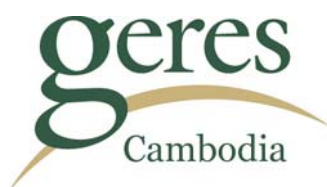


FUEL-WOOD SAVING WITH IMPROVED COOK-STOVES IN CAMBODIA MONITORING REPORT 1ST JANUARY - 31ST DECEMBER 2011



Document Prepared By Kimberley Buss

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1 PROJECT DETAILS

1.1 Summary Description of Project

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.

1.2 Sectoral Scope and Project Type

UNFCCC category: Type II [Energy Efficiency Improvement Projects]

VCS Sectoral Scope 3: Energy demand

1.3 Project Proponent

Groupe Energies Renouvelables, Environnement et Solidarités (GERES) – Cambodia#350, Street 350, Boeung Keng Kang 3, Chamkarmorn, Phnom Penh, Cambodia, P.O Box: 2528

Tel: +855-23-986-891
Fax: +855-23-221-314

1.4 Other Entities Involved in the Project

Improved Cooking Stove Producers Distributors Association of Cambodia (ICOPRODAC)

1.5 Project Start Date

1st January 2003

1.6 Project Crediting Period

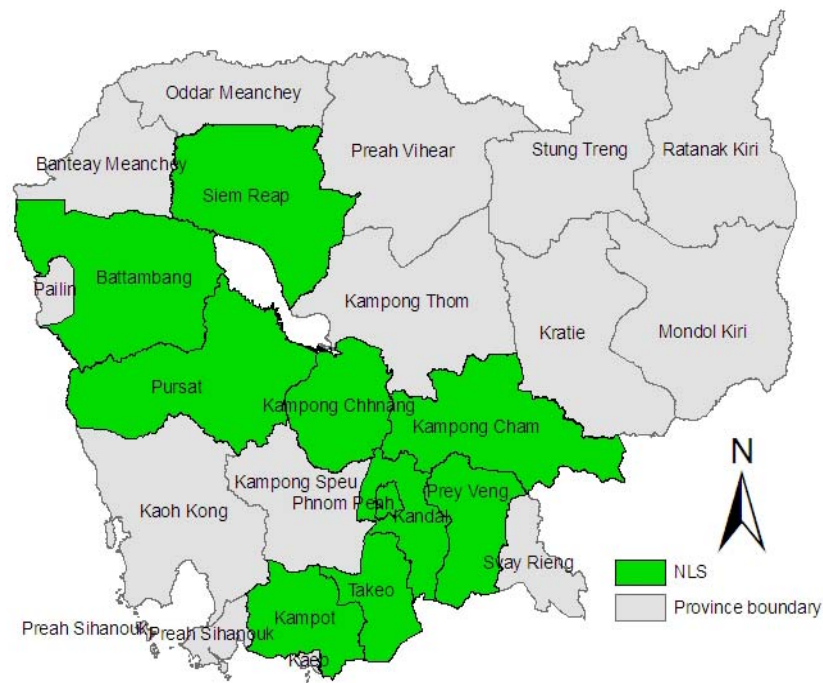
10 years

10th May 2003 – 9th May 2013

1.7 Project Location

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 and one city – Phnom Penh. The nine provinces are Kandal, Kampot, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham, Kompong Chhnang and Pursat (see Figure 1 below).

Figure 1: Map of New Lao Stove Production in Cambodia, 2011



1.8 Title and Reference of Methodology

Title: "Fuel-Wood Saving with Improved Cookstoves in Cambodia"

Methodology: **Voluntary Emission Reductions – Improved Efficiency in Use of Non-Renewable Biomass** as issued by the Climate Care Trust, based on modifications of proposed methodology SSC.II.G. by the Joanneum Institute.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

This is the sixth verification of the project activity (see Table 1 below). This monitoring report covers the period 1st January 2011 – 31st December 2011.

Table 1: Summary of validation & verifications for NLS project

	Period Covered	Date Completed
Validation	2003 - 2012	07/06/07
1st Verification	May 10 th 2003 - Jan 9 th 2007	07/06/07
2nd Verification	Jan 10 th 2007 – Jan 9 th 2008	18/09/08
3th Verification	Jan 10 th 2008 – Dec 31 st 2008	20/08/09
4th Verification	Jan 1 st 2009 – Dec 31 st 2009	28/07/2010
5th Verification	Jan 1 st 2010 – Dec 31 st 2010	14/06/2011
6th Verification	Jan 1 st 2011 – Dec 31 st 2011	

The monitoring parameters that have been updated since the last verification are summarised in Table 2 below. Stove lifetime and equipment ratio were updated based on the findings of the biennial National User Survey¹, conducted in August 2011. Monthly NLS sales and units in use are summarised in Table 3.

