



Monitoring Report

Fuel-Wood Saving with Improved Cook-stoves in Cambodia

Version 6

24th April 2007

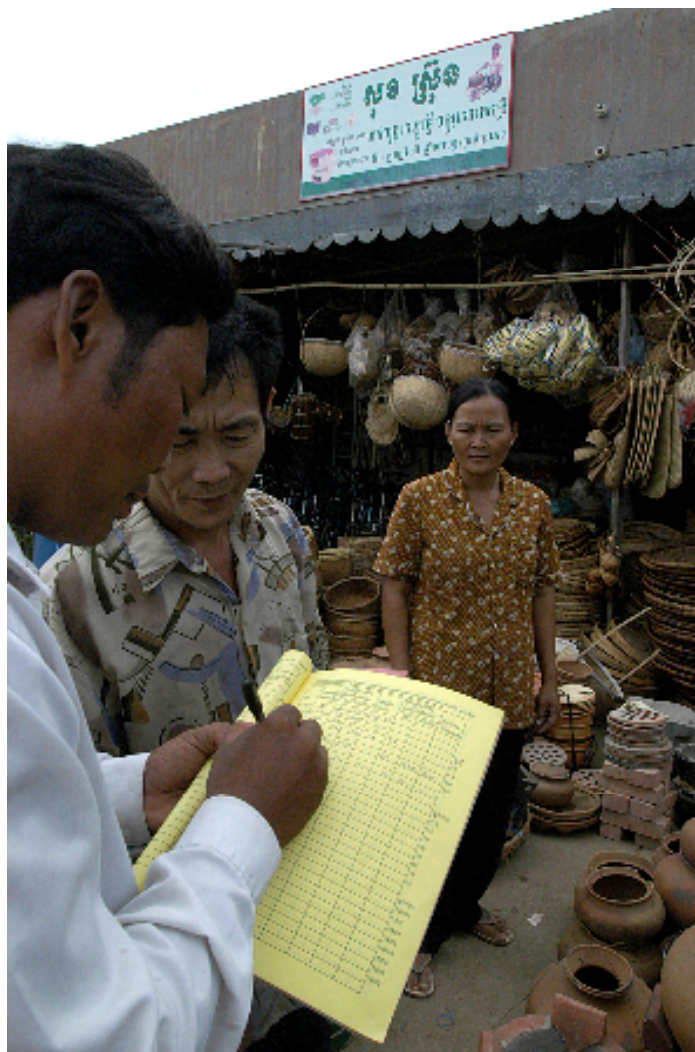


TABLE OF CONTENTS

SECTION A. PROJECT DESCRIPTION	2
SECTION B. CURRENT STATUS OF PROJECT	2
SECTION D. SUSTAINABILITY ENVIRONMENTAL, ECONOMIC AND SOCIAL WELL BEING	6
D.1 Sustainability of Project	6
D.2 Environmental	6
D.3 Economic.....	9
D.4 Social benefits.....	10
SECTION E. PARAMETERS TO BE OBTAINED	12
SECTION F. EMISSIONS REDUCTIONS	16
SECTION G. MEASURES TO ENSURE THE RESULTS.....	17
G.1 Ex-ante Assumptions	17
G.2 Monitoring the Ex-post Data	19
SECTION H. REFERENCES	0
ANNEX 1 DETERMINING POINT OF SALE TIME FOR NEW LAO STOVES IN CAMBODIA.....	1
ANNEX 2- WOOD AND CHARCOAL CONSUMPTION FOR HOUSEHOLD COOKING IN CAMBODIA.....	9

SECTION A. PROJECT DESCRIPTION

The project activity is part of the Cambodian Fuelwood Saving Project (CFSP), which was created to protect forest resources in Cambodia by reducing woodfuel consumption. The CFSP Phase I began in 1997 and ended in 2001. Phase II started in 2002 and was completed in Jan 2007. A commercialized approach was used to disseminate the improved stoves, or New Lao Stove (NLS), through existing market channels. The project has focused on the development of structures that facilitate this in urban and rural areas, particularly those identified as critical (areas with a high population density and wood scarcity). Although the NLS are slightly more expensive, individuals choose them because they last longer and reduce the amount of money spent on charcoal. Phase I was primarily a set up phase which elaborated stove design, trained producers and developed distribution networks. Phase II focused on developing the commercialized distribution of the stove design. The crediting period covered in this report, from May 10th 2003-Jan 9th 2007, occurred during Phase II of the CFSP.

Whilst the primary activity is often seen as the promotion and sales of NLS units, the project is firmly rooted in the wider context of energy use in Cambodia. For this reason the project aims to do more than simply maximizing the number of stoves sold. Additional objectives are:

- A continuation of R&D efforts involving to elaborate new technologies and facilitate fuel switching.
- Lobbying for recognition of the importance of the wood energy sector in Cambodia
- Develop capacity across the production and distributions cycle.

At present some 90% of the Cambodia population are reliant on fuelwood for cooking and all the indications are that, outside of major urban areas, this will continue to be the case for the foreseeable future (NIS, 2005). The ultimate goal of the project is to facilitate a nationwide shift from inefficient exploitation to sustainable and efficient biomass use. Whilst the initial phases of the project have undoubtedly been successful, fuel scarcity continues to exacerbated food security and energy poverty in a country that is already identified, economically, as one of 50 Least Developed Countries (LDC). Thus the project goals are ongoing and there is still much work to do. The project has been co-financed by the EU and, following the withdrawal of start-up funding, additional capital must be identified in order to complete the financing of the first two phases of the project and build on their success. The reduction in emissions of Greenhouse Gases (GHG), stemming from the replacement of inefficient stoves, combined with exceptionally high development dividends make the project an ideal candidate for carbon finance. The utilization of this long term funding stream will ensure that further strides are taken towards the goal of sustainable and efficient woodfuel use in Cambodia.

SECTION B. CURRENT STATUS OF PROJECT

Monitoring of the project began in 2003 in 6 provinces throughout Cambodia. The success of the commercialized approach and stove design has meant that the project and monitoring activities have been extended to 9 different regions/states/provinces: Phnom Penh, Kandal, Kompong Speu, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham and Kompong Chhnang.

B.1 Map of Cambodia



The total crediting period for the project will be ten years. This monitoring report considers *ex-post* emissions reductions that occurred between the 10/05/03 to the 9/01/07. Lifetime survey analysis has concluded that the average stove lifetime in some 3-4 years (Van Mansvelt, 2006). In the interests of ensuring that emissions reductions are conservative the, stove lifetime is calculated as being three years. While further assistance is needed to scale up dissemination of NLS, a recent user survey reported that over 40% of its respondents are now using an ICS and a high level of user satisfaction with the NLS. Thus there are good indications of sustainability in the market (Winrock International, 2006). The project was submitted to Det Norske Veritas Certification Ltd to verify the GHG emission reported as Voluntary Carbon Unit (VCUs). This section contains details of the Forward Action Requests (FAR) and amendments made as a result of the FARs.

Ex-Ante Forward Action Requests

a) *The NLS purchased by distributors are not necessarily being sold to end users. If stoves are not sold to end users, the carbon saving in the calculation may not be real. Therefore, the carbon saving due to the saving of fuels (firewood and charcoals) needs further justification.*

Emissions reductions will not accrue during the time that stoves take to reach the end user. Two points in the supply chain can affect the length of this period. Firstly, during distribution from producers to retailers, sometimes via middlemen. Secondly, the number of Stove Shelf Days (SSD); the length of time stoves are held by the retailer before their eventual sale to the end user. The statistically robust Point of Sale Time (POST), the time between stoves being sold by the producer and utilized by end users, is 25.2 days. It can be asserted with 95% confidence that any given stove will have been sold within 25.2 days of arrival at any given retailer. Combined with an estimated travel time of five days a period of one month is adopted as the average POST for New Lao Stoves to resolve this FAR (See Annex 1).

b) The underlying assumption is that the consumers use only two types of stoves (TLS and NLS) and either use charcoal or fire wood only. The observation during the site visit revealed that users have more than these two types of stoves and that mixing of fuel is practiced.

Values reported in the PDD have been adjusted as previous assumptions were based on test results using just one fuel source. It is hard to replicate fuel mix under test conditions so nationwide survey data is used to establish the quantity of wood and charcoal being used considering the relative proportions of wood and charcoal being used by biomass stoves. According to the survey of 385 biomass stove users across Cambodia the average mix of charcoal and wood in traditional stoves is 32.12kg and 37.56kg a month, respectively. Fuel consumption using NLS is reduced to 25.31kg/month for charcoal and 29.55kg per month for woodfuel (see Annex 2).

c) Values reported in the PDD were the dry season stove efficiency (higher value), 21.76% and 21.49 for charcoal and wood saving when switched to NLS respectively. The lower value of these values or at least the average efficiency of both seasons should be utilized to ensure conservativeness.

Values reported in the PDD have been adjusted to reflect average of both dry and rainy season.

d) It was considered that the result obtained from the two kilns has a difference that requires more kilns to be studied in order to obtain more reliable data.

IPCC default value of 6Kg of wood per Kg of Charcoal is now used in the PDD.

e) As the project has been in operation for more than three years, it should be possible and beneficial to confirm the above assumption for the average lifespan of a NLS, i.e. by ex-post monitoring/surveys.

Additional survey will be carried out to establish average lifespan of NLS.

f) The current calculation has utilized default value of IPCC 1996, i.e. NCV biomass and EFCO₂, biomass. There is no difference between the 1996 and 2006 values; it is recommended that the latest IPCC 2006 values should be referenced

Update of all IPCC default values to reflect the 2006 guidelines

Biomass		IPCC 1996 Guidelines	IPCC 2006 Guidelines
Wood/ Wood Waste	Effective Emissions Factor CO ₂ e	109.6	112
	Net Calorific Value	15	15.6

g) The assumptions of equipment ratio per family (1.27) was found to be conservatives as most families visited have at least two stoves which include both the traditional and NLS.

Although the assumption of equipment ration of 1.27 stoves per family has been found to be conservative the PDD uses an adjusted figure of 1.28 stoves per family. This figure remains conservative and is based on a larger sample size than the previous figure. Furthermore a report is readily available for stakeholders to view.

Ex- Post Forward Action Requests

a) *Inaccurate data transfer.*

Data has been re-entered for the period May 2003- Jan 2007. Internal verification will take place on a monthly basis. Data protection measures will be taken such as assigning passwords and read-only status to files to prevent inadvertent alterations of Ex-post data.

b) *Data Management*

All relevant files will be assigned a password. All raw data will be consolidated and held in Phnom Penh office of GERES.

c) *The PP should review and revise the current monitoring plan to ensure full compliance to the required of the approved methodology used.*

The monitoring plan has been reviewed and revised. (See below and PDD)

SECTION C .STATEMENT TO WHAT EXTENT THE PROJECT ACTIVITY HAS BEEN IMPLEMENTED

The project was operational for the entirety of the monitoring period May 10th 2003 – Jan 9th 2007. The project has been implemented as per the plans in the Project Design Document (PDD).

