



**FUEL-WOOD SAVING WITH IMPROVED
COOK-STOVES IN CAMBODIA**

MONITORING REPORT 1ST JAN - 31ST DEC 2009

SUMMARY

- This monitoring report details the monitoring activities and their results for the **period 1st January 2009 to 31st December 2009**.
- The emission reductions claimed for this period are **268,573 t/CO₂e**.
- The monitoring activities consists of validating ex-ante assumption and collecting ex-post data as per the PDD and previous monitoring reports (see Table 1).

Table 1: Parameters included in the monitoring report

Ex-ante parameters	Ex-post parameters
a. Fuel saving test (laboratory and actual testing)	a. Sales of NLS to distributors
b. Wood to charcoal conversion	b. Stoves produced by respective producers
c. NCV of biomass	c. Stove lifespan ¹
d. EF CO ₂ , biomass	d. Equipment ratio per family

- The outcomes of the monitoring activities are used to calculate emissions reductions as stipulated in the PDD. Table 2 below summarizes the data collected, sources of data and the values used during this verification and previous verifications.

¹ It was agreed during the first verification to be monitored as an ex-post parameter

Table 2: Summary of ex-ante and ex-post data for NLS verification 2003-2008

	Data	Source	Verification 1 May 10th 2003- Jan 9th 2007		Verification 2 Jan 10th 2007- Jan 9th 2008		Verification 3 Jan 10th 2008- Dec 31st 2008		Verification 4 Jan 1 st 2009 -Dec 31 st 2009	
Ex-post	Quantity of Stoves sold	Monthly Producer data	220,588		161,007		222,481		298,013	
Ex-Ante	Traditional Fuel Consumption	National User Surveys	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal
			37.56 kg/month	32.12 kg/month	37.56 kg/month	32.12 kg/month	37.56 kg/month	32.12 kg/month	37.56 kg/month	32.12 kg/month
Ex-Ante	Wood to charcoal ratio	IPCC	6	6	6	6	6	6	6	6
Ex-Ante	Fuel Saving	Household Cooking Test	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal
			20.89%	21.2%	20.89%	21.2%	20.89%	21.2%	20.89%	21.2%
Ex-post	Equipment Ratio	User Survey	1.28		1.6		1.6		1.6	
Ex-post	Stove Shelf life	QC label survey	1 month		1 month		53.4 days		53.4 days	
Ex-post	Stove lifetime	User Survey	3 Years		2.5 years		2.5 years		2.5 years	
Ex-Ante	NCV biomass	IPCC	15.6		15.6		15.6		15.6	
Ex-Ante	EF Biomass	IPCC	112 t		112		112		112	
	Emission Reductions		182, 402 tCO ₂ e		126,022 tCO ₂ e		192,600 tCO ₂ e		268,573 tCO ₂ e	

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SECTION A. PROJECT DESCRIPTION

Currently, the majority of the Cambodian population relies on fuelwood for cooking. This situation is forecast to continue for the foreseeable future (World Bank, 2007). The project has evolved from the Cambodian Fuelwood Saving Project (CFSP), which was created to protect forest resources in Cambodia by reducing woodfuel consumption. It was a service project that converted traditional stove makers to improved stove manufacturers.

The improved stoves, called the New Lao Stove (NLS), are more expensive but individuals choose them because they last longer and reduce the amount of money spent on charcoal. As a competitive advantage exists, a commercialised approach is used to disseminate the improved stoves, or NLS, through existing market channels. The user pays the full cost of the stove and the project does not introduce any market distortion such as subsidies or free distribution.

Whilst at the producer/consumer level the stoves are commercially viable, the project implements initiatives at sectoral level to transform the existing private sector towards a cleaner technology. These externalities, which include R&D, training, technical follow-up, quality control, market development, structuring the supply chain with fair trade values, energy policy work and advertising, cannot be passed on to the consumer and are funded through carbon finance.

The project has proceeded in three distinct phases:

1. Phase I was primarily a set-up phase which elaborated stove design, trained producers and developed distribution networks.
2. Phase II focused on developing the commercialised distribution of the stove design.
3. The third (current) phase involves scaling-up of the project to achieve large-scale dissemination, and is distinguished from the first two phases by its funding source; carbon finance. The project had been co-financed by the EU and, following the end of start-up funding, additional capital was sought in the form of carbon financing to not only complete the financing of the first two phases but also increase market penetration.

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 utilisation of this long term funding stream will ensure that further strides are taken towards transforming the household energy sector in Cambodia.

This monitoring report covers the period 1st January 2009 – 31st Decembner 2009. This is the fourth verification of the project activity.

Table 3: Summary of validation & verifications for NLS project

	Period Covered	Date Completed
Validation	2003 - 2012	07/06/07
Verification	May 10th 2003 - Jan 9th 2007	07/06/07
Verification	Jan 10th 2007 – Jan 9th 2008	18/09/08
Verification	Jan 10th 2008 – Dec 31st 2008	20/08/09
Verification	Jan 1st 2009 – Dec 31st 2009	

SECTION B. CURRENT STATUS OF PROJECT

GEOGRAPHICAL SCOPE

Monitoring of the project began in 2003 in six provinces in Cambodia. The success of the commercialised dissemination approach and stove design has meant that the project and monitoring activities have been extended to nine different provinces: Phnom Penh, Kandal, Kampot, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham and Kompong Chhnang (see Figure 1 below).

Figure 1: Map of New Lao Stove Production in Cambodia



MONITORING PARAMETERS

The majority of parameters monitored remain the same as the previous verification, with exceptions outlined in Table 4 below. Monthly NLS sales and units in use are summarised in Table 5.

Table 4: Updated parameters (compared to previous verification)

Number of NLS sold	298,013
Total number of NLS in use	569,032
Number of producers	30

Table 5: Summary of stoves sold & in use, 1st January – 31st December 2009

Month #	Date		Number of NLS sold	Cumulative number of NLS in use
69	01-Jan-09	31-Jan-09	27,582	429,362
70	01-Feb-09	28-Feb-09	23,605	432,414
71	01-Mar-09	31-Mar-09	22,142	447,786

72	01-Apr-09	30-Apr-09	17,869	458,353
73	01-May-09	31-May-09	26,314	469,701
74	01-Jun-09	30-Jun-09	30,178	481,117
75	01-Jul-09	31-Jul-09	22,546	496,483
76	01-Aug-09	31-Aug-09	27,719	516,650
77	01-Sep-09	30-Sep-09	23,686	531,674
78	01-Oct-09	31-Oct-09	23,559	550,860
79	01-Nov-09	30-Nov-09	28,768	557,658
80	01-Dec-09	31-Dec-09	24,045	569,032
Total			298,013	

OUTSTANDING ISSUES FROM PREVIOUS VERIFICATION

A Forward Action Request (FAR) was issued during the previous verification period:

*However, the revision of the VCS PD (7/7/09) for clarifying of stove size which do not impact negatively to GHG emission reduction or removals after validation without the acknowledgement from VCS was found during the verification. We would like to recommend VCS to review the procedure of the VCS PD revision. **In order to close this issue, the Forward Action Request (FAR) is issued to the project participant to officially notify and obtain the VCS confirmation from VCS on the PD revision prior to the verification of the next crediting period.***

VCS representatives, Jerry Seager (VCS Program Manager) and Bret Bonner (VCS Program Officer) were informed of the revisions to the PDD in an email correspondence on 27th November 2009. The email is reproduced below:

From: Kimberley BUSS [mailto:k.buss@geres.eu]
Sent: Friday, November 27, 2009 2:45 AM
To: bbronner@v-c-s.org; jseager@v-c-s.org
Cc: Samuel Bryan
Subject: Forward Action Request (FAR) for VCS project

Dear Jerry and Bret,

I am seeking some assistance in resolving a Forward Action Request (FAR) for GERES Cambodia's VCS-accredited project involving dissemination of improved cookstoves in Cambodia.

During our last verification we received a FAR, requiring us to inform the VCS about some changes that were made to our PDD. The FAR states that we must: **"officially notify and obtain the confirmation from VCS on the PDD revision prior to the verification of the next crediting period."**

The alterations do not affect the outcome of the project – they merely provide more information about the technology employed by the project and remove irrelevant information.

Do you know who within VCS I can contact regarding this matter?

Thank you in advance for your help.

Kind regards,

Kimberley BUSS
 CDM Analyst

The following reply was received from Bret Bonner on 2nd December 2009:

Dear Kimberly,

If the changes to the PD are substantive then it needs to be revalidated and a new validation report needs to be issued. If the changes are non-substantive it is better to not do them. In this particular case the primary reason for the request was to correct the lack of GPS coordinates and it has been taken care of accordingly. Please contact BV for information on their requested action and our response.

Regards,

Bret Bronner

Program Officer

Voluntary Carbon Standard Association

Tel: +1 202 296 2312

Based on this correspondence, **the FAR is considered closed:**

- VCS were informed of the changes.
- GERES was advised by VCS not to make the changes if they are “non-substantive”.
- The changes are considered non-substantive because they have no impact on the outcome of the project, as acknowledged by BV in the verification report².
- The revised version of the PDD was discarded and the original version remains valid.

² “...the revision of the VCS PD (7/7/09) for clarifying of stove size which do not impact negatively to GHG emission reduction or removals” (Bureau Veritas, 2009, page 14).

SECTION C. SUSTAINABILITY & IMPACTS OF PROJECT

C.1 SUSTAINABILITY OF THE PROJECT

Data from the National User Surveys³ (2007 and 2009) and NLS sales data indicate that the NLS has become established and is substituting traditional stoves (TLS) in the market place. This indicates that the emissions reductions from the project activities are permanent.

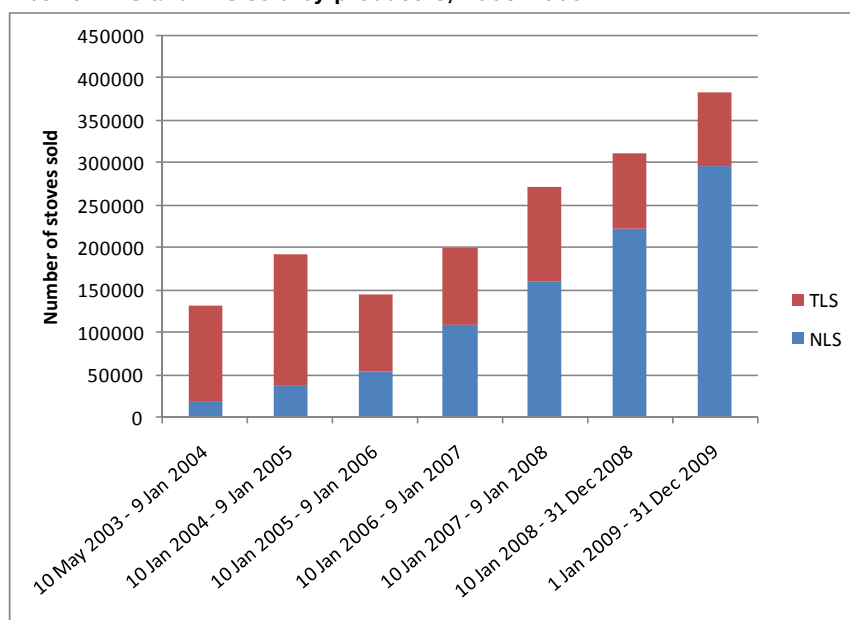
The most recent National User Survey, conducted in 2009, found that 41.7% of the urban/ peri-urban population use NLS (compared to 31.3% in the 2007 National User Survey). Furthermore, the percentage of people using TLS decreased from 68.8% in 2007 to 67.9% in 2009. This indicates that users are not switching back to inefficient stove technologies.