Table 2: Updated parameters (compared to previous verification)

Number of NLS sold	356,436
Total number of NLS in use	48,4274
Number of producers	34
Stove lifetime	1.5 years
Equipment ratio	1.23

Table 3: Summary of stoves sold and in use, 1st January - 31st December 2011

Month #	Date		Number of NLS sold	Cumulative number of NLS in use
93	01-Jan-11	31-Jan-11	31,125	693,399
94	01-Feb-11	28-Feb-11	32,512	459,801
95	01-Mar-11	31-Mar-11	31,258	463,546
96	01-Apr-11	30-Apr-11	28,365	472,066
97	01-May-11	31-May-11	27,756	479,058
98	01-Jun-11	30-Jun-11	28,171	478,506

¹ See Appendix 2 for more information on the National User Survey.

99	01-Jul-11	31-Jul-11	25,273	482,319
100	01-Aug-11	31-Aug-11	32,349	476,951
101	01-Sep-11	30-Sep-11	27,499	479,201
102	01-Oct-11	31-Oct-11	27,292	483,548
103	01-Nov-11	30-Nov-11	29,944	488,496
104	01-Dec-11	31-Dec-11	34,892	484,274
Total			356,436	

2.2 Deviations from the Monitoring Plan

There were no deviations from the Monitoring Plan during the crediting period.

2.3 Grouped Project

Not applicable

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Not applicable, as this is a verification, not a validation.

3.2 Data and Parameters Monitored

Data Unit / 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:	Household Fuel Consumption Test National Stove Users Survey Stove Producer Sales data
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.

Frequency of monitoring/recording:	Household Fuel Consumption Test data – twice per year National Stove Users Survey – once every two years (biennial) Stove Producer Sales data – monthly
Value monitored:	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.
Monitoring equipment:	N/A
QA/QC procedures to be applied:	GERES Cambodia Monitoring Unit will take samples from producers yearly to ensure production standards meet standardised dimensions.
Calculation method:	N/A
Any comment:	N/A

Data Unit / Parameter:	Representative samples of the moisture content of the biomass at the time it is burnt
Data unit:	%
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:	Household Fuel Consumption Test
Description of measurement methods and procedures to be applied:	Humidity meter
Frequency of monitoring/recording:	Twice per year, as part of the Household Fuel Consumption Tests
Value monitored:	Ensure accurate reporting of fuel savings
Monitoring equipment:	Humidity meter
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.
Calculation method:	Humidity meter

Any comment:	Moisture content data is not required for calculations because the humidity of the fuel is automatically taken account of through the HFCT and uniformity of the fuel used for both NLS and TLS HFCTs. Only humidity of wood is checked and only for the purpose of ensuring the moisture content for NLS and TLS HFCTs is comparable. Moisture content for charcoal is usually more uniform – differences in wood species provides scopes for greater discrepancy in moisture content.
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Data Unit / 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 currently uses a conservative estimate of 1.5 lifespan per stove, based on survey data from households. After that period the stove is assumed to be replaced, these stoves are deducted from the monthly stove sales. 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:	National Stove User Survey Stove Producer Sales data
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.
Frequency of monitoring/recording:	National Stove User Survey – every two years (biennially) Stove Producer Sales data – monthly

Value monitored:	Ensure accuracy of emissions reductions
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Internal validation of stove producer's sales data.
Calculation method:	N/A
Any comment:	N/A

Data Unit / 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:	Household Fuel Consumption Test (HFCT)
Description of measurement methods and procedures to be applied:	Field tests using the HFCT protocol, using both TLS and NLS. The HFCTs are conducted with both wood and charcoal during both rainy and dry seasons to provide real field data on fuel saving.
Frequency of monitoring/recording:	Twice per year
Value monitored:	Quality control of stove production
Monitoring equipment:	An accurate balance (simple 10 kg capacity and 10 g accuracy which is available in villages; Wood moisture meter if wood cannot be distributed. 25 NLS and 25 TLS 5kg of charcoal and 5kg of fuelwood 10-litre containers (for water)
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
Calculation method:	$\text{FFS} = \frac{\text{FCTS} - \text{FCICS}}{\text{FCTS}}$ FFS Field Fuel Saving FCTS fuel consumption for cooking in traditional

	stove FCICS fuel consumption for cooking with improved cook stove. The FFS can be calculated for each family and then an average is calculated representing all the families.
Any comment:	N/A