Table C.1: Sales of NLS May 03 – Jan 07

Date		No of units sold	Number of units in use
10-May-03	9-Jun-03	2205	
10-Jun-03	9-Jul-03	2331	2205
10-Jul-03	9-Aug-03	2362	4536
10-Aug-03	9-Sep-03	2630	6898
10-Sep-03	9-Oct-03	2341	9528
10-Oct-03	9-Nov-03	3035	11869
10-Nov-03	9-Dec-03	2261	14904
10-Dec-03	9-Jan-04	2251	17165
10-Jan-04	9-Feb-04	2742	19416
10-Feb-04	9-Mar-04	2709	22158
10-Mar-04	9-Apr-04	2463	24867
10-Apr-04	9-May-04	1498	27330
10-May-04	9-Jun-04	3097	28828
10-Jun-04	9-Jul-04	4046	31925
10-Jul-04	9-Aug-04	3491	35971
10-Aug-04	9-Sep-04	3056	39462
10-Sep-04	9-Oct-04	4112	42518
10-Oct-04	9-Nov-04	3459	46630
10-Nov-04	9-Dec-04	3319	50089
10-Dec-04	9-Jan-05	3487	53408
10-Jan-05	9-Feb-05	4206	56895
10-Feb-05	9-Mar-05	3440	61101
10-Mar-05	9-Apr-05	4508	64541
10-Apr-05	9-May-05	2747	69049
10-May-05	9-Jun-05	4222	71796
10-Jun-05	9-Jul-05	4165	76018

10-Jul-05	9-Aug-05	4770	80183
10-Aug-05	9-Sep-05	5039	84953
10-Sep-05	9-Oct-05	4509	89992
10-Oct-05	9-Nov-05	5207	94501
10-Nov-05	9-Dec-05	5408	99708
10-Dec-06	9-Jan-06	6016	105116
10-Jan-06	9-Feb-06	6469	111132
10-Feb-06	9-Mar-06	6301	117601
10-Mar-06	9-Apr-06	7596	123902
10-Apr-06	9-May-06	6849	131498
10-May-06	9-Jun-06	8221	136142
10-Jun-06	9-Jul-06	7681	142032
10-Jul-06	9-Aug-06	10771	147351
10-Aug-06	9-Sep-06	13383	155492
10-Sep-06	9-Oct-06	11238	166534
10-Oct-06	9-Nov-06	12680	174737
10-Nov-06	9-Dec-06	9750	185156
10-Dec-06	9-Jan-07	8517	192655
Total		220,588	

The Table above shows both the number of units sold by stove producers over the monitoring period and the number of stoves being used by the end user and therefore the number of stoves used to calculate the quantity of emissions reductions. The number of stove in use is adjusted to take into account the length of time needed for the stove to be sold to the end user (see Annex 1) and the average stove lifespan of three years after which it is assumed to be replaced (see Annex 2 –stove numbers).

SECTION D. SUSTAINABILITY ENVIRONMENTAL, ECONOMIC AND SOCIAL WELL BEING

D.1 Sustainability of Project

The emissions reductions from the project activities are permanent as the NLS is substituting traditional stoves in the market place. Monitoring activities have demonstrated this trend, in urban areas, such as Phnom Penh, where the market share has reached 33.5% (Van Mansvelt, 2006²). In fact, the monitoring teams have recorded that the chief complaint of stove retailers is the shortage of supply, whilst producers complain they cannot expand their facilities quick enough to match demand (EU, 2006). In user surveys over 95% of respondents cited the benefits of the NLS and plan to buy the same stove in the future. All evaluation reports have agreed that, whilst there is scope for scaling up, the NLS is now an established energy carrier in Cambodia (EU, 2006, Winrock International, 2006, Atukorala, 2006)

D.2 Environmental

Aside from the environmental benefits of GHG mitigation (see below), the project activity directly contributes to efforts to reduce unsustainable fuel wood consumption. Charcoal savings from the dissemination of the NLS can be calculated using the results of Real Cooking Tests (RCT) which are used to compare the performance of different thermal technologies. The results show that the average charcoal consumption is 2.118 kg / family /day using the traditional stove and the average saving of charcoal using the NLS is 21.8% compared to the traditional one. Therefore the total savings over the duration of the project activity will be the equivalent of saving 945.2 ha of forest¹.

¹ 1 ton = 1.667 m³ 1 ha = 230 m³ (source GERES, 2005)

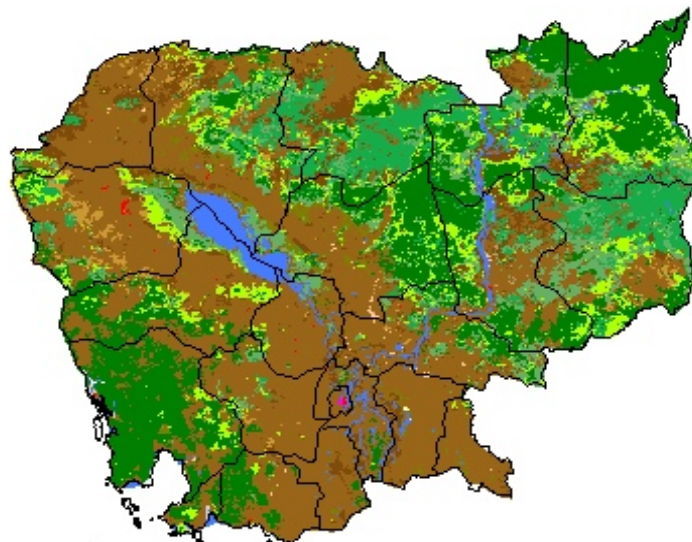
Area of forest saved by NLS project May 2003- Jan 2007

Date		Biomass saved / Tons	Biomass saved/ m³	Biomass Saved / ha	Accumulative
37751.0	37781.0	83.9	139.9	0.6	0.6
37782.0	37811.0	172.6	287.7	1.3	1.9
37812.0	37842.0	262.5	437.5	1.9	3.8
37843.0	37873.0	362.5	604.4	2.6	6.4
37874.0	37903.0	451.6	752.9	3.3	9.7
37904.0	37934.0	567.1	945.4	4.1	13.8
37935.0	37964.0	653.1	1088.8	4.7	18.5
37965.0	37995.0	738.8	1231.6	5.4	23.9
37996.0	38026.0	843.1	1405.5	6.1	30.0
38027.0	38055.0	946.2	1577.3	6.9	36.8
38056.0	38086.0	1039.9	1733.6	7.5	44.4
38087.0	38116.0	1096.9	1828.6	8.0	52.3
38117.0	38147.0	1214.8	2025.0	8.8	61.1
38148.0	38177.0	1368.7	2281.7	9.9	71.0
38178.0	38208.0	1501.6	2503.1	10.9	81.9
38209.0	38239.0	1617.8	2696.9	11.7	93.7
38240.0	38269.0	1774.3	2957.8	12.9	106.5
38270.0	38300.0	1905.9	3177.2	13.8	120.3
38301.0	38330.0	2032.2	3387.7	14.7	135.1
38331.0	38361.0	2164.9	3608.9	15.7	150.7
38362.0	38392.0	2324.9	3875.7	16.9	167.6
38393.0	38420.0	2455.8	4093.9	17.8	185.4
38421.0	38451.0	2627.4	4379.8	19.0	204.4
38452.0	38481.0	2731.9	4554.1	19.8	224.2
38482.0	38512.0	2892.5	4821.9	21.0	245.2
38513.0	38542.0	3051.0	5086.0	22.1	267.3
38543.0	38573.0	3232.5	5388.6	23.4	290.7
38574.0	38604.0	3424.3	5708.2	24.8	315.6
38605.0	38634.0	3595.8	5994.2	26.1	341.6
38635.0	38665.0	3794.0	6324.5	27.5	369.1
38666.0	38695.0	3999.7	6667.6	29.0	398.1
38696.0	38726.0	4228.7	7049.2	30.6	428.8
38727.0	38757.0	4474.8	7459.5	32.4	461.2
38758.0	38785.0	4714.6	7859.2	34.2	495.4
38786.0	38816.0	5003.6	8341.0	36.3	531.6
38817.0	38846.0	5180.3	8635.6	37.5	569.2
38847.0	38877.0	5404.4	9009.2	39.2	608.3
38878.0	38907.0	5606.8	9346.6	40.6	649.0
38908.0	38938.0	5916.6	9862.9	42.9	691.9
38939.0	38969.0	6336.7	10563.3	45.9	737.8
38970.0	38999.0	6648.9	11083.7	48.2	786.0
39000.0	39030.0	7045.3	11744.5	51.1	837.0
39031.0	39060.0	7330.7	12220.2	53.1	890.2
39061.0	39091.0	7550.4	12586.5	54.7	944.9
TOTAL				944.9	

D.2.1 Non-Renewability

The PDD claims emissions reductions on the basis that biomass use in Cambodia is considered non-renewable as the current trend of regional use is unsustainable in the long term. The monitoring report summarizes accredited literature to demonstrate this. Although Cambodia is well endowed with forest resources they are rapidly being depleted. The main forested areas are located in the North and South of the country. The map below illustrates the density of forest cover; the populated corridor where urban centers are located can be clearly seen. The figure below goes somewhat towards illustrating the logistical difficulties of supplying urban centers with fuel wood. As the forest cover recedes so do the distances need to collect fuelwood and so to the associated costs of meeting energy requirements.

Figure D.1 Distribution of forest cover in Cambodia. (source FAO, 2005)



The principle causes of deforestation in Cambodia are agriculture, shifting cultivation, fuelwood harvesting and logging. Pre 1970s forest cover was estimated as being 13 227 100 ha or 73% of the total land area. Although estimations vary and there is a lack of consistency between them a trend of rapid forest resource depletion is apparent. By 1996 forest cover estimated from satellite imagery to be as low as 10 535 763 ha or 58 percent of total land area (FAO, 1997). Some sources put this figure much lower at 30-35% (Global Witness, 1995). Projections to 2010 estimate that forest cover will be 5,174,000 ha. From 1990 – 2000 Cambodia lost an average of 140, 500 ha per year. This amounts to an annual deforestation rate 1.09% per year. In total between 1990 and 2005 Cambodia lost some 19.3% of its forest cover (RWEDP, 1997). Charcoal is mainly used in urban areas or towns, especially in Phnom Penh, the capital of the country. According to the National Statistics Institute, in 1997, 59% of the total wood energy was used in Phnom Penh. A wood energy baseline study found that the annual wood demand for Phnom Penh was 369,000 tones, or approximately 4500 hectares per year. The study concluded that charcoal production is unsustainable as natural forest regeneration is too slow to produce enough fuelwood for demand. Harvesting the same yield sustainably would require the maintenance of a tree plantation some 30,750 ha (Van Mansvelt et al, 2006³). A proposition which is unfeasible in present day Cambodia. A study in Kampong Speu reveals a similar trend (FAO, 2001). The table below shows that sustainable use of fuelwood through re-growth is just 4% of the total demand per year.

Table D.2 Balance between supply and demand Kampong Speu (source FAO, 2001)

Total population in the province	Annual demand in the province (T)	Annual demand outside the province (T)	Total woods surface in the province (ha)	Growing rate per year (T/ha/yr)	Total quantity of wood (T)	Total demand per year (T)
589,873	275,323	38,756	339,147	0.04	13,617	314,079

The study concludes that:

‘One may say that forest areas in the province could be totally lost as a result of illegal fuelwood collection, leaving the province and its neighbors affected by floods and/or droughts almost every year’(FAO,2001)

In fact, as a result of population growth, fuelwood use is expected to increase in the short to medium term.