Table 6: National User Survey data on number / proportion of respondents using NLS

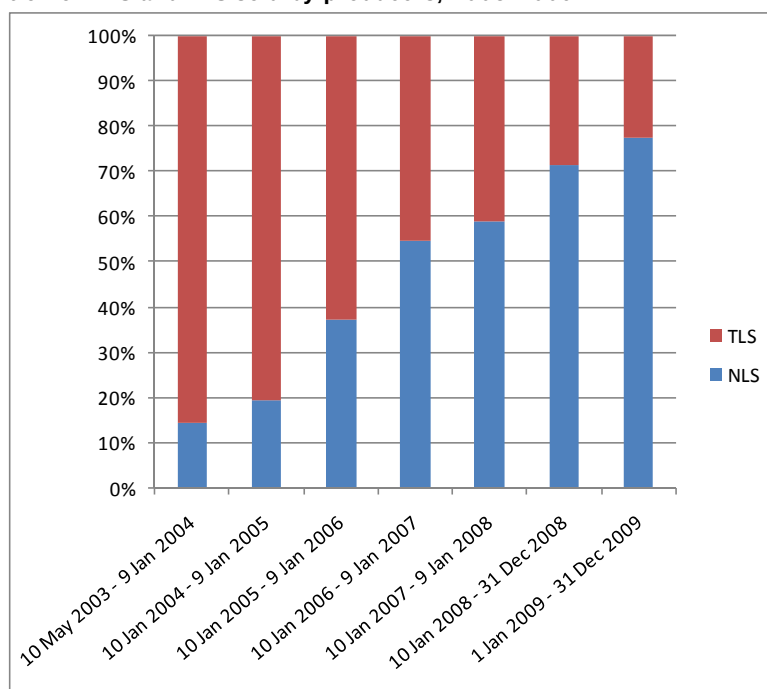
	Frequency	Percent
Yes	697	41.7
No	973	58.2
Total	1670	99.9

Stove sales data indicate that the NLS is accounting for an increasing proportion of total stoves produced, with a corresponding decrease in the proportion of TLS produced. This reflects increasing demand for NLS among consumers and provides further proof of the sustainability of the NLS project. Figures 2 and 3 below illustrate this trend.

Figure 2: Number of NLS and TLS sold by producers, 2003-2009



³ See Appendix 3 for more information on the National User Survey.

Figure 3: Proportion of NLS and TLS sold by producers, 2003-2009

C.2 ENVIRONMENTAL IMPACTS

Aside from the environmental benefits of GHG emission mitigation, the project activity directly contributes to efforts to reduce unsustainable fuel wood consumption.

Fuelwood and charcoal savings from the dissemination of the NLS can be calculated using the results of Household Fuel Consumption Test (HFCT) which are used to compare the performance of different thermal technologies. The savings per stove can be extrapolated to estimate the total savings during the monitoring period. During the 2009 monitoring period, the project saved the equivalent of 1,310.8 ha of forest⁴ and so far, over the project's lifetime, the equivalent of 3,756 ha of forest have been saved.

Table 7: Biomass saved by NLS project, 1st January – 31st December 2009

Month #	Date		No of units sold	Biomass saved	Equivalent wood (m ³)	Equivalent forest (ha)
69	1-Jan-09	31-Jan-09	27,582	13,070.1	21,787.8	94.7
70	1-Feb-09	28-Feb-09	23,605	13,163.0	21,942.7	95.4
71	1-Mar-09	31-Mar-09	22,142	13,630.9	22,722.7	98.8
72	1-Apr-09	30-Apr-09	17,869	13,952.6	23,259.0	101.1
73	1-May-09	31-May-09	26,314	14,298.0	23,834.8	103.6
74	1-Jun-09	30-Jun-09	30,178	14,645.5	24,414.1	106.1
75	1-Jul-09	31-Jul-09	22,546	15,113.3	25,193.9	109.5
76	1-Aug-09	31-Aug-09	27,719	15,727.2	26,217.2	114.0
77	1-Sep-09	30-Sep-09	23,686	16,184.5	26,979.6	117.3
78	1-Oct-09	31-Oct-09	23,559	16,768.6	27,953.2	121.5
79	1-Nov-09	30-Nov-09	28,768	16,975.5	28,298.2	123.0
80	1-Dec-09	31-Dec-09	24,045	17,321.7	28,875.4	125.5
Totals			297,153	180,854.7	27,582	13,070.1

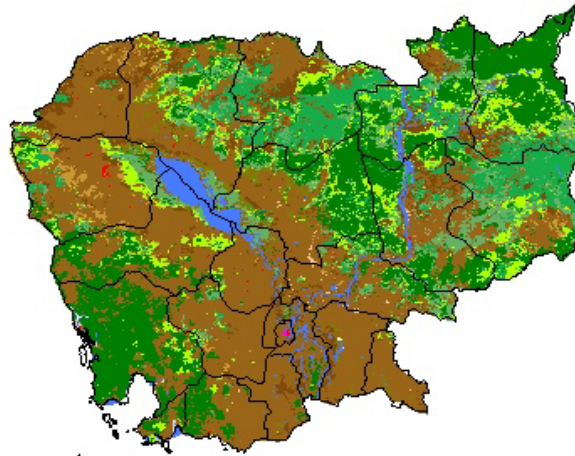
C.2.1 NON-RENEWABILITY

Cambodia's forest resources are rapidly being depleted. Biomass 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. The main forested areas are located in the North and South of the country. The map below illustrates the density of forest cover; the

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

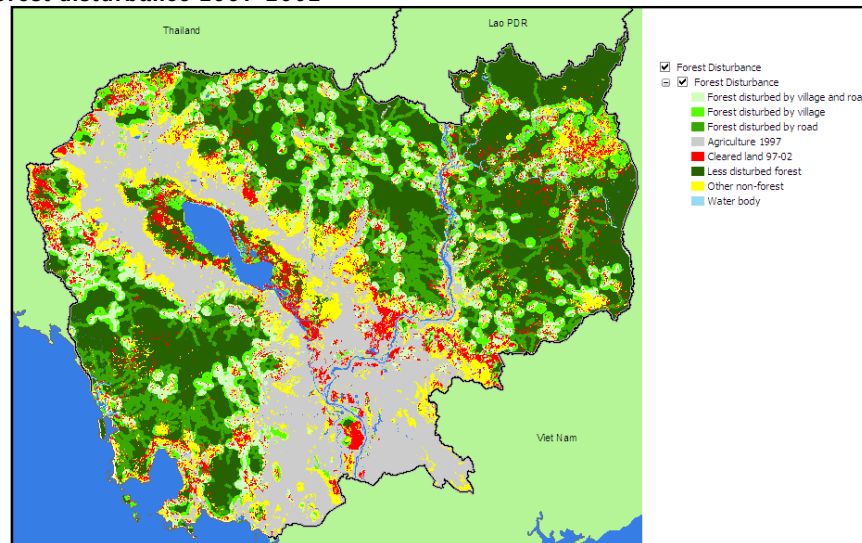
populated corridor where urban centers are located can be clearly seen. The figure below goes somewhat towards illustrating the logistical difficulties of supplying urban centers with fuel wood. As the forest cover recedes so do the distances need to collect fuelwood and so to the associated costs of meeting energy requirements.

Figure 4: Distribution of forest cover in Cambodia⁵



Evidence of non-renewability can be found in Geographic Information System and remote sensing analysis of forestry in Cambodia⁶. This allows the overlay of different themes of data and a spatially explicit representation of the “woodfuel frontier” i.e. where woodfuel is being produced, as well as deforestation and forest degradation areas and maps where the forest is being disturbed. The map below represents a GIS map of forest disturbance in Cambodia from 1997. The red colour on the map is the forest cleared over 1997-2002. It clearly and dramatically shows the fragmentation of primary and less disturbed forest by roads, logging, woodfuel production and land conversion to agriculture and human settlements.

Figure 5: Forest disturbance 1997-2002



Other recent evidence available for non-renewability of biomass resources is given by national forestry statistics. These show that between 2000 and 2005, the rate of forest change in Cambodia has been 1.90% per annum. In total, between 1990 and 2005, Cambodia lost 19.3% of its forest cover, or around 2,499,000 hectares. Cambodia lost approximately 444,000 hectares of its primary forest cover during that time. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, Cambodia lost 19.3% of its forest and woodland habitat. Between 2000 and 2005 alone, Cambodia lost nearly 30 percent of its primary forest cover, and deforestation rates continue to

⁵ FAO, 2005

⁶ GERES Forestry Unit GIS analysis of Forestry in Cambodia.

climb (Mongabay Forestry Statistics 2009⁷, Cambodia Independent Forestry Sector Review Report - World Bank 2004⁸).

The principle causes of deforestation in Cambodia are agriculture, shifting cultivation, fuelwood harvesting and logging. In particular logging in Cambodia has been a source of international concern. Rival factions in the civil war funded themselves through logging and the practice has continued largely unabated ever since.

"Despite public commitments to reform, Cambodia's shadow state has continued to generate money from the timber sector. Officials charged with implementing reforms have instead subverted them; with the result that illegal logging has continued in a variety of forms and is still causing severe damage to Cambodia's remaining forests" (Global Witness, 2008).

Domestic fuel use also adds pressure on environmental resources. Cambodia's increasing population relies heavily on fuel-wood as main energy source. Indeed, 95.3 % of the households use firewood and charcoal for cooking (National Institute of Statistics, 2008⁹). For household and light industrial consumption, charcoal is produced illegally and unsustainably:

"Charcoal-making is not well managed, reflecting short term thinking without a long term planning horizon within an environment of highly insecure rights" (Cambodia Independent Forestry Sector Review Report, World Bank 2004).

"Charcoal production in the Kampong Speu Province west of Phnom Penh (its main supply area) is evidently causing deforestation, converting primary forests into low-productivity degraded shrub-land. Charcoal, produced in traditional earth mound kilns, is mostly obtained from wood collected from the natural forest owned by the government."(Van Mansvelt *et al.*, 2006b¹⁰)

In 2006 GERES conducted a wood energy baseline study. The study found that the annual wood demand for Phnom Penh was 369,000 tones, or approximately 4,500 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.*, 2006b) – a proposition which is unfeasible in present day Cambodia.

An FAO study in 2001¹¹ explicitly linked fuelwood collection with localized deforestation:

"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 neighbours affected by floods and/or droughts almost every year" (FAO, 2001.)