Data Unit / Parameter:	Ensure replaced low efficiency appliances are not used within the boundary
Data unit:	N/A
Description:	Bi-annual survey data on user behaviour in addition the Stove sales data demonstrates the increasing market share of the NLS over time.
Source of data:	Stove sales data National Stove User Surveys
Description of measurement methods and procedures to be applied:	User surveys will establish the percentage of stove users using traditional and NLS simultaneously.
Frequency of monitoring/recording:	Stove sales data – monthly National Stove User Surveys – every two years (biennially)
Value monitored:	Ensure the accuracy of emissions reductions calculations
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Statistical analysis External evaluation
Calculation method:	N/A
Any comment:	N/A

Data Unit / 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:	Independent accredited literature National Stove User surveys
Description of measurement methods and procedures to be applied:	Literature review Survey of representative sample of stove users in Cambodia (National Stove User Survey)
Frequency of monitoring/recording:	Independent accredited literature – annually National Stove User surveys – every two years (biennially)
Value monitored:	Validity of emission reductions from non-renewable biomass
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Peer reviewed published reports.
Calculation method:	N/A
Any comment:	N/A

Data Unit / Parameter:	Greater use of non-renewable biomass outside the project boundary does not exist
Data unit:	%
Description:	Default factor 15% as stipulated in the methodology
Source of data:	Methodology
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording:	N/A
Value monitored:	Conservative factor applied to take account of leakage
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	N/A
Any comment:	N/A

Data Unit / Parameter:	Wider social and economic impact of the projects will be monitored; on-going analysis will be made
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	of its contribution positive or otherwise to sustainable development in the area.
Data unit:	N/A
Description:	Survey data designed to assess 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:	National Stove User Survey
Description of measurement methods and procedures to be applied:	Survey of representative sample of stove users in Cambodia (National Stove User Survey)
Frequency of monitoring/recording:	Every two years (biennially)
Value monitored:	Sustainable development benefits of Project Activity.
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Statistical analysis External evaluation
Calculation method:	N/A
Any comment:	N/A

3.3 Description of the Monitoring Plan

3.3.1 Ex-ante parameters

3.3.1.1 Fuel saving tests

Fuel saving is considered an ex-ante parameter because during validation (in 2007), the DOE (Det Norske Veritas) advised GERES to continue using the fuel saving figures in the PDD (in order to maintain consistency) and simply use subsequent fuel saving tests to verify that the PDD values are still valid.

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 4 below, because they are the most conservative (higher moisture content in biomass fuel during the wet season reduces combustion efficiency).

Table 4: Fuel savings achieved during HFCTs in wet season 2011²

Fuel type	Fuel saving	
	PDD (2003-2007)	2011
Charcoal	21.2%	19.7%
Wood	20.89%	20.0%

² See Appendix 3 for more detailed results of 2009 HFCTs.

3.3.1.2 Wood to charcoal conversion

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

3.3.1.3 NCV of biomass;

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

3.3.1.4 EF CO₂, biomass;

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

3.3.2 Ex-post parameters

3.3.2.1 Stoves produced

The quantity of stoves produced is calculated on a monthly basis. Every month, Quality Control and Monitoring (QCM) staff of the NLS team 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 centre 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 5 below identifies the producer included in this verification, as well as their gender and location.

Table 5: Producers included in verification

	Name	Nick name	Sex	Village	Commune	District	Province
1	Dul Sam Oun	<i>Sim Vann</i>	Male	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
2	Ris Sarath	<i>Mab</i>	Male	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
3	Vann Tola	<i>Pheak</i>	Female	Prey Moan	Sre Thmey	Rolear Bi'ear	KCN
4	Khin Pum		Male	Chamka Samrong 2	Chamka Samrong	Battambang	BTB
5	Mok Soy		Male	Kandach	Chong Ampil	Kanh Chreach	PRV
6	Sim Seth		Male	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
7	Phon Somen	<i>Hing</i>	Male	Banh Chhkol	Chreybak	Rolear Bi'ear	KCN
8	Mak Samith		Male	Tuol Rokar	Chak Angrekrom	Meanchey	PNH