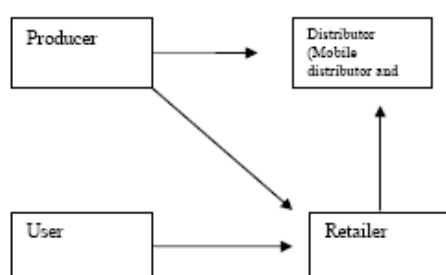
Table D.3 Energy use in Cambodia 1994-2010 (Source RWEDP, 2001)

	1994	1995	2000	2005	2010
Households	81,530	81,395	93,819	108,240	110,508
Wood	77,329	77,329	88,985	102,546	104,730
Charcoal	935	935	1,050	1,179	1,135
Kerosene	1,046	879	1,263	1,468	1,512
LPG	35	57	222	416	546
Diesel	80	176	93	106	107
Electricity	352	378	607	967	1,229
Other	1,754	1,642	1,600	1,559	1,351
Service sector	918	989	1,420	2,104	3,189
Wood	23	23	10	5	3
Charcoal	149	149	142	152	165
Kerosene	278	233	415	614	918
LPG	69	113	199	313	504
Diesel	33	80	50	75	114
Electricity	367	391	605	945	1,486
Industry	405	405	681	1,096	1,764
Wood	370	370	622	1,001	1,611
Charcoal	13	13	22	36	58
Diesel	22	22	37	59	95
Fuel Oil	63	63	101	157	248
Electricity	58	57	96	154	247
Transport	11,174	11,674	17,988	26,712	36,188
Gasoline	6,002	6,089	10,765	15,288	20,284
Diesel	4,445	5,116	7,341	10,299	14,468
Jet Fuel	725	468	881	1,125	14,352
Fuel Oil	2	1	1	1	1

D.3 Economic

An advantage of the commercialized dissemination of the NLS is that the project is able to offer economic benefits throughout the stove distribution network of producers, retailers and end users

Distribution Network



Source. Atukorala, 2006

The stove producers and retailers make a profit of US\$0.50 from each NLS. This compares favorably with profit from traditional stoves which is approximately US\$0.12 per stove. The number of stoves sold throughout the crediting period is 220,833. Therefore both producers and retailers make an additional US\$83,823 in profit over the course of the monitoring period (Winrock International 2006, Atukorala, 2006, GERES, 2005).

The extra profits are provided by the end users, who pay more per unit. However, reductions in charcoal use and the increased durability extend economic benefits of the stove to end users. There are also economic co-benefits associated with the project. For example three

production centers have created 20-30 jobs to satisfy increased demand for NLS (Atukorala, 2006). Furthermore, an iterative approach to problem solving has generated economic co-benefits. Lack of capital is frequently identified as a barrier to stove production; as a consequence a credit facility has been made available. These funds can be used to buy a truck or motorbike, construct a small building, purchase tools, or obtain raw materials such as clay or iron. The ICS producers have access to the loan through CFSP at preferable terms; the standard interest rate at the largest microfinance institution in the country is nearly four times that offered through the CFSP program (Winrock international, 2006).

D.4 Social benefits

New Lao Stoves do not fully alleviate the problems associated with the inhalation of cooking smoke. However, although the reduction in health damaging pollutants has not been directly monitored the greater combustion efficiency and reduced exposure time is expected to mitigate the health impacts of cooking with charcoal.

The cooking stoves have been shown to reduce exposure by an average of 23 minutes or, alternatively, 140 hours per year (GERES, 2005). User surveys have indicated that around 40% of stove users cook outside, and 24% said they used the stove in a kitchen where the smoke could escape. There was a relatively high awareness of the detrimental health effects of smoke (over 60% said it is bad for health) and almost all respondents in had someone in their household with respiratory ailments, with the women being primarily affected. However as many NLS users, as well as non-users, cited respiratory problems, it is difficult at this point to establish a direct correlation between improved health and adoption of the NLS (Winrock International, 2006).



Cooking on a three stone fire, still common practice in rural areas of Cambodia

Secondly, the spread of more efficient cook stoves reduces the gap between rising fuel wood demands and diminishing forest resources. In the wider context of energy use this means there is less competition for the same resources with the result that energy access and food security is improved, especially for the less wealthy in Cambodian society. The adoption of the NLS has been shown to reduce cost of meeting energy requirements and allow the savings to be spent elsewhere. To date these benefits are primarily confined to urban and semi-urban areas where charcoal is used in

larger quantities.

It is estimated that 75% of stoves are destined for urban and semi-urban areas (Autokorala, 2006). In rural areas fuel is often free to collect and home-made three stone fires are used to burn it.

Therefore the competitive advantages that make the stove such as attractive option in urban areas do not necessarily exist in rural areas.

Furthermore, Cambodia's transport infrastructure is under developed and many rural areas are simply not serviced by existing supply routes. Attempts have been made to address this by introducing the NLS through informal rural distributions networks, such as mobile stove retailers.

Thirdly, as almost all stove users, 87.2%, are female, the adoption and use of NLS has strong gender implications.

Whilst the time saving is not enough for users to engage in additional



The Ox and Cart- Enhancing NLS dissemination through rural distribution networks.

income generating activities it does free up time that can be used for other vital survival activities, such as water boiling, childcare and socializing. In addition, the cash savings, although relatively small, take place in an essential area of the family that is managed by women and deals with food nutrition and childcare. The money saved on charcoal purchases is mostly used to buy both durable and consumable goods such as food, for the household (Winrock, 2006). The production process also has a strong gender dimension as a significant number of women participate in the stove business. In case studies of the production process, there is only one task: insulation and cementing which is done solely by men and all other activities are done by both male and female. Skilled work like trimming is done mostly by women and two production centres have female employees in charge of finance (GERES, 2005).

In addition, the development of civil society is encouraged by a strong emphasis on the development of local capacity and expertise. A good example of this is the establishment of the Improved Cooking Stove Producers Distributors Association of Cambodia (ICOPRODAC) which is the professional association of stakeholders along the ICS supply chain. In the past stove producers have been reluctant to cooperate and share information which resulted in some unhealthy competition and a lack of accountability. In response ICOPRODAC was formed to facilitate sectoral development, quality assurance, and the long-term sustainability of ICS dissemination without external assistance. The association supports the producers with new data and coordinate disseminations but also give stakeholder ownership in the project process and a forum to raise issues. Initially DAT organized regular meetings between stove producers and stove distributors. In the meeting, voices from both supplier and distributors are heard. Jointly they have discussed pricing issues and shared information to produce better quality stoves. The quality control and assurance of the stoves is coordinated through ICOPRADAC who issue stickers to the NLS producers who qualify for the hallmark of quality. In return the stove producers provide 1% of the income from selling stoves per month to the ICOPRADAC. The money collected will be used for additional stove promotional activities.



Above: Stove producers and retailers in discussion at a ICOPRADAC meeting.

Ms. Sim Pov's Commercial NLS Production Center - A Case Study

A mother, five sisters and one brother operate the NLS production center in Kompong Chhnang Province. Ms. Sim Pov was attended a training on Royal Thai Bucket Stove Production in Cambodia in 1999 from Thai Stove producer and resource person, which was organized by CFSP. The center produced Traditional Lao Stoves, and after getting training the center slowly replaced the traditional one and now completely replaced the traditional one by the improved one (NLS). Ms. Sim Pov was recruited by CFSP as a practical trainer to other NLS producers in Cambodia in 2003 and 2004. The center has produced NLS since 1999. The center began branding their stoves by coloring the top rim with red color and attaching a butterfly logo. The center is a member of ICOPRADAC and active in the organization.

The center produces range of NLS to adopt various sizes of cooking pots and the cost at the production center and retailer price is given in table 2.

The center produces an average of 664 NLS per month (7,964 NLS in 2005) while demand is 2000 NLS per month. The demand is based on the distributors who place orders with stove producers.. The total numbers of workers in this center are 10, out of it 6 are women and 4 are men.

The center has access to technology and is provided technical back stopping from DATE and CFSP, to improved stove molding, mechanical grate punching technology, standardizing the combustion chamber, etc. Ms. Sim Pov joined the exposure visit to Stove Production Center of Thailand to acquire additional technical skills and production center management.

The center has also access to finance to acquire moto-remorque to transport NLS to retailer shops. The credit was US \$ 2000 and is provided by CFSP.
(source GERES, 2005)

NLS size	Cost at production center / whole seller price	Retailer price
0 3	33,000	40,000
00	17,000	25,000
01	12,000	15,000
1	8,500	10,000
2	7,500	9,000
3	6,500	8,000
4	4,000	5,000

Activities	Who does
clay kneading	Male
stove molding	Male
stove drying	Male
Trimming	Female
grate punching	Female
Firing	Female
fixing refractory liner, grate and coloring	Female
insulation and cementing	Male
taking order from middlemen and retailer	Both
cash control	Female
Delivery	Both

SECTION E. PARAMETERS TO BE OBTAINED

The project activity applies methodology '*Improved Efficiency in Use of Non-Renewable Biomass*'. Under the proposed methodology monitoring shall include the following:

- Monitoring shall measure representative samples of mass of biomass used before and after installation of devices and efficiency measures, ensuring that the measurements are taken for the same loading and thermal effect. It will include descriptions of the before and after technologies.
- Monitoring will measure representative samples of the moisture content of the biomass at the time it is burnt
- Monitoring shall consist of an annual check of all appliances and new measures installed or a representative sample thereof to ensure that they are still operating or replaced by an equivalent in service appliance or measure.
- Monitoring shall include the efficiency of the appliances.
- Monitoring shall ensure that the replaced low efficiency appliances are not used within the boundary.

- Monitoring will include measurement of the quantity of alternative fuels (such as agricultural waste) used by project participants and an assessment will be made as the aggregate biomass renewability status of the project region
- If the leakage deduction of 15% is not applied, monitoring shall demonstrate that greater use of non-renewable biomass outside the project boundary does not occur.
- Wider social and economic impact of the projects will be monitored; on-going analysis will be made of its contribution positive or otherwise to sustainable development in the area.

Data / Parameter:	Representative sample of mass of biomass used before and after installation of devices and efficiency measures.
Data unit:	Kg/ month / Family
Description:	Bi-annual survey results will demonstrate the average consumption per family. These results will be combined with efficiency savings of NLS and monthly sales data to monitor mass of biomass used before and after installation of efficiency devices.
Source of data to be used:	Household Fuel Consumption Test data (2003-2004) Stove Users Survey (2006) Stove Producer Sales data (2003-2007)
Value of data	The data will be used to estimate the emissions reductions from utilisation of the NLS. The data will be used to gauge the effectiveness of the commercialised distribution, as well as the socio-economic benefits of the project activity.
Description of measurement methods and procedures to be applied:	The monitoring will combine <i>ex-ante</i> calculations with the monitored stove sales and periodic verification of fuel savings. The GERES Cambodia Monitoring Unit will test producers to ensure compliance and efficiency standards are maintained. (see Annex 3)
QA/QC procedures to be applied:	GERES Cambodia Monitoring Unit will take samples from producers yearly to ensure production standards meet standardised dimensions.
Any comment:	

Data / Parameter:	Representative samples of the moisture content of the biomass at the time it is burnt
Data unit:	Kg/month/family
Description:	Fuel savings are calculated using data from studies conducted in both rainy and dry season. Test are conducted under laboratory conditions but designed to replicate actual use.
Source of data to be used:	Household Fuel Consumption Test data (2003-2004)
Value of data	Ensure accurate reporting of fuel savings
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Standardised methodology and replicability of tests. Test are repeated frequently allowing results to be verified by the observable range of data
Any comment:	Water boiling tests are used to check the quality of stove production. Moisture content of the wood

Data / Parameter:	Annual check of representative samples to ensure that they are still operating or replaced by an equivalent in service appliance or measure
Data unit:	Stove lifetime years No of stoves sales per month
Description:	The project activity uses a conservative estimate of three years lifespan per stove. After that period the stove is assumed to be replaced, these stoves are deducted from the monthly stove sales. Thus monitoring system adopts a conservative value to ensure that the ER takes the replacement of stove units into consideration. These calculations are underpinned by the stove sales data which will demonstrate the increased market share of NLS. In addition survey data demonstrate user's preferences.
Source of data to be used:	ICS lifetime tests (GERES, 2006). Stove Producer Sales data (2003-2007) Bi-annual survey data
Value of data	Ensure accuracy of emissions reductions
Description of measurement methods and procedures to be applied:	Measurement method combines <i>ex-ante</i> and <i>ex-post</i> data. Conservative lifetime assumption of three years is determined by survey data. This figure is combined with sales figures collected by the monitoring unit every month from each stove producer.
QA/QC procedures to be applied:	Internal validation of stove producer's sales data.
Any comment:	