This observation remains pertinent because, as a result of population growth, fuelwood use is expected to increase in the short to medium term as shown.

⁷ <http://rainforests.mongabay.com/20cambodia.htm>

⁸ <http://www.cambodia-forest-sector.net/docs/mainreport.pdf>

⁹ HTTP://WWW.NIS.GOV.KH/NIS/CSSES/NIS_CSSES_REPORT_HOUSING_FINAL200809.PDF

¹⁰ Van Mansvelt *et al.*, 2006b

¹¹ FAO, 2001.

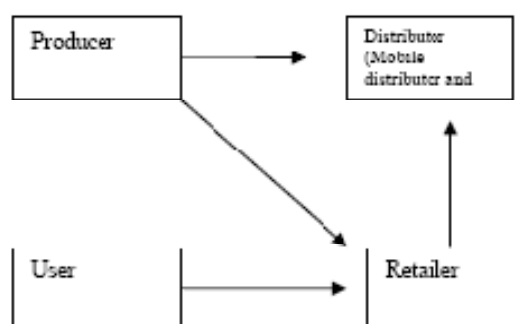
Table 8: Energy use in Cambodia 1994-2010¹²

	1994	1995	2000	2005	2010
Households	81,530	81,395	93,319	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
Desel	80	176	93	106	107
Electricity	352	378	607	967	1,229
Other	1,754	1,642	1,300	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
Desel	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
Desel	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	35,188
Gasoline	6,002	6,089	10,765	15,288	20,284
Desel	4,445	5,116	7,341	10,299	14,468
Jet Fuel	725	468	381	1,125	14,352
Fuel Oil	2	1	1	1	1

In summary, this evidence shows that woodfuel use in all sectors will increase over the medium term and it will continue to be used on an unsustainable basis.

C.3 ECONOMIC IMPACTS

An advantage of the commercialised 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

Figure 6: Stove distribution network¹³

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 stove¹⁴. The number of stoves sold throughout the monitoring period is 297,153, which means producers made an additional¹⁵ \$112,918.14 during the period. So far, during the lifetime of the project, producers have made an additional \$342,467.02 through the sale of NLS.

The profits are ultimately provided by the end users, who pay more per unit (around 3\$ compared to 1\$ for a comparable TLS); however, reductions in charcoal and fuelwood use and the increased

¹² RWEDP, 2001.

¹³ Atukorala, 2006.

¹⁴ Winrock, 2006

¹⁵ Compared to exclusive sale of TLS

durability of the NLS (around 2.5 years compared to 1 year for TLS) extend economic benefits of the stove to end users¹⁶.

C.4 SOCIAL IMPACTS

C.4.1 HEALTH & LIFESTYLE

The NLS does not fully alleviate the problems associated with the inhalation of cooking smoke and 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. Furthermore, the 2009 National User Survey found that around 45% of NLS users report a “high” level of satisfaction concerning smoke produced during cooking, compared to only 18.7% of TLS users. This is particularly noteworthy because nearly three quarters (73.9%) of people in urban areas cook inside their house¹⁷.

In addition, around 60% of NLS users reported a “high” level of satisfaction the NLS’ performance in terms of cooking time, compared to less than 40% of TLS users.

C.4.2 ENERGY ACCESS & FOOD SECURITY

The dissemination 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 the 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. The most recent National User Survey (2009) indicated that nearly 75% of NLS users were “highly satisfied” with the charcoal consumption rate of the NLS, compared with 48.7% of TLS users.

C.4.3 GENDER IMPLICATIONS

Almost all (around 98%) stove users are female, thus the adoption and use of the NLS has strong gender implications. Whilst the time saving from using the NLS is not enough for users to engage in additional income generating activities, it does free up time that can be used for other vital activities, such as water boiling, childcare and socializing¹⁸.

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 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 and in fact, nearly one quarter of NLS producers are women. 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).

C.4.4 CIVIL SOCIETY

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, coordinates dissemination, allows the stakeholders to assert ownership of the project process and provides a forum to raise issues.

GERES facilitates regular meetings between stove producers and stove distributors, through a stove producers and retailers association, known as ICOPRODAC. During the meetings members

¹⁶ Winrock 2006

¹⁷ National User Survey, 2009.

¹⁸ See National User Survey, 2007.

discuss pricing issues and share information to produce better quality stoves. The quality control and assurance of the stoves is also coordinated through ICOPRADAC; the organisation issues stickers to the NLS producers who qualify for the hallmark of quality.

A finance facility, known as the Economic Pillar, has also been established to serve as a savings and credit association. Members contribute 20,000 Riel per month to fund the association.

SECTION D. PARAMETERS TO BE OBTAINED

The parameters are obtained through a combination of ex-post and ex-ante data.

Data / Parameter:	Representative sample of mass of biomass used before and after installation of devices and efficiency measures.
Data unit:	Kg/ month / Family
Description:	Quantity of biomass saved as a result of the project activity.
Source of data to be used:	Household Fuel Consumption Test data (2008) National Stove Users Survey (2007) Stove Producer Sales data (2008)
Value of data	Emissions reductions from utilisation of the NLS
Description of measurement methods and procedures to be applied:	National Stove User Survey results demonstrate the average fuel mix and consumption per family. Data from Household Cooking Tests generates data on efficiency savings. Monthly sales data of stove producers to monitor mass of biomass used before and after installation of the efficiency devices.
QA/QC procedures to be applied:	Household Fuel Consumption Test Data (2008) follows an internationally recognized methodology and replicates previous studies. The data used is within acceptable standard deviation of the data series. National Stove Users Survey is conducted by GERES –Cambodia Policy and Study Unit. The results us statistical confidence levels to ensure results. Stove producers sales data is collected on a monthly basis. Internal verification procedures ensure data entry. Every three months samples taken from stove producers are tested using water boiling tests. These measures ensure the quality of stove production.
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:	Variations in the moisture content of the biomass affects fuel saving of improved cooking stoves
Source of data to be used:	Household Fuel Consumption Test data (2008)
Value of data	Accuracy of fuel savings
Description of measurement methods and procedures to be applied:	The fuel savings are calculated under field conditions using fuel purchased in the market. The tests are conducted in the wet season where combustion efficiency is lower.
QA/QC procedures to be applied:	Results are part of a series of test conducted since 2004. Data used will be within acceptable standard deviation of the data series.
Any comment:	

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:	No of stoves sales per month
Description:	Stove sales demonstrate that appliances are still in use or replaced by an equivalent appliance.
Source of data to be used:	Stove Producer Sales data (2008)
Value of data	Ensure accuracy of emissions reductions
Description of measurement methods and procedures to be applied:	The increasing market penetration is used as a proxy for ensuring that devices are operating or being replaced. 30 months after their sale the stoves are subtracted from the total number of units in use.

applied:	
QA/QC procedures to be applied:	National Stove Users Survey (2007) demonstrates high level of user satisfaction with the NLS.
Any comment:	

Data / Parameter:	Monitoring shall include the efficiency of the appliances
Data unit:	%
Description:	Representative samples from stove producers to measure the efficiency of stoves constructed by producers.
Source of data to be used:	Water Boiling Test
Value of data	Quality control of stove production. Quality assurance for emissions reductions calculations.
Description of measurement methods and procedures to be applied:	Every three months each stove producer submits 3 stoves for quality control testing. This consists of checking dimensions of the samples and conducting water boiling tests. To ensure efficiency of stoves being produced by each NLS producer.
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 behaviour.
Source of data to be used:	National Users Survey (2007)
Value of data	Ensure the accuracy of emissions reductions calculations
Description of measurement methods and procedures to be applied:	User surveys will establish the percentage of stove users using traditional and NLS simultaneously.
QA/QC procedures to be applied:	Stove producer data (2008). Stove sales data demonstrates the increasing market share of the NLS over time.
Any comment:	

Data / Parameter:	Quantity of alternative fuels used by project participants and assessment of aggregate biomass renewability in the region.
Data unit:	Fuel mix Deforestation rate
Description:	The mix of fuels and saving from those fuels affects the emission reductions. Emissions reductions are dependent on the renewability of the biomass.
Source of data to be used:	National stove Users Survey (2007) Independent accredited literature
Value of data	Validity of emission reductions from non-renewable biomass
Description of measurement methods and procedures to be applied:	National users survey includes measurements of the proportions of agricultural waste, wood and charcoal used in biomass stoves. National users survey collects data of increasing price of charcoal and wood as a proxy for non-renewability.
QA/QC procedures to be applied:	National Stove Users Survey is conducted by GERES –Cambodia Policy and Study. The results us statistical confidence levels to ensure results. Peer reviewed published reports.

Any comment:	
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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:	National Stove Users Survey
Value of data	Sustainable development benefits of Project Activity.
Description of measurement methods and procedures to be applied:	Survey of stoves users. Market data
QA/QC procedures to be applied:	Peer review of literature.
Any comment:	

Data / Parameter:	Transport Emissions from monitoring activities
Data unit:	T/CO ₂ e
Description:	Monitoring staff travel to producers and retailers to collect stove sales data. This is a source of project emissions
Source of data to be used:	Fuel receipts from monitoring staff
Value of data	Conversion from price to volume multiplied by emissions coefficient gives transport emissions
Description of measurement methods and procedures to be applied:	Submission of fuel expenditure receipts
QA/QC procedures to be applied:	Auditing of accounts
Any comment:	

SECTION E. EMISSIONS REDUCTIONS

The emissions reductions are calculated as per the formula presented in proposed methodology CC-NRB-BSAS and detailed in the PDD. The total emissions reductions over the monitoring period are **268,578 tCO₂e**.

Table 9; below the monthly emissions reductions that occurred as a result of the project activity during this monitoring period. The table is abridged; the full table is reproduced in Appendix 2.

Table 9: Emissions reductions for the monitoring period 1st January 2009 – 31st December 2009

Month #	Start date	End date	No. Units sold (per month)	No. Units in use (cumulative)	Total biomass saved (t/ month)	ER (tCO ₂ e / month)	ER adjusted for leakage (tCO ₂ e / month)
69	01-Jan-09	31-Jan-09	27,582	429,362	13,070.1	22,836	19,410
70	01-Feb-09	28-Feb-09	23,605	432,414	13,163.0	22,998	19,548
71	01-Mar-09	31-Mar-09	22,142	447,786	13,630.9	23,816	20,243
72	01-Apr-09	30-Apr-09	17,869	458,353	13,952.6	24,378	20,721
73	01-May-09	31-May-09	26,314	469,701	14,298.0	24,982	21,233
74	01-Jun-09	30-Jun-09	30,178	481,117	14,645.5	25,589	21,749
75	01-Jul-09	31-Jul-09	22,546	496,483	15,113.3	26,406	22,443
76	01-Aug-09	31-Aug-09	27,719	516,650	15,727.2	27,479	23,355
77	01-Sep-09	30-Sep-09	23,686	531,674	16,184.5	28,278	24,035
78	01-Oct-09	31-Oct-09	23,559	550,860	16,768.6	29,298	24,902
79	01-Nov-09	30-Nov-09	28,768	557,658	16,975.5	29,660	25,209
80	01-Dec-09	31-Dec-09	24,045	569,032	17,321.7	30,265	25,723
Totals			298,013		180,851.0	315,983	268,573

SECTION F. MEASURES TO ENSURE THE RESULTS

The results are ensured through a combination of ex-ante assumptions and ex-post data. The validity of the ex-ante assumptions will be assured through continuous validation. For example, bi-annual stove user surveys and twice-yearly HFCTs are 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 reductions. Quality assurance measures are in place throughout the NLS supply chain consisting of producers, middlemen, retailers and end-users.

