration of Reference Data for a Woodfuel-Reducing Strategy, II. Dissemination Strategies, III. Support (ICE), IV. Proprosal for the Second Phase, V. Recommendations..

workshops (and wholesale depots) in Kompong Chhnang and Phnom Penh, and develop a strategy for marketing a sufficiently large number of wood and charcoal stoves to make a felt impact. For this it needs to structure itself into several independent divisions:

- R&D division (to continue development and improvement to make existing models more efficient and cost-effective and record technical data),
- an M&E division (to study the markets and follow diffusion and sales, as well as making the economic and financial calculations on benefits and impact),
- an ICE[10] division (to develop marketing strategies with producers, retailers and consumers, elaborate communication, publicity and training modules and conduct training).

Training - of provincial and extension staff - [11] should precede expansion to other areas and sectors. Specific modules ought to be developed with particular partners, [12] and specialized aspects should be contracted to special partners.

In an overall perspective, the CFSP has made important progress and laid the ground for a successful dissemination of fuel-saving stoves in Cambodia. The activities below under ii.2. were implemented as planned and the results accomplished, with the exception of no.13. Basic wood-saving and charcoal-saving stove models have been developed, tested and integrated into existing distribution networks. The technical reports are well presented and contain important data.

However, the progress made in the field needs to be translated in a transparent monitoring and evaluation system, to record the test and marketing results, fuelwood-savings and other impact indicators, before extension of the project to other regions can be made. All results should be embodied in a single document. Adaptation and refinement of existing stoves - especially of an extended range of improved Lao, sheet metal, kerosene and LPF stoves for the urban users - should continue parallel to the commercial marketing of the mature models.

Concentration on those areas and sectors of fuel-consumption where energy cost forms an important part of business and household budgets like the Phnom Penh market, is advised for the design of the follow-on phase. Before intervening in other areas, these areas need to be better known to arrive at fuel demand-supply balances and formulate appropriate strategies and marketing approaches.

ii. INTRODUCTION

ii.1 Definition of Objectives, Results and Activities of the Project

In the project document of 1997, the following 3 **Global Objectives** were formulated:
1. Develop an approach to reduce fuelwood consumption referring to the social, economic and technical aspects of the community (this was formulated alternatively as "to obtain a clear status on social, economic and technical (sic!) on fuelwood utilisation and related matters." and "develop references on reduction fuelwood consumption in Cambodia by taking the case of K.Chn. province."

[10] Marketing, Communication nd Education
[11] of MIME, Min.Environment and NGO's and other partners
[12] for example with Community Forestry agencies a module how to integrate ICS technology into CF areas.

and evaluation. While Siam and Lao K.Ch. are already shipped widely[6], the Twin seems not to be marketed outside Kompong Chhnang town.

On the other hand, the charcoal stove technology of the improved Lao rather suits urban than rural consumers - households and small enterprises alike. But likewise, marketing efforts will have to go a long way before the new Lao will replace the old Lao in the sortiment of the traders. Our impression is for both ICS that the margin of efficiency and of fuel economy is too low to warrant the substantial price increase from the traditional to the modern model.

For the self-built stoves, a difference exists depending on whether they are for commercial customers or not - and depending on whether customers purchase fuel or not.[7]

The higher the part of fuel-energy in the entire household or enterprise budget, the more appropriate is ICS technology, and the more likely it will be adopted. The project should therefore concentrate on those target groups where the likely impact of stoves-technology is greatest. However, precise data on fuel-economy and household or enterprise budgets are still lacking.

c) while all base data are not yet available, the beginnings of a publicity strategy have been developed: The target groups seem rather to be in the middle of the spectrum - they are local multipliers (VDC village leaders), extension workers and trainers - while the donors on one end, or the end-consumers and retailers at the other end have not so much been in focus. So far, publicity has been entirely financed by project, but efforts should be made to help producers or traders who will be the final beneficiaries to develop their own publicity, as they will reap most benefits from higher sales.

Publicity covers a wide range of tools : TV spots, video cassette, brochures, comic book, T-shirts and jerseys, training manuals and CD, and a yet incomplete website. But we need more precise data on the cost and effectiveness of each.

d) CFSP has proposed to extend the project to other provinces through partners and a network of interested organizations linked losely in WenetCam. While a networking strategy is valid and necessary, we want to underline here again three basic principles on which an extension of stoves technology should be based: i. concentration on the areas of the greatest likely impact, ii., insertion of stove dissemination as much as possible into the existing private marketing networks in order to be sustainable. iii. development of specific marketing strategies for each target group, each producer and each product.