Data / Parameter:	Monitoring shall include the efficiency of the appliances
Data unit:	%
Description:	Monitoring Unit will test samples from stove producers to measure the efficiency of stoves constructed by producers.
Source of data to be used:	RCT (Real Cooking Test)
Value of data	Quality control of stove production
Description of measurement methods and procedures to be applied:	See section G.5
QA/QC procedures to be applied:	Training for technicians is provided and established methodology is used. Test are repeated frequently allowing results to be verified by the observable range of data
Any comment:	

Data / Parameter:	Ensure replaced low efficiency appliances are not used within the boundary
Data unit:	
Description:	Bi-annual survey data on user behavior in addition the Stove sales data demonstrates the increasing market share of the NLS over time.
Source of data to be used:	Stove sales data (2003-2006) User surveys (2003-2006)
Value of data	Ensure the accuracy of emissions reductions calculations
Description of measurement	User surveys will establish the percentage of stove users using traditional

methods and procedures to be applied:	and NLS simultaneously.
QA/QC procedures to be applied:	Statistical analysis External evaluation
Any comment:	

Data / Parameter:	Quantity of alternative fuels used by project participants and assessment of aggregate biomass renewability in the region.
Data unit:	Deforestation rate Fuel mix
Description:	Establish that the trend of biomass use is unsustainable in the long term through independent literature and GIS data. Bi-annual survey data will monitor fuel mix being used.
Source of data to be used:	Independent accredited literature
Value of data	Validity of emission reductions from non-renewable biomass
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Peer reviewed published reports.
Any comment:	

Data / Parameter:	Greater use of non-renewable biomass outside the project boundary does not exist
Data unit:	N/A
Description:	N/A
Source of data to be used:	N/A
Value of data	N/A
Description of measurement methods and procedures to be applied:	N/A
QA/QC procedures to be applied:	N/A
Any comment:	N/A

Data / Parameter:	Wider social and economic impact of the projects will be monitored; on-going analysis will be made of its contribution positive or otherwise to sustainable development in the area.
Data unit:	N/A
Description:	Survey data designed to assesses socio-economic impacts of the stove project. Furthermore the increasing market share is testament to the competitive advantages of the NLS and consequently the socio-economic benefits that are derived from them.
Source of data to be used:	Survey results
Value of data	Sustainable development benefits of Project Activity.
Description of measurement methods and	Survey of stoves users. Market data

procedures to be applied:	
QA/QC procedures to be applied:	Peer review of literature.
Any comment:	

SECTION F. EMISSIONS REDUCTIONS

The emissions reductions are calculated as per the formula presented in proposed methodology CC-NRB-BSAS and detailed in the Project Design Document (PDD). The total emissions reductions over the monitoring period are 182,402 t/CO₂e. The following table shows the monthly emissions reductions that occur as a result of the project activity.

Table F.1 Emission Reductions 10 May'03 – 9 Dec '07 t/CO₂e

Date		Biomass saving wood tones/month	Biomass savings charcoal tones/month	ER t/CO ₂ e	Leakage deduction [15%]	Adjusted ER t/CO ₂ e	Yearly Totals ER t/CO ₂ e
10-May-03	9-Jun-03						
10-Jun-03	9-Jul-03	13.5	70.4	147	22	125	
10-Jul-03	9-Aug-03	27.8	144.8	302	45	256	
10-Aug-03	9-Sep-03	42.3	220.2	459	69	390	
10-Sep-03	9-Oct-03	58.4	304.1	633	95	538	
10-Oct-03	9-Nov-03	72.8	378.9	789	118	671	
10-Nov-03	9-Dec-03	91.4	475.8	991	149	842	2822
10-Dec-03	9-Jan-04	105.2	547.9	1141	171	970	
10-Jan-04	9-Feb-04	119.0	619.8	1291	194	1,097	
10-Feb-04	9-Mar-04	135.8	707.3	1473	221	1,252	
10-Mar-04	9-Apr-04	152.4	793.8	1653	248	1,405	
10-Apr-04	9-May-04	167.5	872.4	1817	273	1,544	
10-May-04	9-Jun-04	176.7	920.2	1917	287	1,629	
10-Jun-04	9-Jul-04	195.7	1019.1	2122	318	1,804	
10-Jul-04	9-Aug-04	220.5	1148.2	2391	359	2,033	
10-Aug-04	9-Sep-04	241.9	1259.7	2624	394	2,230	
10-Sep-04	9-Oct-04	260.6	1357.2	2827	424	2,403	
10-Oct-04	9-Nov-04	285.8	1488.5	3100	465	2,635	
10-Nov-04	9-Dec-04	307.0	1598.9	3330	500	2,831	21833
10-Dec-04	9-Jan-05	327.4	1704.8	3551	533	3,018	
10-Jan-05	9-Feb-05	348.8	1816.1	3783	567	3,215	
10-Feb-05	9-Mar-05	374.5	1950.4	4062	609	3,453	
10-Mar-05	9-Apr-05	395.6	2060.2	4291	644	3,647	
10-Apr-05	9-May-05	423.3	2204.1	4591	689	3,902	
10-May-05	9-Jun-05	440.1	2291.8	4773	716	4,057	
10-Jun-05	9-Jul-05	466.0	2426.6	5054	758	4,296	
10-Jul-05	9-Aug-05	491.5	2559.5	5331	800	4,531	
10-Aug-05	9-Sep-05	520.7	2711.8	5648	847	4,801	
10-Sep-05	9-Oct-05	551.6	2872.6	5983	897	5,085	
10-Oct-05	9-Nov-05	579.3	3016.6	6283	942	5,340	
10-Nov-05	9-Dec-05	611.2	3182.8	6629	994	5,634	50980
10-Dec-06	9-Jan-06	644.3	3355.4	6988	1048	5,940	
10-Jan-06	9-Feb-06	681.2	3547.4	7388	1108	6,280	
10-Feb-06	9-Mar-06	720.9	3753.9	7818	1173	6,646	
10-Mar-06	9-Apr-06	759.5	3955.1	8237	1236	7,002	

10-Apr-06	9-May-06	806.0	4197.5	8742	1311	7,431	
10-May-06	9-Jun-06	834.5	4345.8	9051	1358	7,693	
10-Jun-06	9-Jul-06	870.6	4533.8	9443	1416	8,026	
10-Jul-06	9-Aug-06	903.2	4703.6	9796	1469	8,327	
10-Aug-06	9-Sep-06	953.1	4963.5	10337	1551	8,787	
10-Sep-06	9-Oct-06	1020.8	5315.9	11072	1661	9,411	
10-Oct-06	9-Nov-06	1071.1	5577.8	11617	1743	9,874	
10-Nov-06	9-Dec-06	1135.0	5910.4	12310	1846	10,463	95880
10-Dec-06	9-Jan-07	1180.9	6149.7	12808	1921	10,887	10887
Total			103034.2	214591	32189	182,402	182,402

SECTION G. MEASURES TO ENSURE THE RESULTS

The results are ensured through a combination of conservative ex-ante assumptions and regularly monitored ex-post data. The validity of the ex-ante assumptions will be assured through continuous validation. For example bi-annual survey data or annual RCT results will be carried out. The results of the ex-post data are ensured through regular monitoring activities throughout the NLS supply chain. The data obtained consists of easily verifiable field measurements which can be used to accurately gauge emission reduction. The supply chain consists of producers, middlemen, retailers and end-users

G.1 Ex-ante assumptions

Stove Point of Sales Time (POST)

According conducted on retailer sales data it can be asserted with 95% confidence that all stoves will be sold within 25.2 days of reaching the retailer. Assuming a further five days, averaged over all stoves, for transportation time a conservative estimate for POST is one month. Therefore ER in the PDD accrue one month after being sold by the producers to account for the time before users begin utilizing the stove.

Fuel Saving

Real Cooking Tests (RCT) are carried out at the production and end user phases of the product cycle. The tests show the potential fuel savings of the NLS compared with the traditional stoves. During the first phase of the CFSP 100 household were tested using a standard kitchen test. It was found that the procedure was too complicated, used too many human resources and, as it had various sources of errors, was not very accurate. Statistical



Weighing water to conduct to conduct restaurant fuelwood consumption test

analysis showed it was possible to reduce the sample size because of the homogeneity in cooking habits and establish the fuelwood saving ratio by comparing the amount used by amount of water used for boiling (food and drinking water). These realisations are the basis of the RCT which calculate the fuelwood savings that are made possible though the NLS. As the temperature is constant all year it's not necessary to conduct a test for cold and hot season (a well insulated stove will be more efficient in winter compared a non insulated one). The absolute data is only interesting for estimating the global consumption of a population; it's obtained by large sampling survey to obtain a statistically valuable

averaged mean.

To conduct the test, 20 sample households are identified based on the number of stoves distributed in that particular area which should be statistically significant. It lasts two weeks, one week cooking with traditional one, one week with improved one. That means we obtain 140 daily tests with one stove model, and 140 daily tests with the other model. Before performing the test, a typical schedule of meals, water used especially for cooking, is to be established in both traditional and improved stoves. Whatever the foods (breakfast, lunch and dinner) are cooked in the traditional stove should be cooked in the improved stoves. In that way, we can compare the averages of the daily ratio of kg of charcoal by kg of water for the traditional model and for the NLS. Daily consumption of wood and water used for boiling (food and drinking) is measured by help of 1% accuracy balance, and containers dedicated for water to be boiled. The **Household Fuel Saving (HFS)** is calculated based on the following formula:

$$\text{HFS} = \frac{\text{FCTS} - \text{FCICS}}{\text{CFTS}}$$

Where,

FCTS = fuel consumption with respect to water used for cooking in **traditional stove**

FCICS = fuel consumption with respect to water used for cooking with **improved cook stove**

=

The HFS can be calculated for each family, an average is calculated for representing all the families (statistic analysis help to eliminate extreme values, we consider acceptable when the ratio of standard deviation/average mean is maximum 5 %) The PDD uses averages based on tests conducted in both the rainy and dry season.

\

Table G.1 Fuel saving comparison between NLS and TLBS.

	Fuel Saving Rainy Season%	Fuel Saving Dry Season%	Average Fuel Saving %
Charcoal	20.6	21.8	21.2
Fuelwood	20.3	21.49	20.89

Fuel Mix

Two separate survey results have been analyzed to examine these questions. A study conducted by CFSP showed that on average NLS users will own 1.28 stoves. A second study conducted by Winrock International showed the average consumption of charcoal and wood to be 29.8 kg/month and 34.9 Kg/month respectively. As this data combines results from both traditional and improved studies it has been reanalyzed to separate the two technologies. According to the survey of 385 biomass stove users across Cambodia the average mix of charcoal and wood in traditional stoves are 32.12kg and 37.56kg a month, respectively. Fuel consumption using NLS is reduced to 25.31kg/month for charcoal and 29.55kg per month for woodfuel.

Wood to Charcoal Ratio

The PDD uses IPCC (2006) default value for wood to charcoal conversion

NCV and EFCO² biomass

PDD uses Net Calorific Value (NCV) and Emissions Factors stipulated in the IPCC guidelines 2006.

Stove Lifespan

Estimate of stove lifetime is considered to be conservative at 3 years. When research was undertaken on the matter of lifetime not enough stoves had reached the end of their lifetime to establish an average stove lifetime. Further research will be undertaken on this subject. In the meantime an average lifespan of three years is deemed to be conservative

G.2 Monitoring the ex-post Data

The producers of New Lao Stove (NLS) are provided with equipment and training to record:

- The date on which the stoves were produced
- The number and type of stove produced (traditional or improved) produced
- Date on which the stoves were sold, kind of stove
- Amount and the price of stoves sold
- To whom they were sold (retailer or middleman).



Above. Collecting market data from stove producer and family

Each month trained staff visit the production centers to collect market data. The collected data is used to calculate the number of NLS that have been disseminated in that period. Where production centers are not easily accessible the data is collected through monthly telephone interviews and a personal visit every four months. Aside from the monitoring of sales data NLS are collected from newly trained or copy producers to check whether the stoves are produced according to specified dimensions. Experience has found that there are 6 key components to stove construction that must be monitored to ensure stove quality and burning efficiency.