F.1 EX-ANTE PARAMETERS

A. FUEL SAVING TEST (LABORATORY AND ACTUAL TESTING);

Household Fuel Consumption Tests (HFCTs) are used to determine the fuel savings achieved through use of the NLS. The results for the tests conducted during the wet season are presented in Table 10 below, because they are the most conservative (higher moisture content in biomass fuel during the wet season reduces combustion efficiency).

During the first verification, the verifier advised that the original fuel saving estimates used in the PDD should be maintained (rather than updating the data based on subsequent HFCTs), in order to maintain consistency; therefore, the original figures are maintained in the calculations. This also preserves the conservative approach to the calculations, as the 2009 HFCTs returned fuel savings that are higher than the original savings quoted in the PDD.

Table 10: Fuel savings achieved during HFCTs, 2003-2010¹⁹

Fuel type	Fuel saving			
	2003-2007	2007-2008	2008-2009	2009-2010
Charcoal	21.2%	22.08%	19.07%	24.46%
Wood	20.89%	20.1%	20.1%	23.03%

B. WOOD TO CHARCOAL CONVERSION

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

C. NCV OF BIOMASS;

The PDD uses Net Calorific Value (NCV) stipulated in the IPCC guidelines 2006.

D. EF CO₂, BIOMASS;

The PDD uses Emissions Factors stipulated in the IPCC guidelines 2006.

E. FUEL CONSUMPTION

The results of the 2009 National User Survey are outlined in Table 11 below.

Table 11: Charcoal and wood consumption based on 2009 National User Survey

Fuel	Number of stoves	Consumption		
		kg / day	kg / month	tonnes / month
Charcoal	910	1.04	31.52	0.03
Fuelwood		0.73	22.35	0.02

The results are lower than previous estimates attained through National User Surveys and the data applied in the PDD see Table 12 below. During previous verifications, GERES has been advised to apply the original fuel use figures in the PDD rather than updated estimates obtained during National User Surveys, as the PDD figures are considered “defaults” and the figures obtained during National User Surveys serve as verification that the PDD data is still applicable. Therefore, the data cited in the PDD is maintained for this verification period.

¹⁹ See Appendix 4 for more detailed results of 2009 HFCTs.

Table 12: Charcoal and wood consumption data cited in the PDD

Fuel	Number of stoves	Consumption		
		kg/ day	kg/ month	tonnes/ month
Charcoal	256.03	1.06	32.12	0.03212
Fuelwood		1.24	37.56	0.03756

F.2 EX-POST PARAMETERS

F.2.1. STOVES PRODUCED

The quantity of stoves produced is calculated on a monthly basis. Every month, QCM staff visit each stove producer and collect the data from producer logbooks. The data is then entered into spreadsheets at the GERES office. The following data is collected:

- 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).

Table 13 lists producers included in this verification.

Table 13: Producers included in verification

	Name	Code	Sex	Village	Province	Stove logo
1	LENG SOPHAT/ SOR HOUT	HBTB	Male	Slaket	Battambang	Tadombangkronhoung
2	NHEK SAKUN	KBTB	Male	Chamka Samrong1	Battambang	Diamond
3	KHIN PUM	PBTB	Male	Chamka Samrong 2	Battambang	Heart
4	MENG CHHUN	CKCM	Male	Kor Koh	Kampong Cham	Moon
5	SOK HOAN	HKCM	Male	Sror Nge	Kampong Cham	Star & Moon
6	DUL SAM OUN	SVKC	Male	Kdey Tnoat	Kampong Chhnang	Butterfly
7	VANN TOLA/ YEM KOEUN	KCK	Female	Prey Moan	Kampong Chhnang	Coconut Palm
8	KHOEM TIM	KTKC	Female	Andong Russey	Kampong Chhnang	Deymeas Mountain
9	PHON SOPHA	PHKC	Male	Banh Chhkol	Kampong Chhnang	Camel
10	PHON SOMEN	PMKC	Male	Banh Chhkol	Kampong Chhnang	Apple
11	RIS SARATH	RRKC	Male	Kdey Tnoat	Kampong Chhnang	Gourd
12	SUN THA	SAKC	Female	Andong Russey	Kampong Chhnang	Chicken
13	SIM MOM	SMKC	Female	Chamkar Tamao	Kampong Chhnang	Butterfly
14	SIM SETH	SKC	Male	Kdey Tnoat	Kampong Chhnang	Rabbit
15	SIM SOUR	SSKC	Female	Kdey Tnoat	Kampong Chhnang	Butterfly
16	TRAINING CENTRE/ DATE	TCD	Male	Andong Russey	Kampong Chhnang	DATe Logo
17	LONG TY	LYKC	Female	Trear	Kampong Chhnang	Swan
18	MOM SAMEAN	MMKC	Male	Kdey Tnoat	Kampong Chhnang	Rabbit

19	KONG SOPHEAR	KPKC	Male	Chamkar Tamao	Kampong Chhnang	Flower
20	PHUN SOPHAL	SPKC	Male	Andong Russey	Kampong Chhnang	Cow
21	YONG SUNHAI	HKPT	Male	Kampong Kreng	Kampot	Durian
22	PON RATHA/ PON VUTHY	TKPT	Male	Trapaing Chrey	Kampot	
23	SEM KOSAL	ECX1	Male		Kandal	
24	BIN THEARA/ CHUM SRENG	SKV1	Female	Lu	Phnom Penh	Duck
25	BUN SUN/ BUN RITH	BSPP	Male	Thoamtrai	Phnom Penh	Bird
26	BUN TIKEAR	HK2	Male	Stoeng Meanchey	Phnom Penh	Kang Chak
27	MAK SAMITH	HK3	Male	Tuol Rokar	Phnom Penh	Chicken
28	MOK SOY	MSPV	Male	Kandach	Prey Veng	Goat
29	VONG SIENG LENG	SRP	Male	Wat Svay	Siem Reap	Angkor Wat
30	KONG SOK	STKO	Male	Tadu	Takeo	Elephant

F.2.2. SALES OF NEW LAO STOVES TO USERS: POST

Emission reductions from the NLS project are based on monthly sales of stoves sold by producers. Calculation of emissions reductions assumes that stoves are used immediately upon purchase by the end user and therefore start to generate emissions reductions at this point; however, it is important to account for the time lapse between the stoves' production and actual use (POST), during which no emissions reductions are generated.

The duration of the POST is defined by two points in the stove supply chain:

1. During distribution from producers to retailers, sometimes via middlemen.
2. The number of stove shelf days (SSD), which refers to the length of time stoves are held by the retailer before their eventual sale to the end user.

GERES' NLS labelling system assists in estimating the time lapse between stove production and stove use. The labels serve not only as a mark of quality control, but also provide a unique serial number. This number is recorded at three points in order to determine the POST:

1. When the label is issued to producers.
2. When the stove is sold to producers.
3. When the stove is sold to end users.

Using the figures of the QC labels, a survey was conducted in 2008, based on 535 stoves (out of a total of 244,102, providing a confidence level of 95.7%). Based on the data obtained, the average POST is 53.4 days²⁰, which is a conservative estimate because:

- It includes the time lapse between the point at which the producers obtain the QC label and the point at which the producers label the produced stove. Producers generally apply labels in batches, rather than on a stove-by-stove basis, which means the delay between receiving and issuing the label could be in the order of weeks (since labels are issued monthly).
- Extreme POST data was included in the calculation. The extreme values may result from a number of situations, such as misplacement of the labels by producers, or using new batches of labels before using leftover labels from the previous month.
- It is not discounted for sales closer to the point of production.

F.2.3. STOVE LIFESPAN

The lifespan adopted is 2 ½ years or 30 months. Data collected during the National User Survey showed that of stoves users who were no longer using their first stoves the average life time was 29 months. However of the 513 NLS user survey only 12% reported that they were no longer using their first stove. This indicates that the majority of stoves are still in operation and 30 months is a conservative estimate.

²⁰ See Appendix 5 for further detail on POST calculation

F.2.4 EQUIPMENT RATIO: STOVES PER FAMILY.

Equipment ratio refers to the number of stoves used per family. Results from the National User Survey (2007) identified an equipment ratio of 1.6. This ratio is higher than the previously calculated ratio of 1.28; since the higher ratio is the more conservative figure, it has been adopted for the verification period

Number of stoves	Frequency	Total Stoves	Equipment Ratio
1	311	311.0	
2	116	232.0	
3	55	165.0	
more than 3	17	68.0	
Total	499	776.0	1.6

F.2.5. TRANSPORT EMISSIONS

Transportation emissions are generated from collecting producer and retailer data, quality control activities and conducting household fuel cooking tests. These emissions would not have occurred in the absence of the project activity. These emissions are calculated as project emissions and deducted from total emissions reductions. Transport emissions from monitoring activities are generated by:

- monthly visits to producers and retailers
- quality control activities
- marketing and awareness-building activities
- meetings of the improved cookstove producers association

The transport emissions are calculated based on the consumption of fossil fuel associated with the monitoring activities. The fuel consumption is derived from GERES' accounting records for the period 1st January 2009 – 31st December 2009. Receipts to cover travel expenses are submitted to the Finance Unit of GERES Cambodia. In its records, the Finance Unit ensures that travel for monitoring activities of the NLS project are distinguishable from travel associated with other projects.

Transport emissions were determined according to fuel consumption, which was calculated based on average prices for gasoline and diesel in 2009. The average price was calculated from randomly selected fuel receipts submitted to the Finance Department by the QCM team throughout 2009. **In this crediting period, 12.75 tCO₂e were emitted from transport associated with monitoring of the NLS project.** Further information on the transport emissions calculation is available in Appendix 6.

F.2.6. QUALITY ASSURANCE MEASURES

Samples of NLS are collected every three months from producers to check the quality of stove production. The stoves are then tested to determine their efficiency.

Adapted Water Boiling Tests (AWBTs) are conducted to determine the efficiency of the stoves, power input, burning rate and useful heat input. Performance should be within pre-determined thresholds. Based on these tests the quality of the stoves in terms of fuel savings and time to boil is analysed.

The samples are also measured to ensure they conform to standardised stove dimensions – this is a **largely cosmetic check**, as stove dimensions have limited influence on the efficiency of the stoves²¹. The stove dimensions testing was altered in 2009 to detect problems early in the production chain – rather than just measuring the finished product, the clay stove body is measured at different different stages of production.