In the light of these we recommend that CSFP concentrate on the major urban and urbanized areas in and around the capital [8], and on small enterprises [9], starting with the existing producer

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[6] oxcarts and moto-carts pick them up at the wholesale depots in K.Ch. and transport them in direction of Phnom Penh and Sihanoukville. However, we have no information on the distribution networks and retail chains, which would be pre-condition to a distribution of improved stoves.

[7] For example, there is little financial incentive for the monks to introduce Improved Stoves in the Buddhist pagodas, as fuelwood is donated by the believers; on the other hand, the publicity effect may be substantial. This is only an example for the need of a specific strategy for each product and target group, which has to be reflected by its place in the operation plan.

[8] but also the provinces with the highest densities and lowest forest cover, see n.10 and Insert 1.

[9] a market study of this sector needs to be done in order to develop marketing strategies; there are hundreds of small stalls and market restaurants in Phnom Penh and elsewhere which use the traditional Lao bucket, and are the main charcoal consumers and merit action .

i. EXECUTIVE SUMMARY

The object of the Mission from nov.23 to dec.4 to Cambodia was to "Review and Evaluate
a) approaches made by CFSP during the period of 2 years esp. in developing base-line (data) to define strategies of the project
b) appropriate ICS technologies that fit to the condition of the people within the target area
c) strategies and pedagogic tools developed for disseminating various models of ICS for target users in K.Chhnang
d) estimate the relevance of proposal of CSFP for a second phase, esp. feasibility of duplication of the K.Chhnang experience at national level."

a) CSFP has initially pursued a strategy of **rural** stove dissemination, at provincial level - and proceded quite logically according to the following steps: - provincial base line survey, estimate of supply and demand of fuelwood, training of producers, selection of pilot areas for consumer sensitization and promotional distribution of stoves. From 1999 on it has also focussed on **urban** markets and stove-producing factories in Phnom Penh by training them to improve a traditional charcoal stove from clay relying on their dissemination channels. A third strategy was to train project personnel to design self-built stoves from clay, either for households, small producers (of palm sugar) [1] or institutions (orphanages, schools, pagodas).

These are at least three strategies which address quite different market segments, and require separate marketing strategies for producers, products and target groups. Without focussing directly on them, CSFP has also targetted the markets of small-scale enterprises and urban households, while somehow neglecting the rural market in the K.Ch. province - no detailed monitoring or specific marketing efforts for the wood stoves were done[2].

While the basic production technologies of rural and urban pottery and clay (self-built) stoves were improved by training more producers, CFSP still lacks solid data on performance and advantages of the stoves and on the markets as well as on the potential impact of the different improved stoves (national fuel balance, savings, incomes, jobs). Due in part to the recent introduction of most stove models an evaluation is almost too early.

b) as said before, target areas have changed: while starting in the K.Ch. area, the CFSP has been looked at others.[3] While improvement of pottery woodstoves is interesting for the Kompong Chhnang area, the development of charcoal stoves is primarily of interest for urban households outside Kompong Chhnang.[4] Even for woodstoves, CFSP could have focussed on further improving the well-introduced Siam or Lao K.CH before introducing an entirely new stove - the Twin.[5] It seems that the Twin stove has - beyond the initial introduction through free/subsidized distribution, certain difficulties in penetrating rural markets. Even though we could not visit each pilot area of Twin stove distribution since 1998, - it seems rural retailers of Siam have not entered the Twin into their sortiment, because they do not sell it in those areas. The obstacles to marketing have not been investigated through systematic monitoring

[1] a majority of palm sugar producers lives in the Kompong Speu area, where the project made pilot tests.
[2] Monitoring and Evaluating
[3] namely the Phnom Penh urban market and the Kompong Speu province
[4] yet, CFSP has not surveyed and targeted this interesting urban market of Kompong Chhnang town.
[5] one area where improvement is necessary is kiln development, so that pottery stoves are fired at higher temperatures, become more solid and show less losses; stoves should be tested by firing them in gas kilns which have been placed into Kompong Chhnang by PRASAC.

CAMBODJA FUELWOOD SAVING PROJECT - External Evaluation Report

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