- Variation of clay and clay mixing which determines the quality of stove body.
- Maintenance of mould dimensions.
- Craftsmanship to produce standardized dimension of stove and attractive appearance
- Grate must be maintained its thickness, holes diameter, holes position and the position of grate in the stove.
- Final production of stove, including insulation and bucket installation.
- Regularity of production in terms of quantity that relates to labor availability, production line system, raw material stock management, season



Above. Applying the finishing touch; Stove producer attaches the quality assurance label.

The stoves are then tested to determine their efficiency. Simple Real Cooking Tests (RCT) are conducted to determine the efficiency of the stoves, power input, burning rate and useful heat input. Based on these tests the quality of the stoves in terms of fuel savings and time to boil is analyzed. If accepted stove producers are asked to market them. If the stoves are not acceptable the monitoring teams works with the producers to diagnose the reason and rectify it. Finally, a system of labeling has been initiated for quality assurance of NLS. Producers whose construction standards have consistently met the required specifications are provided with labels to attach to the finished product. Quality control labels are issued on the basis of observed sales and only once the stock has been monitored. To assure the strength of the QC and QA procedures, GERES Cambodia is in the process of double certification ISO 9001/14000.

Monitoring Intermediaries

The intermediaries transport NLS and generally operate as a link between production and retail. Monitoring of middleman is not as extensive as with other stages in the supply chain as they are not involved with stove production or selling directly to the end-user. Nevertheless, it is important to ensure that only stoves constructed by trained producers are being sold. Therefore the details of their clients, recognized retailers, and work whereabouts are recorded.

Monitoring NLS Retailers

Retailers of NLS record the following details

- date on which the stoves were bought,
- amount and type of stoves bought,
- buying price
- from which production center or middleman the stoves were bought
- date on which the stoves were sold
- amount and kind of stoves sold
- selling price,
- to whom they were sold (middleman or individual).

This data is compiled from a representative sample of retailers who are visited each month by monitoring personnel. In addition retailers are invited to attend ICOPRADAC meetings as a forum to present their views and opinions.

Right: Collecting stove data from the retailers. The stand used to market the stoves can be seen on the left of the picture

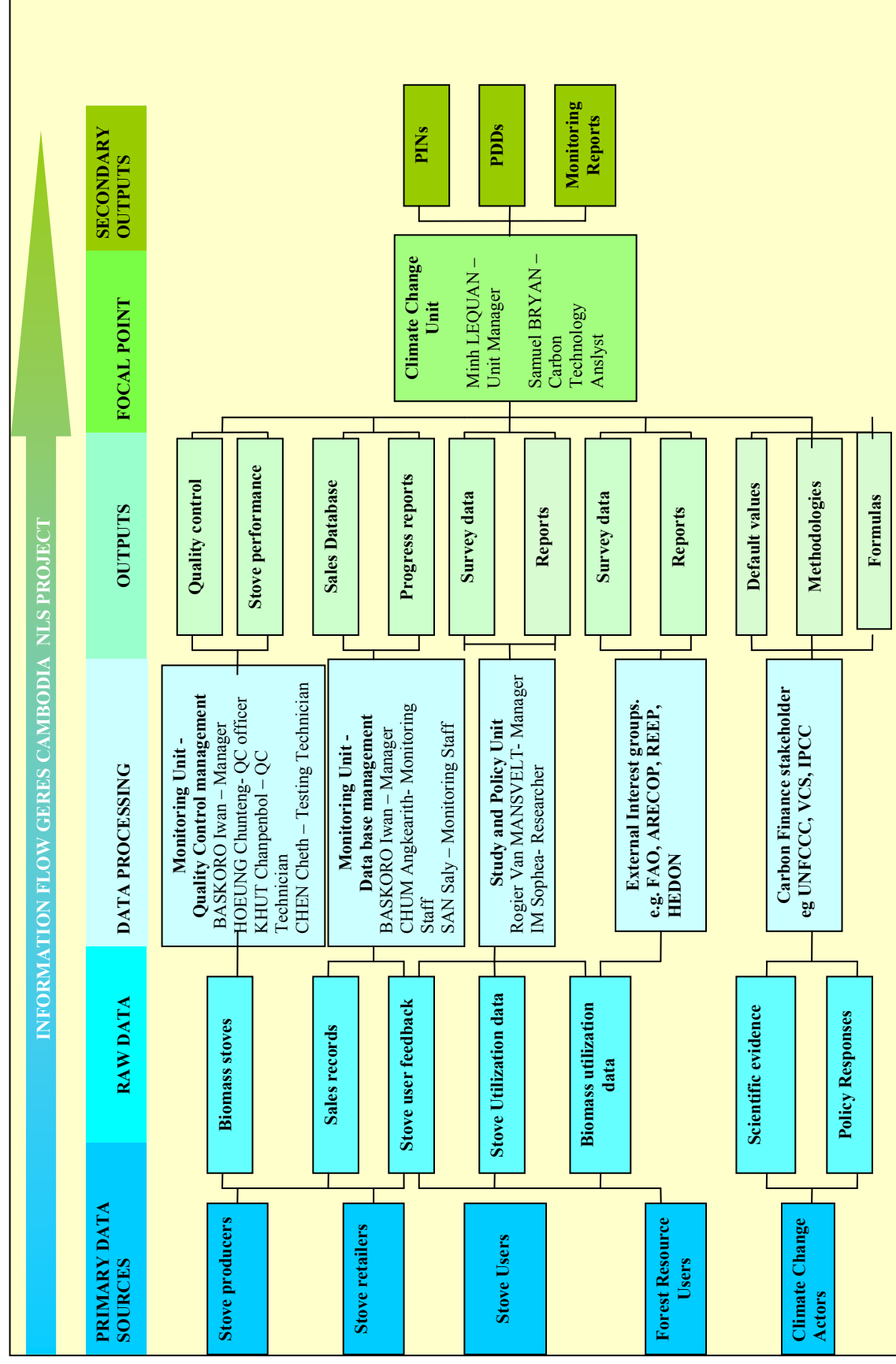


Monitoring End users.

From the retailers' data mentioned above, a sample of NLS users is interviewed. This choice of interviewee is based on the location of the merchants who sold the most. Our skilled promoters go to these areas and visit people's homes to check their NLS. They sit and talk with them about their experience with their NLS and make sure that the traditional cook-stoves are not used at their home. End users provide data on equipment ratios, replacement rates, cook-stove lifetime and most importantly user satisfaction.

The chart below illustrates the information flow and data management process of the project activity.

Figure G.2 Information Flow GERES Cambodia NLS Emissions Reductions Project.



SECTION H. REFERENCES

Atukorala. K, (2006) *The Evaluation Study of the Commercialized Fuel Efficient Stoves Project in Cambodia*, Report submitted to Cambodian Fuelwood Savings Project March 2006.

EU (2006), *Monitoring Report – KH – National Wood Energy Policy Implementation in Cambodia*.

GERES (2005), *Sustainability of Improved Cookstove Production and its Impacts: A case study*.

FAO (1997) *Asia-Pacific Forestry Sector Outlook Study: Country Paper on Some Aspects of Forestry in Cambodia*, Food and Agricultural Organization of the United Nations, Available online [<http://www.fao.org/DOCREP/W7710E/W7710E00.HTM>]

FAO (2006) *FAO Country Profiles and Mapping Information System*, Food and Agricultural Organization of the United Nations, available on line [<http://www.fao.org/countryprofiles/Maps/KHM/09/lc/index.html>]

NIS (2005) *Statistical Yearbook 2004.*, National Institute of Statistics,

RWEDP (1997) *Regional Study on Wood Energy Today and Tomorrow in Asia*, Regional Wood Energy Development Program.

Smith. K, (2000) *Greenhouse Gases from Small Scale Combustion Devices in India*.

Van Mansvelt. R, (2006), *Improved Cookstove Lifetime Survey*, GERES.

Van Mansvelt. R, (2006²) *ICS share between Households and Restaurants in urban areas in Cambodia*, GERES

Winrock International (2006), *Cambodian Case Study: ICS Dissemination*.

ANNEX 1 DETERMINING POINT OF SALE TIME FOR NEW LAO STOVES IN CAMBODIA

1. SUMMARY

This research will aid the accurate and conservative reporting of greenhouse gas (GHG) reductions from GERES Cambodia's New Lao Stove (NLS) project. Emission reductions from this project activity are calculated through monitoring the monthly sales of stoves being sold by producers. However, the NLS purchased by distributors are not necessarily immediately being sold to end users. It can be assumed that once the stoves reach the end users; they are utilized and emission reductions can accrue. However, emissions reductions will not accrue during the time that stoves take to reach the end user. Two points in the supply chain can affect the length of this period. Firstly, during distribution from producers to retailers, sometimes via middlemen. Secondly, the number of stove shelf days (SSD), the length of time stoves are held by the retailer before their eventual sale to the end user. The statistically robust Point of Sale Time (POST), the time between stoves being sold by the producer and utilized by end users, is 25.2 days. It can be asserted with 95% confidence that any given stove will have been sold within 25.2 days of arrival at any given retailer. Combined with an estimated travel time of five days a period of one month should be adopted as the average POST for New Lao Stoves.

2. INTRODUCTION

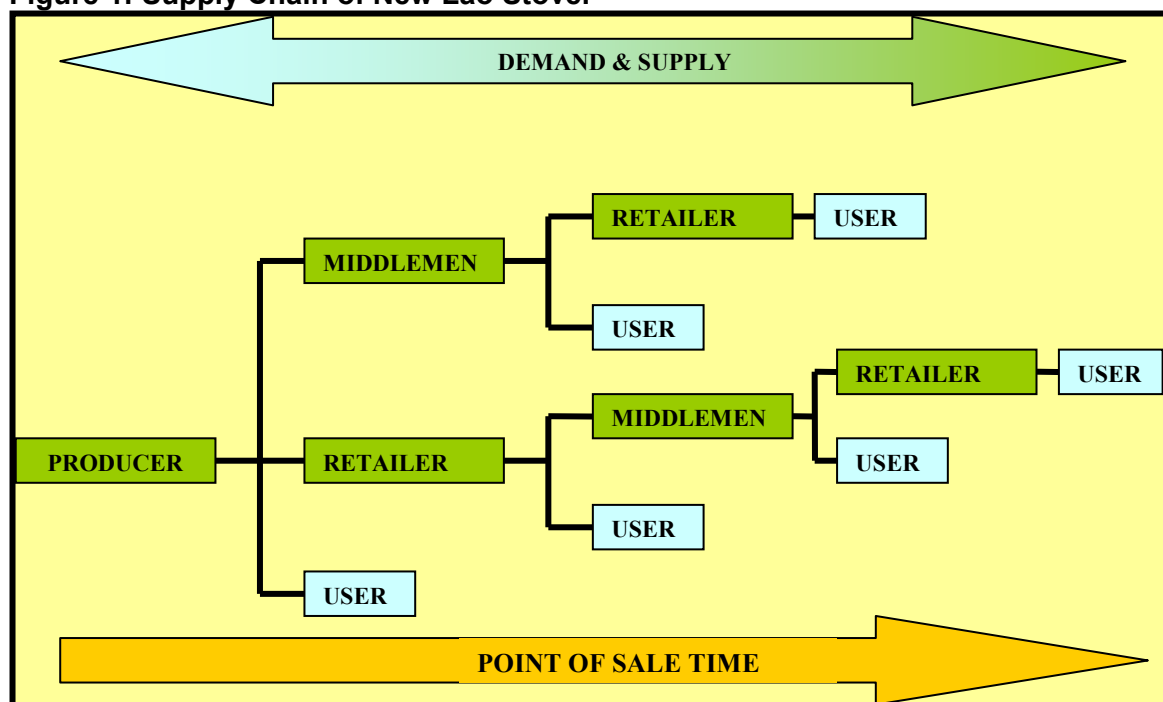
2.1. RESEARCH AIMS

This research will aid the accurate and conservative reporting of greenhouse reductions from GERES Cambodia's New Lao Stove (NLS) project. Emission reductions from this project activity are calculated by monitoring the monthly sales of stoves being sold by producers. However, the NLS purchased by distributors are not necessarily immediately being sold to end users. It can be assumed that once the stoves reach the end users; they are utilized and emission reductions can accrue. However, emissions reductions will not accrue during the time that stoves take to reach the end user. This research will calculate the average Point of Sale Time (POST) between stoves being sold by the producer and utilized by end users.