Finally, a system of labeling has been initiated for quality assurance of NLS. Producers whose construction standards have consistently achieved adequate results in the AWBTs are provided with labels to attach to the finished product.

²¹ This was proven during the 2009 testing of stoves that scored poorly in stove dimension tests. The average efficiency of the tested stoves was 31.1% in spite of their “poor” performance in the stove dimension tests.

F.3 ORGANISATIONAL STRUCTURE & CORRECTIVE ACTIONS

In an effort to improve early detection of problems associated with the manufacture of the NLS, GERES commissioned Ms. Manon DELACHANEL, of Odysseo2, to conduct an analysis of the existing QCM system to identify organisational and operational problems; and to suggest methods for diagnostic and corrective actions.

The structure of the QCM department was re-organised based on Ms Delachenal's analysis, with activities being divided into three fields:

1. Performance QC
2. Physical QC
3. Monitoring

The restructuring of the QCM department, based on Ms Delachenal's suggestions is complete. Team Leaders were appointed to oversee the QCM Unit's three core activities. QCM staff are supervised by these team leaders and perform tasks for each team on a rotational basis, in order to diversify the staff's skills and and provide variety in their work tasks. An Executive Assistant was appointed to relieve the administrative burden on the Team Leaders. It is anticipated that these changes will assist in avoiding a high turnover rate among QCM staff.

Figure 7: Structure and activities of the QCM Unit

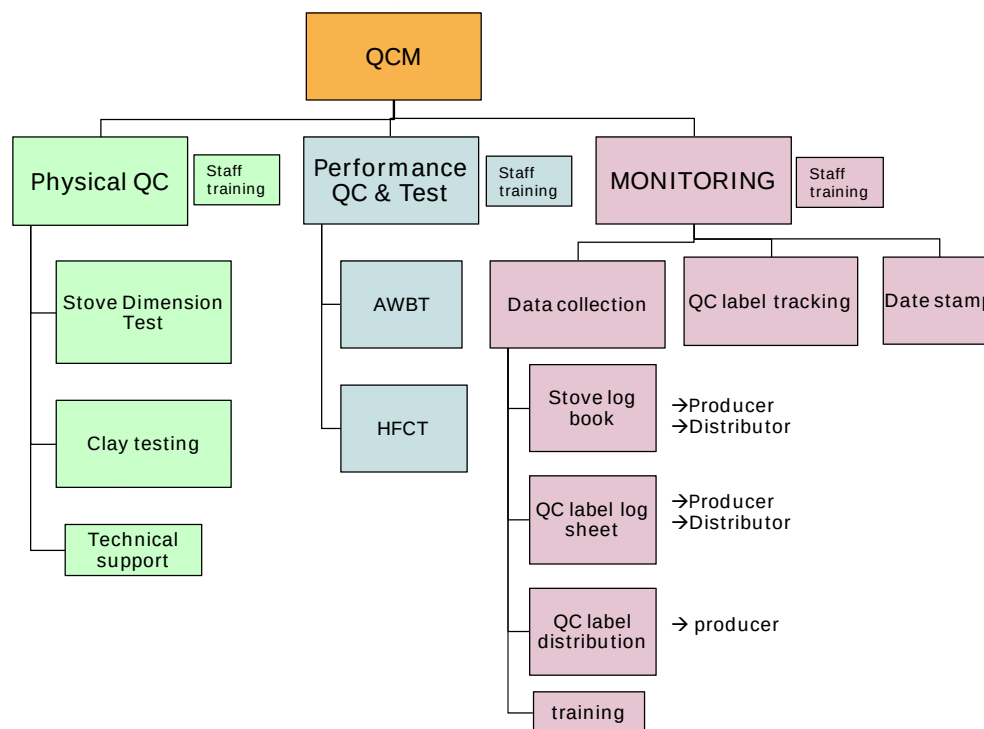
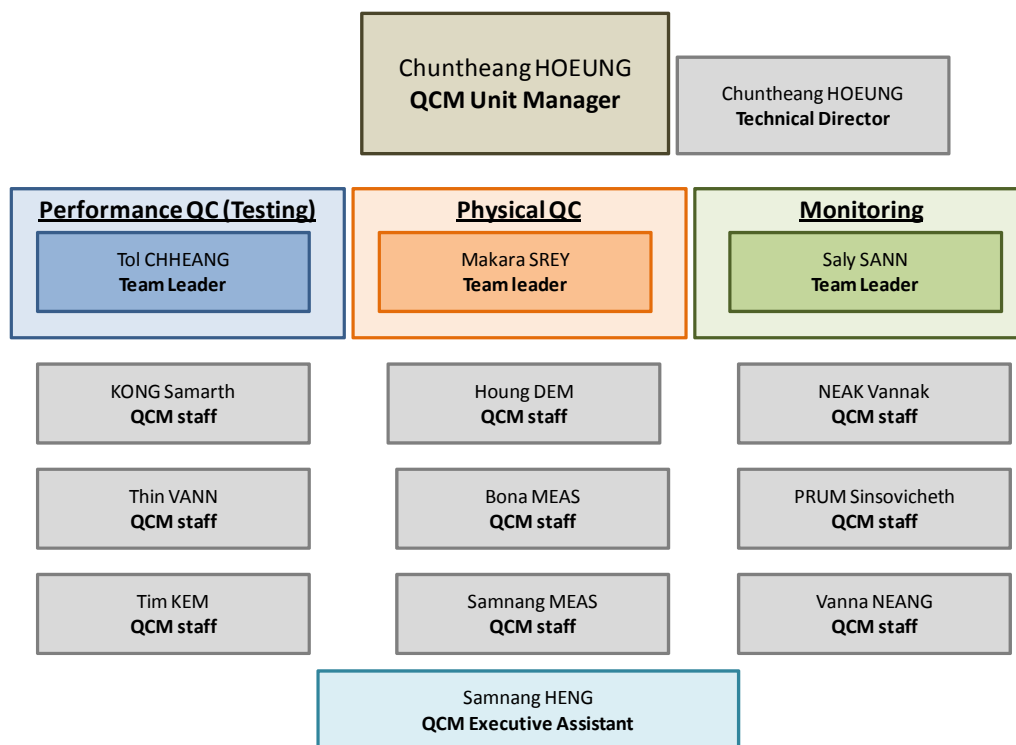


Figure 8: QCM Unit staffing structure

A “tracking system” for QC results of producers was also proposed by Ms. Delachenal and is under development. Its aim is to facilitate prompt identification of producers who may be experiencing problems in maintaining appropriate quality standards for NLS. The system consists of charts that list each producer and their performance in each of the QC tests conducted by GERES (see Appendix 4 for a sample chart). The charts are intended to be displayed in the QCM office, and it is anticipated that Physical QC and Performance QC staff will update the chart after each field visit. Failure to perform adequately will be evident in the chart through the use of a colour-code system and its display in the QCM office will serve as a visual indicator for timing the implementation of corrective actions.

Based on the findings of the “tracking system”, corrective actions are to be implemented. Three corrective action systems were developed by Ms. Delachenal, based on the QCM Unit’s three main fields of work:

- Monitoring corrective actions
- Physical QC corrective actions
- Performance QC corrective actions

The systems are intended to:

- identify problems early
- raise awareness among producers regarding problems
- provide an opportunity for producers to solve the problems under GERES’ guidance

If the producers consistently fail to meet GERES’ QC or monitoring standards, their cases will be referred to ICOPRODAC for the members to decide on the most appropriate course of action (eg. removal of accreditation). Appendix 7 illustrates the procedures being implemented.

The entire tracking and corrective action system is expected to be fully implemented by July 2010.

F.4 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.

F.5 CONSERVATIVENESS

- Emissions reductions from non-CO₂ gases are not included in the emissions reductions calculations
- Emissions reductions from avoidance of charcoal production, mainly methane, are not included in the calculations.
- National stove user surveys indicate that fuel consumption is increasing lower values as validated in the PDD are used.

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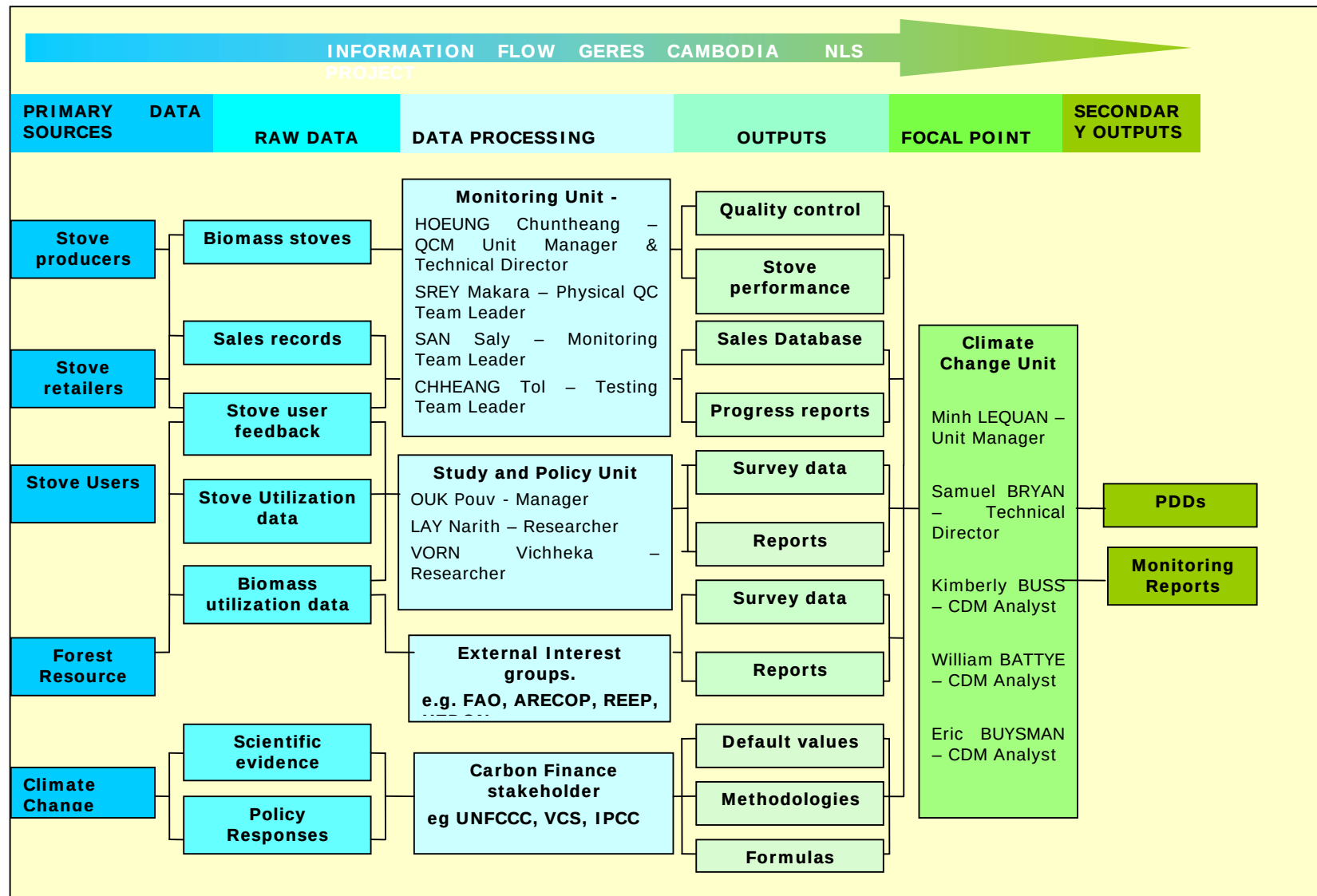
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APPENDIX 1. INFORMATION FLOW GERES CAMBODIA NLS EMISSIONS REDUCTIONS PROJECT.