2.2. NEW LAO STOVE SUPPLY CHAIN

The figure below illustrates that the supply chain of the NLS consists of stove producers, middlemen, retailers and end users.

Figure 1: Supply Chain of New Lao Stove.



Stove units are moved through the chain by user demand and by the need to turn over stock in order to generate revenue. That such a demand exists is evident by the longevity of the NLS project, which

began in 1997, and the observable growth in market share. Stove production is determined by market signals from distributors and, in turn, end users. If there was no demand or stock could not be regularly turned over then the NLS would no longer be available as production would cease. There are multiple paths stove units can take before they reach the end user and the Point Of Sale (POS). Two generalizations can be made about the supply chain. Firstly, the further along the supply chain the stoves travel; the greater the time lapse between production and use. Secondly, that the cost per unit is higher the further down the supply chain the stove is purchased. There is a vested interest for all links in the supply chain to minimize the time lapse from production to end use. In the case of producers and distributors this is to realize a return on their initial investment. End users will seek a competitive price and purchase as close to the point of production as is feasible. Therefore, the POST is not an open-ended time period but is necessarily limited by constraining factors. For the purposes of calculating average POST there are two parts of the supply chain that need to be examined:

- I. Distribution
- II. Retail

2.2.1 Distribution

The delivery to POS is delayed as stoves move from middlemen to retailers or, in other words the number of Stove Delivery Days (SDD). Nevertheless, a regular and dependable turn over of stock is essential to generate income for middlemen. They will not take stock of a quantity of units that they cannot dependably turnover within a short space of time. Furthermore, it can be assumed that as the commercialized production of NLS has been in existence since 1997 and a establish pattern of supply and demand exists, for example in many cases the distributors will be responding to pre-orders. Therefore, transportation time becomes a decisive factor. Transportation time will vary depending on the mode of transport and the proximity of retailers to the point of production. A conservative estimation of a week can be used to account for transportation time between middlemen and retailers.

2.2.2 Retail

Information is required on the number of Stove Shelf Days (SSD), the length of time stoves will be held in stock before they are sold. As part of the monitoring procedure for the New Lao Stove project data is recorded from 64 stove retailers. The monitoring process records the date and quantity of stoves that have been delivered, as well as the number of stoves sold.

2.3. RESEARCH METHODOLOGY

The data from 53 of the 64 stoves being monitored has been analyzed. The remainder are considered ineligible because they have either ceased to sell NLS or have not recorded any NLS stove sales, see Annex 1 for details. The retailers record the information contained in the table below:

Table 1: Information recorded through monitoring of retailer sales

Stall ID	Unique identification number of retailer
Date	Date of stove transaction
Kind of Stove	Kind of stove purchased or sold
Producers in	Number of stoves purchased form producers
Producer ID	Unique identification of stove producer
Producer Price	Price of stoves purchased
Middleman	Number of stoves purchased from middlemen
Middleman Price	Price of stove purchased by middlemen
Middleman ID	Identification of middleman
Out Middlemen	Number of stove sold to middlemen
Price Out Middlemen	Price of stoves sold to middlemen
Out User	Number of stoves sold to users
Price Out User	Price of stoves sold to users

This data can be analyzed to produce the following data.

- Average number of stove shelf days (SSD): (see annex 2 for calculations)
- Percentage of stoves purchased from retailers
- Number and percentage of stoves purchased from middlemen
- Number and percentage of stoves sold to middlemen

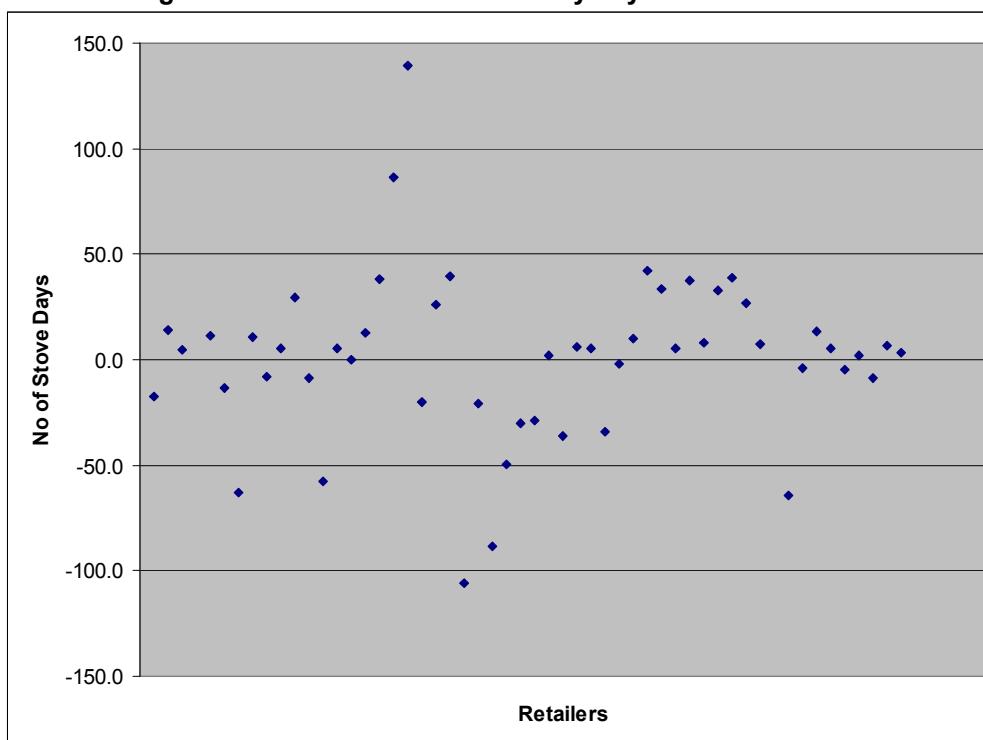
- Number and percentage of stoves sold to end users

This data will be applied to improve understanding of the supply chain of the NLS as well as provide an average shelf lifetime

3. RESULTS

Results show that the average length of time that stoves remain in stock before they are sold to end users is 16.3 days. However, the results also show a large standard deviation from the mean; 30.5 SSD. This indicates that the average value is not robust. Figure 2 shows the distribution of results. It illustrates the majority of results occur between 50 and -50 SSD but the presence of a few outliers further distorts the mean value.

Figure 2: Number of stove shelf days by retailer 2003-2007



Furthermore, the results return some negative values for SSD. This is a reflection of the fact that stoves are preordered and sold before they are held in stock. Monitoring teams have recorded that the chief complaint of stove retailers is the shortage of supply, whilst producers complain they cannot expand their facilities quick enough to match demand. This conclusion is supported by independent external evaluations which reported instances where demand outstrips supply (EU, 2006: Atukorala, 2006). Nevertheless, for the purposes of calculating SSD this is counterintuitive; the minimum number of days a stove can be displayed for is 0. Therefore, the results have been adjusted to reflect this minimum value. Using statistical analysis a 95% confidence interval can be applied to derive a more accurate figure. The confidence interval is 8.9 days; there is a 95% confidence level that the number of stove shelf days of any given stove will fall within a range of 8.9 either side of the mean. In other words there is a 95% confidence level that any given stove will be sold within 25.2 days.

In addition the data shows that 69% of the stoves are supplied directly from the producer with no intervening distribution delay such as might occur when a middleman is involved

Finally the data indicates that the supply chain is short with 88% of retailer stove sales being made directly to the user. The remaining 12% are sold to middlemen.

Table 1. Average Stove Shelf Days

Average Stove days	16.3	
Standard Deviation	30.5	
Maximum no of stove days	152.0	
Minimum no of stove days	0.0	
Confidence Interval	8.9	
95% of stoves will be sold within	25.2	days

Figure 3 Sources of stoves sold.

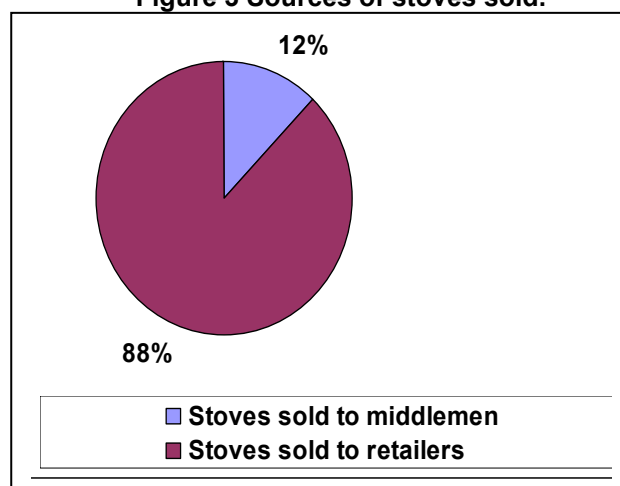
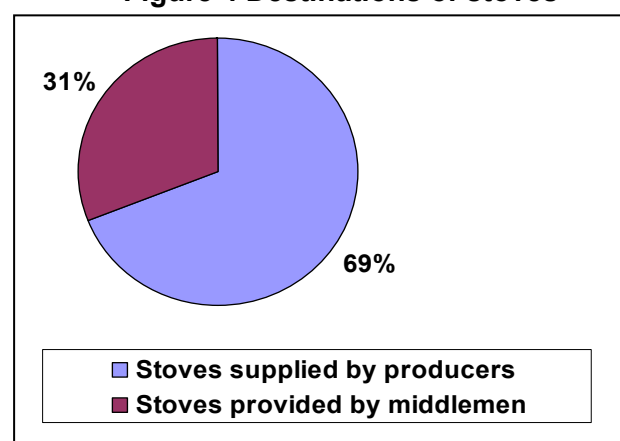


Figure 4 Destinations of stoves



4. CONCLUSIONS & RECOMMENDATIONS

The principal aim was to establish the length of time taken between producers selling of stoves and users utilization of stoves. The length of this period will determine when emission reductions from stove sales can begin to accrue. There are two determining factors which affect the length of this period

1. The period of time the stove takes to reach the retailers, stove distribution days (SDD).
2. The length of time the stove is displayed until purchased by an end user, stove shelf days (SSD)

There is insufficient data to directly calculate the average number of SDD. However, the data does show that 69% of stoves are sold directly to retailers and just 31% of stoves are distributed through middlemen. When consider the latter proportion it should be noted that middlemen have well established distribution networks allows for predictable turn over of stock within a short period of time. A period of five days can cover the transportation time needed for SDD. This is a conservative value as most stoves are supplied directly from producer to retailer.

The average number of SSD is 16.3. However the 95% confidence interval is 25.2 days. In other words there it can be asserted with 95% confidence that any given stove will have been sold within 25.2 days of arrival at any given retailer. Combined with an estimated travel time of five days the report finds that a t period of one month should be adopted as the average POST for New Lao Stoves.

ANNEX 1 LIST OF MONITORED RETAILERS

Highlighter cells indicate retailers used in this research.