APPENDIX 2: EMISSIONS REDUCTIONS FROM NLS PROJECT 1ST JANUARY 2009 – 31ST DECEMBER 2009

Date			No of units sold		Number of units in use	Biomass wood t/month	Biomass charcoal t/month	Biomass saving wood t/month	Biomass saving charcoal t/month	Total Biomass Saving t/month	ER t/CO ₂ e	Leakage deduction [15%]	Transport Emissions tCO ₂ e	Adjusted ER t/CO ₂ e	Yearly Totals ER t/CO ₂ e
69	01-Jan-09	31-Jan-09	27582	13383	429362	10079.3	51719	2105.6	10964.5	13070.1	22836	3425	0.61	19,410	
70	01-Feb-09	28-Feb-09	23605	11238	432414	10150.9	52087	2120.5	11042.4	13163.0	22998	3450	0.11	19,548	
71	01-Mar-09	31-Mar-09	22142	12680	447786	10511.8	53939	2195.9	11435.0	13630.9	23816	3572	0.67	20,243	
72	01-Apr-09	30-Apr-09	17869	9750	458353	10759.8	55212	2247.7	11704.9	13952.6	24378	3657	0.49	20,721	
73	01-May-09	31-May-09	26314	8517	469701	11026.2	56579	2303.4	11994.6	14298.0	24982	3747	0.94	21,233	
74	01-Jun-09	30-Jun-09	30178	11892	481117	11294.2	57954	2359.4	12286.2	14645.5	25589	3838	1.16	21,749	
75	01-Jul-09	31-Jul-09	22546	8146	496483	11654.9	59805	2434.7	12678.6	15113.3	26406	3961	1.84	22,443	
76	01-Aug-09	31-Aug-09	27719	8786	516650	12128.4	62234	2533.6	13193.6	15727.2	27479	4122	1.41	23,355	
77	01-Sep-09	30-Sep-09	23686	7547	531674	12481.0	64044	2607.3	13577.2	16184.5	28278	4242	1.17	24,035	
78	01-Oct-09	31-Oct-09	23559	16857	550860	12931.4	66355	2701.4	14067.2	16768.6	29298	4395	1.51	24,902	
79	01-Nov-09	30-Nov-09	28768	13458	557658	13091.0	67174	2734.7	14240.8	16975.5	29660	4449	1.26	25,209	
80	01-Dec-09	31-Dec-09	24045	14489	569032	13358.0	68544	2790.5	14531.3	17321.7	30265	4540	1.57	25,723	268,573
			902,089	301,763		399649.1	2050706.1	83486.7	434749.7	518236.4	905463	135819	33.02	501,025	576,998

APPENDIX 3: NATIONAL USER SURVEY – BACKGROUND

BACKGROUND

The National Stove Users Survey is conducted every two years to monitor the social impacts of the NLS and several parameters relevant to the NLS project:

- Fuel consumption in traditional stoves
- Equipment ratio
- Stove lifetime
- NLS usage
- TLS usage
- User satisfaction
- Social/ economic impacts on families

SITE SELECTION OF THE COOKSTOVE USER SURVEY

The survey employed a particularly quantitative approach targeting basically urban and suburban households. The preliminary site selection was based on information available on the National Cookstove User Survey conducted by GERES Cambodia in 2007 and several publications cited from GERES Cambodia in 2009. It reveals that among 9 provinces, 30 percent of urban and suburban used NLS and 70 percent used LPG and traditional cookstoves. Phnom Penh, Kampong Chhnang, Kampong Thom, Kampong Speu, Siem Reap, Battambang, Kampot, Sihanoukville and Kampong Cham provinces were the targeted areas of NLS users; thus these provinces were analyzed for the survey.

The urban and suburban areas in each provincial town were selected by identifying various social classes. In each main city, three roads each of urban and suburban areas were selected to represent to low, middle and upper classes of households. However, business junction roads were excluded due to the fact that many business buildings and very few households were present.

The Phnom Penh Municipality report in 2003 and 2006 defines urban and suburban Phnom Penh by population density, in which 500 inhabitants per hectare is counted in urban Phnom Penh and 50 inhabitants per hectare in suburban areas. Moreover, the area where agriculture is active has also been counted as a suburban area.

From a total of 399,954 urban households in the provinces surveyed, a sample population of 1,108 provides a 97% confidence level (using the formula below):

$$n = \frac{N}{1 + N(e)^2}$$

Where

N is the total population

e is the desired level of precision

If confidential level is 97%:

$$N = 399,954 / 1 + 399,954 * (0.03)^2 = 1,108 \text{ Households}$$

This 1,108 was then corrected twice:

1. For the possibility that people under 14 years may be the only household members present at the time that the surveyors visit the family.

Based on a report published by the Ministry of Planning in 2009, 33.7% of the population in Cambodia is between 0-14 years old, so the sample size was increased by 33.7% to anticipate the risk that the only household members present during the surveyors' visit would be under 14 years old.

$$1,108 + (0.337 * 1,108) = 1,481$$

2. For the fact that the population data was from 2007 and it is likely that the population in urban areas has increased since that time.

We added another 190 households to the total population surveyed in Phnom Penh, based on the assumption that most of the population increase would be concentrated in Phnom Penh due to migration to urban centres.

$$1,481 + 190 = 1,671$$

A sample size of 1,671 provides a confidence level of between 97 % and 98 %.

Table 14: Sample population for National User Survey 2009

Province	Provincial Town	Population	% of sample	Household Sample Size		
				Urban	Suburban	Total
Phnom Penh	Krong Phnom Penh	260,468	65.0%	987	110	1,097
Kampong Cham	Krong Kampong Cham	9,726	2.5%	37	4	41
Kampong Chhnang	Krong Kampong Chhnang	8,411	2.1%	30	4	34
Kampong Thom	Krong Steung Sen	11,510	3%	43	5	48
Siem Reap	Krong Siem Reap	45,717	11.4%	168	19	187
Kampot	Krong Kampot	7,358	1.8%	27	3	30
Sihanoukville	Krong Preahsihanouk	19,157	4.8%	71	8	79
Kampong Speu	Krong Chbarmon	9,139	2.3%	34	4	38
Battambang	Krong Battambang	28,468	7.1%	105	12	117
Total		399,954	100 %	1,502	169	1,671

SURVEY METHODOLOGY

A structured questionnaire was employed for data collection, which was divided into 3 main parts consisting of kind of cookstove used, cookstove lifetime, fuel consumption and user satisfaction. To assess household economy, household income, expenditure and household physical assets were mainly asked.

During the field survey, 4 research teams consisting of 5 members per each team was mobilized. Surveyors were required to follow the guidelines, which were comprised of three main points: (1) follow the junction road identified by the researcher, (2) survey every tenth household in the preselected area, and (3) interview households that use biomass fuel occasionally or eventually. All data existing in the questionnaire was entered into SPSS file. Data was checked for consistency, reliability and input error. To analyze the level of cookstove user satisfaction, a Weight Average Index was used, scaling mainly based on dissatisfaction, neutral and high satisfaction levels.

APPENDIX 4: HFCT RESULTS, 2009 WET SEASON

CHARCOAL

Test conducted 18-25 October, 2009, in Boeung Tumpun, Phnom Penh

For NLS (25 families), 7 days			
Average	Rice	Water	Charcoal
Consumption/week for the family(kg)	278.80	2627.00	322.80
Consumption/day for the family(kg)	39.83	375.29	46.11
Consumption/week/eq.adult	56.36	586.10	70.38
Consumption/day/eq.adult	8.05	83.73	10.05

For TLS (25 families) 7 days			
Average	Rice	Water	Charcoal
Consumption/week for the family(kg)	307.60	2591.00	417.80
Consumption/day for the family(kg)	43.94	370.14	59.69
Consumption/week/eq.adult	62.94	572.40	93.17
Consumption/day/eq.adult	8.99	81.77	13.31

For an average of 1 family		
Rice	Water	Charcoal
11.15	105.08	12.91
1.59	15.01	1.84
2.25	23.44	2.82
0.32	3.35	0.40

For an average of 1 family		
Rice	Water	Charcoal
12.30	103.64	16.71
1.76	14.81	2.39
2.52	22.90	3.73
0.36	3.27	0.53

Real Fuel Saving % 24.46

Total Fuel (Kg) 740.60

Wood

Test conducted 8-21 December 2009 in Takhmao, Kandal Province

For NLS (24 families), 7 days			
Average	Rice	Water	Chop Wood
Consumption/week for the family(kg)	369.71	3695.50	590.00
Consumption/day for the family(kg)	52.82	527.93	84.29
Consumption/week/eq.adult	64.02	669.85	106.52
Consumption/day/eq.adult	9.15	95.69	15.22

For TLS (24 families) 7 days			
Average	Rice	Water	Chop Wood
Consumption/week for the family(kg)	331.63	3457.10	762.21
Consumption/day for the family(kg)	47.38	493.87	108.89
Consumption/week/eq.adult	57.73	643.60	138.39
Consumption/day/eq.adult	8.25	91.94	19.77

For an average of 1 family		
Rice	Water	Chop Wood
15.40	153.98	24.58
2.20	22.00	3.51
2.67	27.91	4.44
0.38	3.99	0.63

For an average of 1 family		
Rice	Water	Chop Wood
13.82	144.05	31.76
1.97	20.58	4.54
2.41	26.82	5.77
0.34	3.83	0.82

Real Fuel Saving %	23.03
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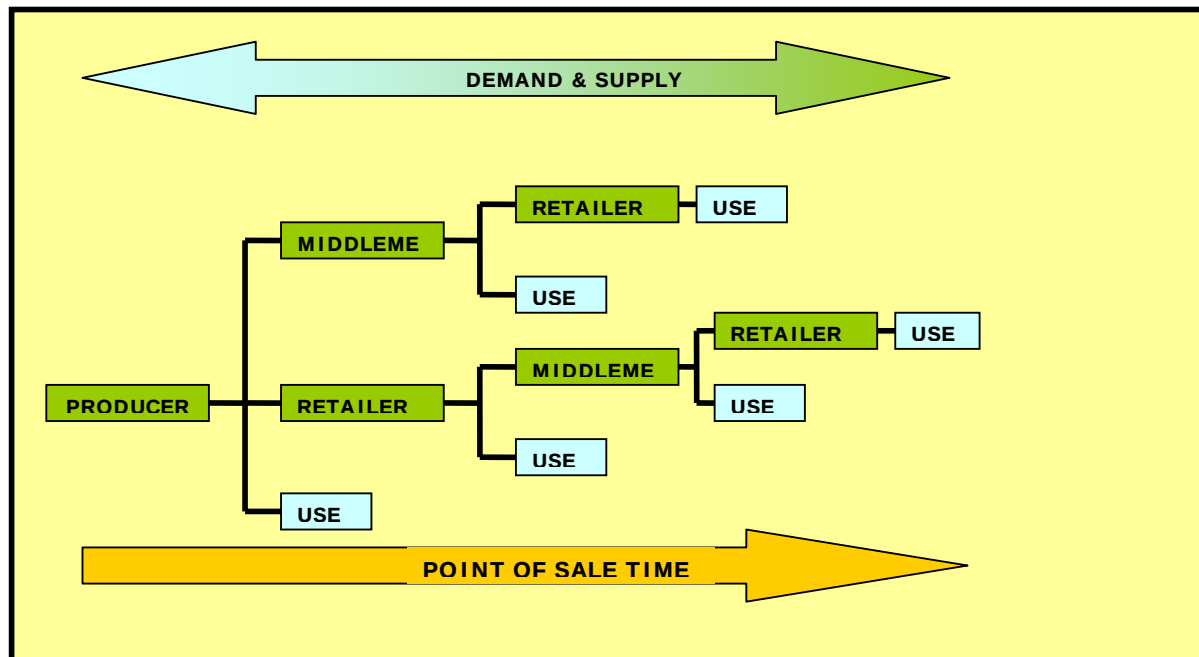
Total Fuel	1352.21
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APPENDIX 5: POST TIME CALCULATION

BACKGROUND: SUPPLY CHAIN OF NLS

Figure 9 below illustrates that the supply chain of the NLS consists of stove producers, middlemen, retailers and end users.

Figure 9: Supply chain of NLS



Stove units are moved through the chain by user demand and by the need to turn over stock in order to generate revenue. Evidence of such demand is reflected in the longevity of the NLS project (which began in 1997) and the observable growth in market share (see Figures 2 and 3). 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 stoves can take before they reach they are sold to the end user. Two generalisations can be made about the supply chain:

1. the further along the supply chain the stoves travel, the greater the time lapse between production and use
2. the further down the supply chain the stove is purchased, the higher the cost of the stove.

There is a vested interest for all links in the supply chain to minimise the time lapse from production to end use (POST); in the case of producers and distributors, to realise a return on their initial investment and for end users, to minimise the price paid for a stove.

Therefore, the POST is not an open-ended time period but is necessarily limited by constraining factors. Of the whole NLS supply chain, the majority of stoves are moved from the retailers to the users. Consequently, the time lapse between production and final use is a good estimate for the POST. The methodology is outlined in the next paragraph.

RESEARCH METHODOLOGY

One aspect of GERES' quality control system for the NLS is the quality control labels ("QC labels") that are provided to certified NLS stove producers. The QC label has two primary purposes:

1. To inform potential buyers that the product meets the quality standards of the stove as set by GERES
2. To trace the stove back to the producers.

The QC label contains a unique number, which is linked to the date on which the producer obtained the label. This means that the POST time can be determined by visiting retailers and recording the point of sale (the moment the stove is bought by the end-user). This was achieved through the following strategy:

1. The monitoring team visited 44 shops in five provinces throughout 2008 and recorded the unique number of the QC labels of the NLS sold.
2. The QC label numbers of the sold NLS stoves were traced back to the moment the labels were obtained by the producers.

The eventual sample size was 535 stoves (out of a total of 244,102). This sample size returns a confidence level of 95.7%. The distribution of the sample throughout the provinces is outlined in Table 15.

Table 15: Distribution of sample used to calculate POST time

Province	Survey period in 2008	Number of retailers surveyed	Sample size (number of NLS)
Kampong Chnang	17-29 May	12	104
Siem Reap	17-22 August	11	128
Kandal	10 March -25 April	5	103
Battambang	16-27 May	14	100
Phnom Penh	7-26 March	2	95
Total		44	535

The representativeness of the chosen sample size for the total population of NLS disseminated in 2008 is ensured by the application of the Yamane formula (Yamane, 1963).

$$n = \frac{N}{1 + N(e)^2}$$

Where:

N = total population

E = desired level of precision

Monitoring of stove production for 2008 gave a total population of stove units sold of 244,102 (GERES, 2008). The sample size necessary for a range of confidence levels are illustrated in Table 16 below.

Table 16: Sample sizes and corresponding precision and confidence levels

Sample size	Precision level	Confidence %
100	0.1	90
123	0.09	91
156	0.08	92
204	0.07	93
277	0.06	94
399	0.05	95
623	0.04	96
1103	0.03	97
2462	0.02	98
9415	0.01	99
244102	0	100

Table 17 below indicates that a precision of 95% can be obtained with a sample size of 400. These figures correspond to published tables which give generic samples sizes needed when the size of population being studied is known. The table shows that for any population size 400 samples are required for any population over 100,000.

Table 17²²: Sample sizes and corresponding precision levels

Size of Population	Sample Size (n) for Precision (e) of:			
	± 3 %	± 5 %	± 7 %	± 10 %
1,000	a	286	169	91
5,000	909	370	196	98
10,000	1,000	385	200	99
20,000	1,053	392	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

In the case of the NLS project, a sample size of 535 was collected from a total population of 224,102. According to the Yamane formula this will give confidence level of 95,7% for the results contained within the sample size.

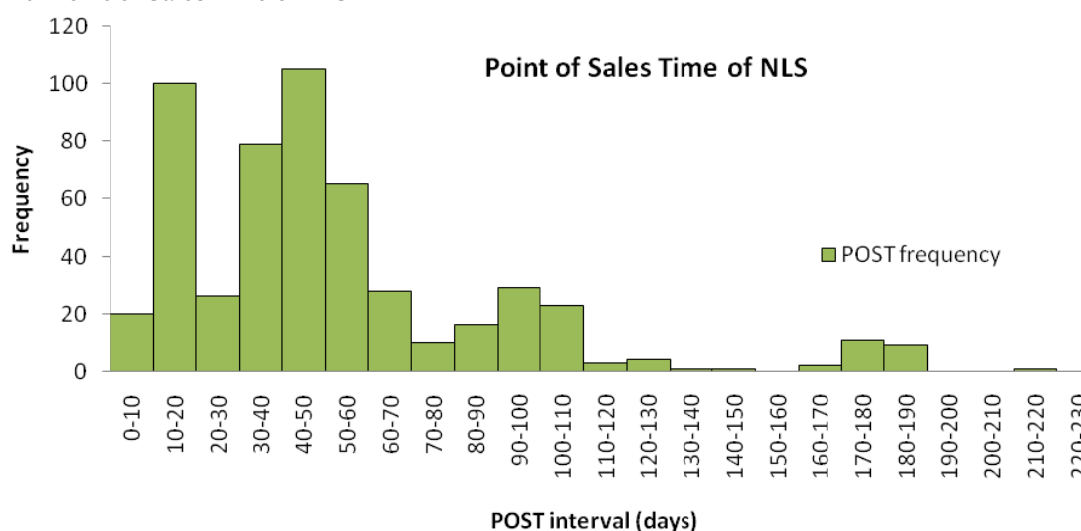
RESULTS

The average POST in the 5 provinces is 53.4 days with a standard deviation (SD) of 40.7 days. Table 18 below lists the average POSTs per province.

Table 18: Sample sizes and average POSTS in surveyed provinces

Province	Average POST (days) ²³	Sample size
Kampong Chnang	34.5 (18.6)	104
Siem Reap	60.7 (41.3)	128
Kandal	60.2 (40.7)	103
Battambang	65.0 (62.6)	100
Phnom Penh	45.4 (7.0)	95
Average	53.4 (40.7)	535

The results show that in most provinces, the SD is very large. The SD is directly influenced by both the frequency of each quoted POST and the actual POST in days. To understand the effect of both influences on the SD, a histogram is depicted showing the POST frequency distribution (see Figure 10 below). The large value of the SDs can be explained by the occurrence of extreme values in the number of POST days

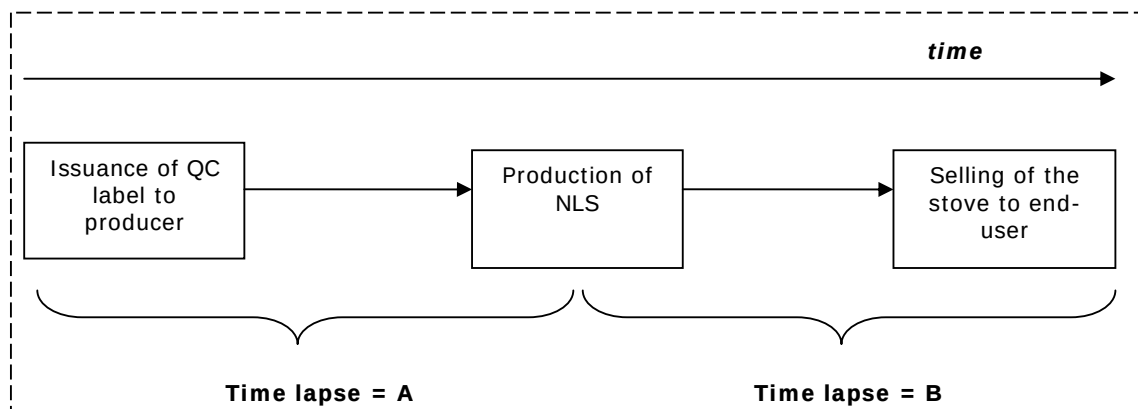
Figure 10: Point of Sales Time of NLS

²² University of Florida, 2007

²³ Standard deviation is in parenthesis

The average POST of 53.4 days is a conservative estimation because the average POST reflects the time lapse between the issuance of the QC label to the producer and the point of sale to the end-user, rather than the time lapse between the **actual point of production** and the point of sale to the end-user. Figure 11 below illustrates the time expenditure between the label issuance, label application and point of sale.

Figure 11: Time lapse between label issuance, application and POST



Total time (C) = A + B

Actual POST = B (time lapse between NLS production and point of sale)

Hence:

Actual POST = C – A, where C is the obtained average POST value of 53.4 days.

MAINTAINING A CONSERVATIVE APPROACH

The obtained POST value is conservative, since it included the time lapse between the point at which the producers obtain the QC label and the point at which the producers label the produced stove. Producers generally apply labels in batches, rather than on a stove-by-stove basis, which means the delay between receiving and issuing the label could be in the order of weeks (since labels are issued monthly).

The assumption that the time lapse is in the order of weeks is further supported by the occurrence of extreme POST values, as shown in Figure 9. The extreme POST times, which skew the calculation of average POST, number 100 days or more and likely to reflect a very long time lapse between the obtainment of the QC labels and the labeling of the NLS. This could result from a number of situations, such as misplacement of the labels by producers, or using new batches of labels before using leftover labels from the previous month.