ID	NAME	SEX	Market	Sangkat/District	City/Province	Marketing staff
EC01	Ea Kimcheing	Male	KPS	Chbamoun	KPS	SA
EC02	Lim Tech leang	Male	KPS	Chamoun	KPS	SA
EC03	Kim Leang	Female	KPS	Chbamoun	KPS	SA
EC04	Sok chheng	Male	KPS	Chbamoun	KPS	SA
EC05	Chek Pek	Female	KPS	Chbamoun	KPS	SA
EC06	Ou Ngouv	Male	KPS	Chbamoun	KPS	SA
EC07	Sok Sron	Male	KPS	Chbamoun	KPS	SA
EC08	Kim Chan	Male	KPS	Chbamoun	KPS	SA
EC09	Heng Sivchou	Female	KPS	Chbamoun	KPS	SA
EC10	Hong Pouy	Female	KPS	Chbamoun	KPS	SA
EC11	Keam Sareth	Female	KPS	Chbamoun	KPS	SA
EC12	Kim Moum	Female	KPS	Chbamoun	KPS	SA
EC13	Ang Ny	Female	KPS	Chbamoun	KPS	SA
EC14	Meas Oun	Female	KPS	Chbamoun	KPS	SA
ECA1	Chhoun Vanna	Female	Angsnoul	Angsnoul	KD	SA
ECB1	Chhey Eng	Female	Bakchan	Angsnoul	KD	SA
ECB2	Phang Poav	Female	Bakchan	Angsnoul	KD	SA
ECC1	Leang Ngoun	Female	Chompou1	Kandongko	KD	SA
ECC2	Hak Sitha	Female	Chompou1	Kandongko	PP	SA
ECP1	Chea Sokom	Female	Pochentong	Kandongko	PP	SA
ECT1	Sreng Lang	Female	Thnal Totoung	Angsnoul	KD	SA
ECT2	Sok Ros	Male	Thnal Totoung	Angsnoul	KD	SA
ECT3	Kim Lang	Female	Thnal Totoung	Angsnoul	KD	SA
ECT4	Kang Pouy	Female	Thnal Totoung	Angsnoul	KD	SA
ECT5	Lim Peng	Female	Thnal Totoung	Angsnoul	KD	SA
ECT6	Cheang Pouch	Female	Thnal Totoung	Angsnoul	KD	SA
ECT7	Sron Khom	Female	Thnal Totoung	Angsnoul	KD	SA
HKC1	Chear Hout	Male	Chba Ampouv	Chba Ampouv	PP	SA
HKD1	Eak Sambo	Female	Dem ampel	Olampic	PP	HR
HKD2	Luy Srey Pich	Female	Dem ampel	Olampic	PP	HR
HKD3	Kim Pov	Female	Dem ampel	Olampic	PP	HR
HKF1	Ta Pagna Raksmeay	Female	Kilomet4	Tol kok	PP	HR
HKK1	Chear Srey Oun	Female	Koki	Kean svey	KD	HR
HKK2	Vong Sopha	Female	Koki	Kean svey	KD	SA
HKK3	Srun Heang	Female	Koki	Kean svey	KD	SA
HKK4	Mok Sivone	Female	Koki	Kean svey	KD	SA

HKP1	Seng Singleng	Male	Toul Tompoung	Tol kok	PP	HR
HKS1	Kong Nareth	Female	Samaki	Depou1	PP	HR
HKS2	Srey Ros	Female	Samaki	Depou1	PP	HR
HKT1	Sambo	Female	Takmouv	Takmouv	KD	SA
HKT2	San Phanny	Female	Takmouv	Takmouv	KD	SA
HKT3	Chhor Sok Hount	Female	Takmouv	Takmouv	KD	SA
HKT4	Ouch Chorvy	Female	Takmouv	Takmouv	KD	SA
HKT5	Long Toung	Female	Takmouv	Takmouv	KD	SA
SA01	Chae Poev	Female	Prey Pduev	Somrong Tong	KPS	SA
SK01	Hou Dany Van	Female	Oudong	Oudong	KPS	HR
SK02	Souphea	Female	Oudong	Oudong	KPS	HR
SK03	Chea Sreyleak	Female	Oudong	Oudong	KPS	HR
SK04	Hou Someun	Male	Oudong	Oudong	KPS	HR
SK05	Mouy Heng	Male	Oudong	Oudong	KPS	HR
SK06	Oun Vothy	Male	Oudong	Oudong	KPS	HR
SK07	Ngim houy	Female	Oudong	Oudong	KPS	HR
SK08	Sok Toung	Male	Oudong	Oudong	KPS	HR
SKD1	Sok Neang	Female	Depou	Toul kok	PP	HR
SKL1	Oun Nol	Female	Preak Leap	Preak Leap	KD	HR
SKL2	Yen Im	Female	Preak Leap	Preak Leap	KD	HR
SKL3	Chan Tobopha	Female	Preak Leap	Preak Laep	KD	HR
SKP1	Sok Saron	Female	Preak Pnouv	Por ngealue	KD	HR
SKP2	Sron Bonhak	Male	Preak Pnouv	Por ngealue	KD	HR
SKP3	Doung Keat	Male	Preak Pnouv	Por ngealue	KD	HR
SKP4	Teb Somony	Female	Preak Pnouv	Por ngealue	KD	HR
SKP5	Bout Sarom	Female	Preak Pnouv	Por ngealue	KD	HR
SKR1	Hey Kimlang	Female	Orussey	Orussey1	PP	HR
SKR2	Chann Pom	Male	Orussey	Orussey1	PP	HR
SKT1	You Lavy	Female	Phsar Thmei	Phsar Thmei1	PP	HR

ANNEX 2 STOVE SHELF LIFE FORMULA

$$\text{Average Shelf life} = \Sigma x / \Sigma s$$

Where:

Total stoves in = Σx

Total shelf days = Σs

$$\Sigma s = x^1 + q^0 - p^1$$

Where:

stoves in = x^1

Balance from previous day = q^0

Stoves sold = p^1

$$q^0 = x^0 - p^0$$

IN	OUT	BALANCE	STOVE DAYS
10	0	10	10
10	0	20	30
0	1	19	49
0	1	18	67
0	1	17	84
0	1	16	100
0	1	15	115
0	2	13	128
0	1	12	140
0	2	10	150
0	1	9	159

ANNEX 3 RETAILER SALES DATA

Retailer	IN		OUT	
	Producer	Middleman	Middleman	User
ECA1	230	0	0	292
ECB1	328	0	20	321
ECC1	431	0	0	465
ECC2	116	0	0	95
ECO1	911	50	310	549
ECO2	329	0	5	322
ECO3		42	0	24
ECO4	23	20	0	76
ECO5	390	5	68	264
ECO6	310	15	0	322
ECO7	186	378	67	476
ECP1	546	89	0	575
ECT1	0	0	0	5
ECT3	55	25	0	99
ECT4	178	0	10	322
ECT5	323	15	16	365
ECT6	75	51	0	121
ECT7	210	36	0	206
HKC1	395	180	5	467
HKD1	1064	1731	254	1765
HKD2	5084	240	953	1815
HKD3	5	74	0	115
HKF1	243	40	0	253
HKK1	1343	85	31	1198
HKK2	2328	215	94	2842
HKK3	61	0	28	61
HKK4	10	0	0	3
HKP1	149	178	0	324
HKS1	34	193	0	324
HKS2	62	270	0	406
HKT1	723	50	36	840
HKT2	377	15	25	356

HKT3	65	0	10	53
HKT4	708	67	57	786
HKT5	0	0	0	3
SAO1	107	15	0	139
SKD1	0	0	0	1
SKL1	2	23	0	33
SKL2	118	17	0	89
SKO1	18	290	0	256
SKO2	189	425	0	458
SKO4	0	30	1	13
SKO5	177	352	0	469
SKO6	18	0	3	12
SKO7	174	230	0	371
SKO8	320	86	0	324
SKP1	103	468	0	421
SKP2	4	8	0	8
SKP3	86	175	2	235
SKP4	72	477	0	401
SKP5	29	297	0	284
SKR1	29	0	35	13
SKR2	1993	2417	1058	2002
SKT1	26	40	0	130
TOTAL	20757	9414	3088	22169

ANNEX 2- WOOD AND CHARCOAL CONSUMPTION FOR HOUSEHOLD COOKING IN CAMBODIA

Aims

This research will aid the accurate and conservative reporting of greenhouse gas (GHG) reductions from GERES Cambodia's New Lao Stove (NLS) project. Emission reductions from this project activity are derived by calculating the savings in fuel consumption that result from switching to the New Lao Stove (NLS). In order to calculate how much fuel is saved it must be established what type of fuel is being burnt and in what quantities. The objective of this report is to calculate the amounts of fuelwood and charcoal that is used for cooking with traditional stoves. Secondary data from a national survey conducted by Winrock international on biomass fuel use in Cambodia will be used.

Background

90 % of the Cambodian population depends daily on fuel-wood for cooking purposes. This dependency has increased considerably in recent years. As a consequence, forest resources are seriously threatened if no action is taken to control wood consumption at a household level. The objective of the project is to reduce charcoal and fuel wood consumption by introducing improved New Lao Stoves (NLS) in Cambodia. The new, more energy-efficient cook stoves are disseminated by a marketing strategy aiming at attracting local traditional cook stove producers to produce the improved stoves, which are then sold to households via wholesalers, mobile vendors and retailers. By including the local producers and merchants in the project activities a technology transfer is achieved.

This cook stove project is part of the larger Cambodian Firewood Saving Project (CFSP), which was created to reduce the wood consumption in Cambodia to protect its forest resources. During the project's second implementation period (2002-2006) the technology portfolio was expanded to include, not only improved stoves, but also kilns to produce the stoves and further firewood saving innovations such as improved wood carbonization, biomass upgrading and a national protocol of stove testing. Furthermore, all concerned actors and partners are assisting in the definition and elaboration of a national strategy for the management of wood-energy supply and consumption chain in Cambodia.

In Cambodia food prepared for daily meals usually consists of two or three dishes, rice as the staple, vegetables and fish/meat that have different thermal requirements. Two observations can be made from this fact. Firstly that to produce these different types of food more than one stove is required and secondly more that one type of fuel is required.

Stove numbers

The question of number of stoves used per family has been investigated by a number of studies. A CFSP study conducted in 1998 found that 66% of families utilized more than one stove every day (CFSP, 1989). The other 34% or 277 families of the sample utilize only one stove

Table 1. Number of stoves owned by Interviewees (CFSP, 1998)

combination	Single		STSS		STDS		MTS	
no of stoves	n	% tot	n	% tot	n	% tot	n	% tot
1 stove	277	34.0%						
2 stoves			319	39.1%	91	11.2%	87	10.7%
3 stoves			9	1.1%	7	0.9%	25	3.1%

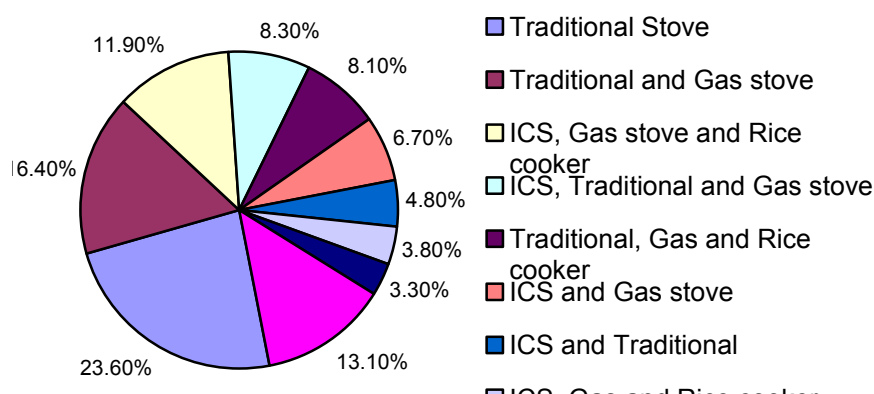
STSS = same type same size

STDS = same type different sizes

MTS = multi types stoves

The above table shows 61% of total sample families utilizing two stoves at once every day, and the other 5.1% utilizing three stoves. From stove combination point of view, 40.2% of all sample families utilize multi stove in STSS pattern and 12.1% utilize multi stove in STDS. What is important from the perspective of emissions reductions is that the replaced low efficiency devices do not continue to be used. These pattern shows most of families prefer to utilize similar stove model either all in same size or in different size. This is supported by a later study of NLS stove utilization by Winrock international (2006), which also demonstrated that most households use more that one stove to perform their cooking requirements. However the report also reflected the preference of stove users to utilize similar stove models, with just 4.2% of users using both ICS and traditional stoves. The traditional stove has the highest dissemination at almost 80%. ICS is owned by 41.7% of the interviewees.