Finally, a proportion of the stoves are not sold by retailers; rather they are sold closer to the point of production, i.e. directly from the producers or a middleman. These cases were not incorporated in the calculations due to monitoring limitations.

APPENDIX 6: TRANSPORT EMISSIONS

In order to calculate the GHG emissions related to transport for NLS monitoring activities, GERES undertook the following:

1. Calculate average monthly price of diesel and gasoline, based on randomly selected receipts for each month of 2009 (see Table 19).

Table 19: Fuel prices randomly selected from QCM accounting records, 2009

Date	Ref #	Diesel in USD / L	Ref #	Gasoline in USD / L
31-Jan-09	GJ308	0.71	GJ308	0.72
27-Feb-09	GJ335	0.71	GJ332	0.73
31-Mar-09	GJ359	0.69	GJ351	0.77
24-Apr-09	GJ375	0.68	GJ375	0.77
29-May-09	GJ402	0.75	GL402	0.81
30-Jun-09	GJ439	0.65	GJ439	0.87
31-Jul-09	GJ482	0.79	GL477	0.93
31-Aug-09	GJ508	0.79	GJ508	0.94
30-Sep-09	GJ533	0.81	GJ537	1.00
30-Oct-09	GJ564	0.81	GJ564	0.94
25-Nov-09	GJ603	0.81	GJ603	1.00
24-Dec-09	GJ638	0.83	GJ638	0.96

Table 20: Average fuel price, 2009

Fuel	Average monthly price (USD / L)
Diesel	0.75
Gasoline	0.87

2. To calculate total consumption of each fuel, the equation below is applied. Table 21 outlines the sources of data used in the equation and Table 22 outlines the findings of the calculation.

$$E = C * F * NCV * EF$$

Where:

E = Total annual CO₂ emissions from transportation

C = Annual fuel consumption in litres (diesel or gasoline)

F = Factor to convert litres of fuel to tonnes of fuel (diesel or gasoline)

NCV = Net Calorific Value in TJ/t (diesel or gasoline)

EF = Emissions Factor in t/TJ (diesel or gasoline)

Table 21: Sources of data for transportation emissions calculation

	Value		Source
	Diesel	Gasoline	
C	4,073.77 litres	985.01 litres	GERES Cambodia Finance Department records
F	1,185 litres/ tonne	1,350 litres/ tonne	IEA/ OECD, 2004, <i>Energy Statistics Manual</i> .
NCV	0.0434 TJ/t	0.0448 TJ/t	IEA/ OECD, 2004, <i>Energy Statistics Manual</i> .
EF	69.3 TJ/t	74.1 TJ/t	IPCC, 2006, <i>2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 3: Mobile Combustion</i> .

Table 22: Transport emissions from NLS monitoring, 2009

Month	Diesel consumption (\$)	Gasoline consumption (\$)	Diesel consumption (t)	Gasoline consumption (t)	Diesel emissions (t)	Gasoline emissions (t)	Total GHG emissions (t)
Jan	112	81.02	0.13	0.07	0.38	0.23	0.61
Feb	27	8	0.03	0.01	0.09	0.02	0.11
Mar	178	25.97	0.20	0.02	0.60	0.07	0.67
Apr	121	29.42	0.14	0.03	0.41	0.08	0.49
May	223.57	66.42	0.25	0.06	0.75	0.19	0.94
Jun	303.5	48.98	0.34	0.04	1.02	0.14	1.16
Jul	501	52	0.56	0.04	1.69	0.15	1.84
Aug	363.88	65.63	0.41	0.06	1.23	0.19	1.41
Sep	270	93.77	0.30	0.08	0.91	0.26	1.17
Oct	341.56	127.44	0.38	0.11	1.15	0.36	1.51
Nov	221	183.81	0.25	0.16	0.75	0.52	1.26
Dec	403	74.5	0.45	0.06	1.36	0.21	1.57
	\$3065.51	\$856.96	3.44	0.73	10.33	2.42	12.75

APPENDIX 7: DIAGNOSTIC / CORRECTIVE ACTION PROCEDURES

QC PERFORMANCE TRACKING SYSTEM

Figure 12: Chart tracking QC performance for NLS producers

	Results								
Producer	Stove dimension Test				AWBT				Next action
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
P1									LABEL
P2									Formal notice delivered
etc.									
P 31									
V : pass	X : fail								

PHYSICAL QC

Figure 13: Physical QC Corrective Action Procedure

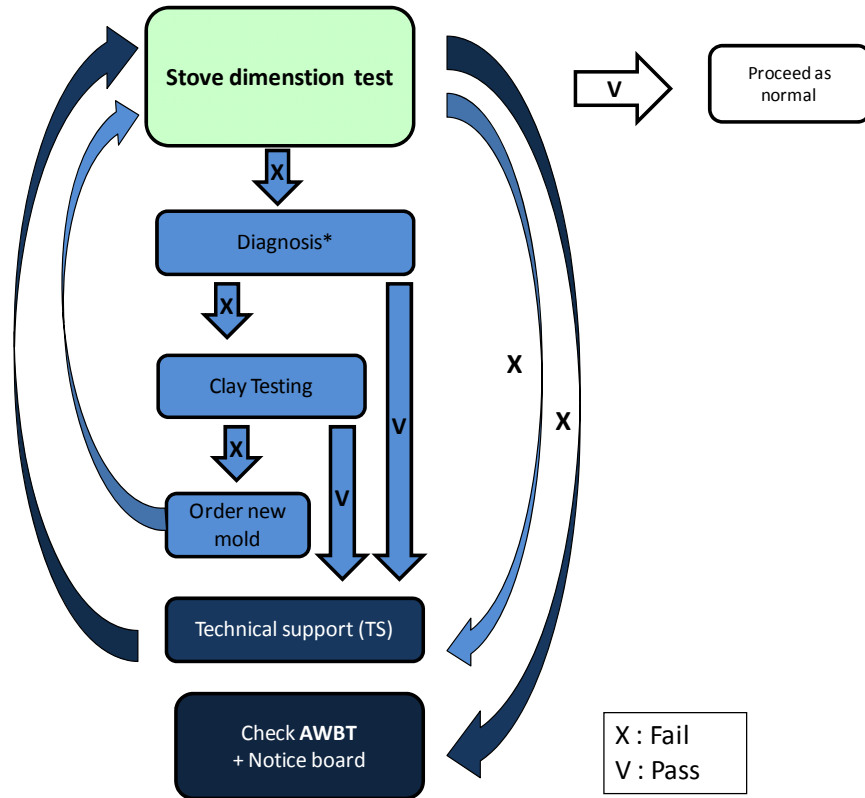
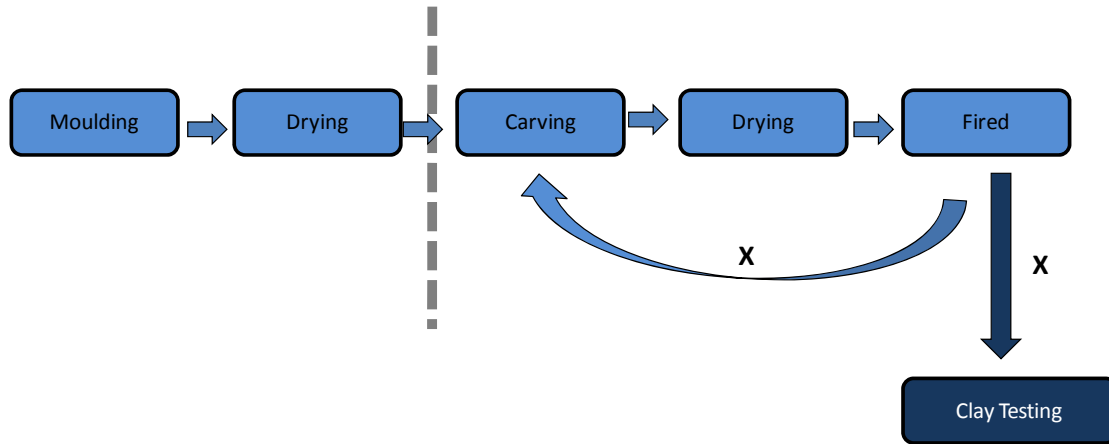
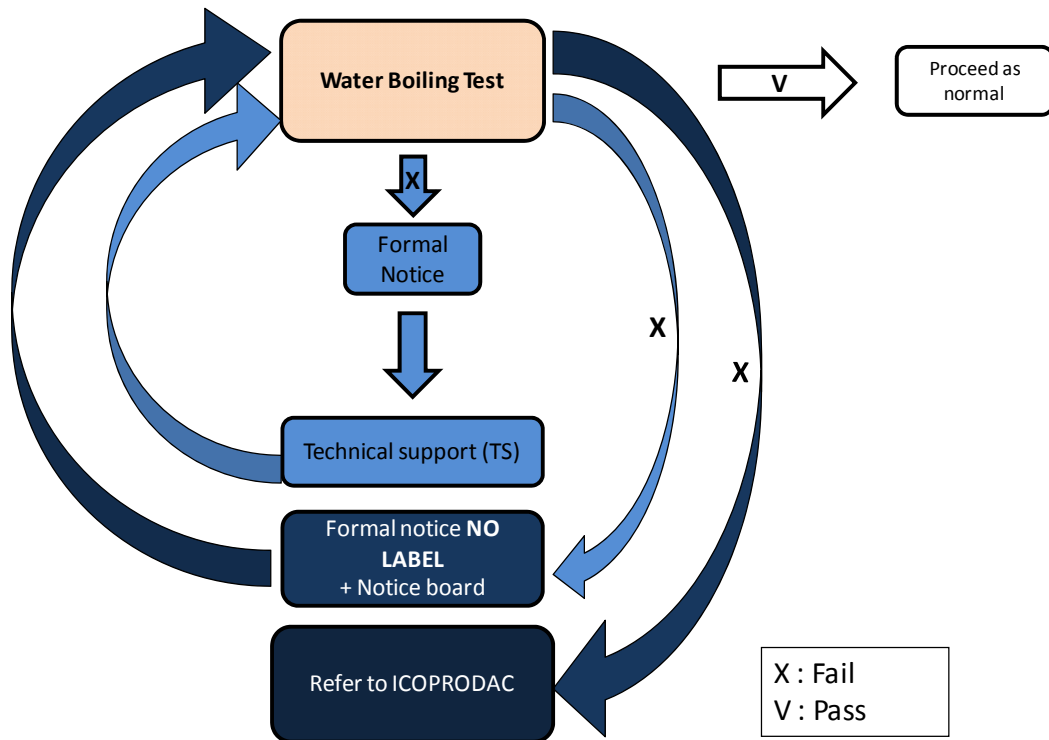


Figure 14: Physical QC Diagnostic Procedure



PERFORMANCE QC

Figure 15: Performance QC Corrective Action Procedure



MONITORING

Figure 16: Monitoring Corrective Action Procedure