Graph 1: Dissimination of Stoves



A further CFSP study (Van Mansvelt, 2006) calculated the average number of NLS per family. A total of 1561 households were interviewed, 670 were using one or more NLS. According to the data, 33.50% of households use NLS. Households using NLS own 1.28 of the stoves, on average.

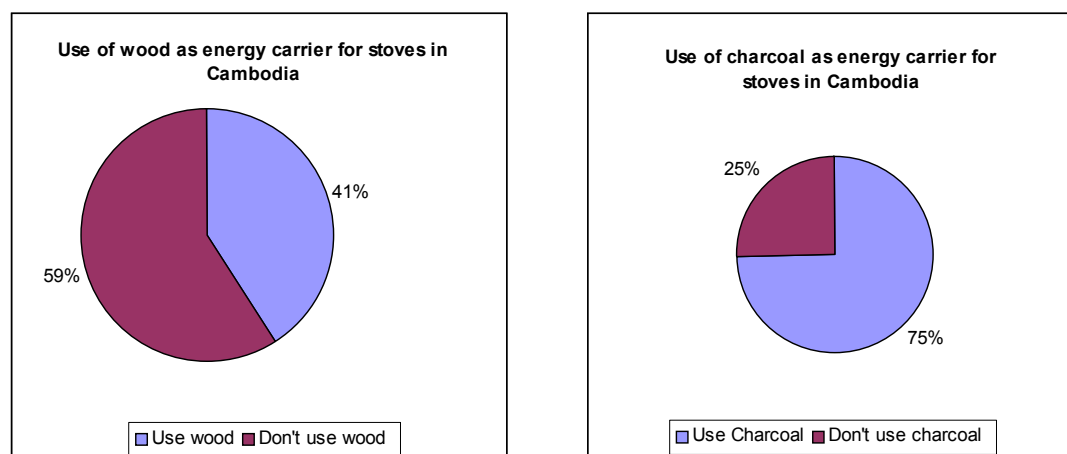
Fuel Type Study Methodology

Five provinces were selected for the survey, Phnom Penh, Kandal Province, Kampong Chhnang, Siem Reap province, Kampong Thom. In total 385 families were interviewed, randomly chosen in both rural and urban areas in each province. The questionnaire is included in Annex 1.

Table 2 Number of interviews per provincial town

Province / City	Number of interviews	Percent %
Phnom Penh	175	45
Kg. Chhnang	55	14
Kendal (Tamou)	36	9
Siem Reap	40	10
Kg. Thom	34	9
Kg. Chham	45	12
Total	385	100

The charts below show the percentage of users using wood and charcoal. Clearly there is some overlap between the two with users using wood and charcoal as well

Figure 1. Wood and Charcoal as energy carriers for biomass stoves in Cambodia

The overall results of the survey are shown in the table below. It shows that of the stove users burning firewood the average consumption is 85.65Kg a month. Stove users burning only charcoal use 40.02kg a month.

Table 3 Preliminary results from survey

		Firewood per month / kg	Charcoal per month/kg
N	Valid	157	287
	Missing	228	98
Mean		85.65	40.02
Std. Deviation		104.29	26.77
Minimum		0.3	2
Maximum		600	150
Sum		13446.65	11487

However, field observations have shown that rather than simply using one type of fuel a mix of firewood and charcoal is used depending on thermal requirements, availability and other socio-economic factors. For example, short and fast cooking would normally use firewood which can generate quick and intense heat whereas slow and time consuming cooking such as boiling soup, water and rice might normally utilize charcoal. Therefore it is inaccurate to claim that stove users will be using only wood or charcoal. Therefore, the results must be averaged across the whole population of stove users to obtain the average consumption per household.

Table 4 Average fuel consumption of wood and charcoal in Cambodia

Energy Carrier	Total Number of Stoves	Total amount/ Kg per month	Consumption per stove per month/ Kg	Consumption per stove per day/ Kg
Wood	385	13447	34.9	1.1
Charcoal	385	11487	29.8	1.0

The survey shows that an average household will burn a combination of 34.9kg of wood and 29.8 kg of charcoal a month. However, the result is misleading because it assumes the wood and charcoal are being combusted by the same technology. In reality they are being combusted by a combination of traditional stoves and the NLS. According to the study by Van Mansvelt (2006) the national share of NLS is 33.5%. Of the 1561 households interviewed in the survey, 670 were using one or more NLS, according to the distribution shown in Table 5.

Table 5. NLS used by households interviewed.

Number of NLS per household	Number of Households	Total number of NLS in survey
0	1038	0

1	395	395
2	113	226
3	11	33
4	4	16
TOTAL	1561	670

Source Van Mansvelt, 2006

Of the 385 stoves included in the survey 33.5% or 129 are NLS and 66.5 % or 256 stoves are traditional stoves. Therefore the average fuel consumption is weighted because the traditional stoves are less efficient and more numerous. Household cooking tests conducted by CFSP have shown that NLS are 21.2% more efficient when burning charcoal and 20.89% more efficient when burning fuelwood. The results are shown in the tables below.

Table 6. Average consumption of Charcoal

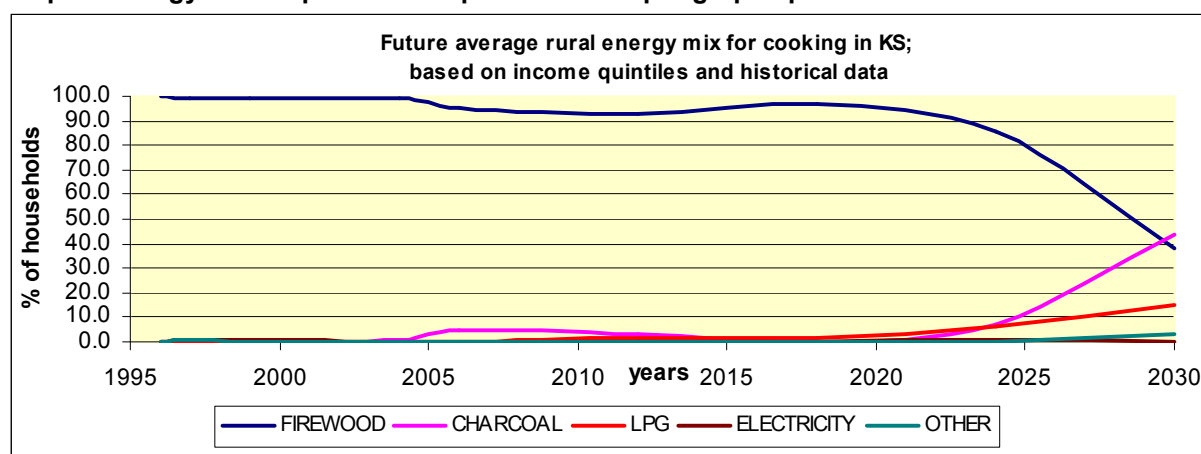
Stove Type	Number	Average Consumption	KG/ Month	KG/ Day	Tones/month
NLS	128.98	3848.15	25.31	0.83	0.02531
TLBS	256.03	7638.86	32.12	1.06	0.03212
	29.84	11487.00			

Table 7. Average consumption of Wood

Stove Type	Number	Average Consumption			
NLS	128.98	4504.63	29.55	0.97	0.02949
TLBS	256.03	8942.02	37.56	1.23	0.03756

Consistency of results

Tables 6 and 7 presented here are consistent with similar studies on fuel consumption in Cambodia. Most recently a MIME (2007) survey has studied the fuel consumption in the provinces of Kampong Speu and Svey Rieng. The number of rural poor in these provinces is much higher than the in urban areas, supply of primary energy demand is critical. The area for wood supply for the charcoal production in Kampong Speu causes pressure for the areas closing in on Aural Wildlife Sanctuary and Kirirom National Park. The charcoal production in Kampong Speu provides charcoal mainly for the demand in Phnom Penh. Svay Rieng is a province, with shortage of fuelwood due to forest depletion. Some families are still using cow dung and rice husk to cook because. The fuel consumption reflects these socio-economic conditions in the provinces with users consuming less charcoal and more fuelwood than the national average, which includes large urban centers like Phnom Penh. Poor people in rural areas tend to use mainly firewood, once their income increases more charcoal is used and the people with higher incomes use LPG but often still use some wood or charcoal for certain dishes. The next income quintile graph from rural Kampong Speu shows the fuel source shift per five income quintiles. In come quintile one are the poor people, income quintile 5 the rich.

Graph 1 Energy source per income quintile in Kampong Speu provincial town

(MIME 2007)

The rural households use a different energy mix than urban households. Tables 8 and 9 show the fuel source for cooking. It shows clearly that people are using more than one energy source.

Table 8 Rural Energy sources for cooking in Kampong Speu

Kampong Speu - Energy for Cooking	Kg/ Per Day	Per Month		Nr Households	Users
Firewood purchased	4.89	149	Kg	376	38%
Firewood collected	5.77	175	Kg	526	53%
Palm tree branch	2.61	79	Kg	217	22%
Charcoal	1.22	37	Kg	239	24%
LPG	0.31	9	Kg	121	12%
Electric rice cooker	0.31	9	kWh	24	2%
Animal Dung	2.74	83	Kg	11	1%

(MIME 2007)

Table 8 Rural Energy sources for cooking in Svay Rieng

Svay Rieng - Energy for Cooking	Per Day	Per Month		Nr Households	Users
Firewood purchased	4.85	148	Kg	122	13%
Firewood collected	4.77	145	Kg	840	87%
Palm tree branch	2.64	80	Kg	149	15%
Charcoal	0.34	10	Kg	58	6%
LPG	0.13	4	Kg	75	8%
Electricity	0.23	7	kWh	2	0%
Animal Dung	5.57	169	Kg	7	1%

(MIME 2007)

Conclusions

In Cambodia food prepared for daily meals usually consists of two or three dishes, rice as the staple, vegetables and fish/meat that have different thermal requirements. Two observations can be made from this fact. Firstly that to produce these different types of food more than one stove is required and secondly often more than one type of fuel is employed. In order to calculate emissions reductions both factors must be known. Three separate survey results have been analyzed to examine these questions. A study conducted by CFSP showed that on average NLS users will own 1.28 stoves. A second study conducted by Winrock International showed the average consumption of charcoal and wood to be 29.8 and 34.9.. As this data combines results from both traditional and improved studies it has been reanalyzed to separate the two technologies. According to the survey of 385 biomass stove users across Cambodia the average mix of charcoal and wood is 32.12kg and 37.56kg a month, respectively. Fuel consumption using NLS is reduced to 25.31kg/month for charcoal and 29.49kg per month for woodfuel. The third study by MIME shows the difference in sources for cooking by urban and rural households and shows data consistent with the other studies.

References

CFSP (1989), *Social and Energetic Study*, GERES Cambodian, Phnom Penh.

MIME (2007) "Residential Energy Use in Rural Areas" Historical trends, user Characteristics and Forecasting, Draft Version, MIME, Phnom Penh.

Van Mansvelt, ER, (2006), *ICS share between Households and Restaurants in Urban Areas in Cambodia*, GERES.

Winrock International (2006), *Cambodian Case Study: ICS Dissemination*.