9	Leng Sophat	<i>Sor Hout</i>	Male	Slaket	Slaket	Battambang	BTB
10	Nhek Sakun	<i>Mil</i>	Male	Chamka Samrong1	Chamka Samrong	Battambang	BTB
11	Sim Mom		Female	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
12	Sim Sour		Female	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
13	Vong Siengleng	<i>Chab</i>	Male	Wat Svay	Sala Komroek	Siem Reap	SRP
14	Meng Chhun		Male	Kor Koh	Trapaing Preah	Prey Chhor	KCM
15	Yong Sunhai		Male	Kampong Kreng	Kampong Kreng	Toek Chhou	KPT
16	Kong Sok		Male	Tadou	Rokar Knong	Dounkeo	TKO
17	Sun Tha		Female	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN
18	Khoem Tim		Female	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN
19	Phon Sopha		Male	Banh Chhkol	Chreybak	Rolear Bi'ear	KCN
20	Kong Sophear		Male	Chamkar Tamao	Sre Thmey	Rolear Bi'ear	KCN
21	Mom Samean	<i>Hul</i>	Male	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
22	Long Ty		Female	Treang Chheng	Sre Thmey	Rolear Bi'ear	KCN
23	Phun Sopha		Male	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN
24	Keo Chanthear	<i>Mom</i>	Female	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN
25	Thon Chamrern		Male	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN
26	Meas Sim		Male	Ou Thkov	Kampong Thkov	Krolanh	SRP
27	Phai Horn		Male	Toul Thkov	Pratheath	Oraing Oev	KCM
28	Sor Phy		Female	Slaket	Slaket	Battambang	BTB
29	Khin Sokchenda	<i>Khmok</i>	Male	Kroper Chheng	Phnom Sampov	Banon	BTB
30	Dourng Saronn		Male	Kdey Tnoat	Sre Thmey	Rolear Bi'ear	KCN
31	Ven Chomraeun		Male	Chamkar Tamao	Sre Thmey	Rolear Bi'ear	KCN
32	Yem Yun		Male	Punleu	Lumhach	Angsnoul	KND
33	Kem Sokha	<i>Takuok</i>	Male	Banh Chhkol	Chreybak	Rolear Bi'ear	KCN
34	DATe		Male	Andong Russey	Sre Thmey	Rolear Bi'ear	KCN

3.3.2.2 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 by 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 days³, 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.

3.3.3 Stove lifetime

The lifespan adopted is 1.5 years or 18 months. GERES suspects the decrease in stove lifetime is due to scaling-back of GERES awareness-raising activities. It is very important that NLS users do not move the stove around too much, as this decreases stove lifetime. In the early stages of the project, GERES invested more time and effort in educating users about the appropriate operation of the NLS but in recent years, such activities have decreased.

3.3.4 Equipment ratio: stoves per family.

Equipment ratio refers to the number of stoves used per family. Results from the National User Survey (2011) identified an equipment ratio of 1.23 (see Table 6). This ratio is lower than the previously calculated ratio of 1.6, probably due to the fact that LPG is becoming more common as a cooking fuel in urban and peri-urban areas.

Table 6: Equipment ratio calculation

Number of stoves	Frequency	Total Stoves	Equipment Ratio
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³ See Appendix 4 for further detail on POST calculation

1	565	565	
2	137	274	
3	12	36	
Total	714	875	1.23

3.3.5 Transport Emissions

Transportation emissions are generated from collecting producer and retailer data, quality control activities and conducting household fuel consumption 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 – 31st December 2011. 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 monthly prices for gasoline and diesel in 2011 (obtained from random selection of fuel receipts from GERES' records – see Appendix 4 for further information). **In this crediting period, just over 16tCO₂e were emitted from transport associated with monitoring of the NLS project.**

3.3.6 Quality Assurance Measures

Samples of NLS are collected every four 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 stoves⁴. 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 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.

⁴ 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.

3.3.7 Organisational structure and responsibilities

The structure of the NLS team is divided into three fields (see Figure 2):

1. Performance QC
2. Physical QC
3. Monitoring

The department is managed by the NLS Project Manager (Mr. Sokhanaro HEP). Three team leaders represent the three areas of the NLS project's operation. The members of the team perform tasks for each of the three work areas on a rotational basis, in order to diversify the staff's skills and provide variety in their work tasks. An Executive Assistant was appointed to relieve the administrative burden on the Team Leaders. Table 7 identified all staff involved in monitoring/ quality control of the NLS project in 2011.

Figure 2: Structure and activities of the NLS team – Quality Control and Monitoring (QCM)

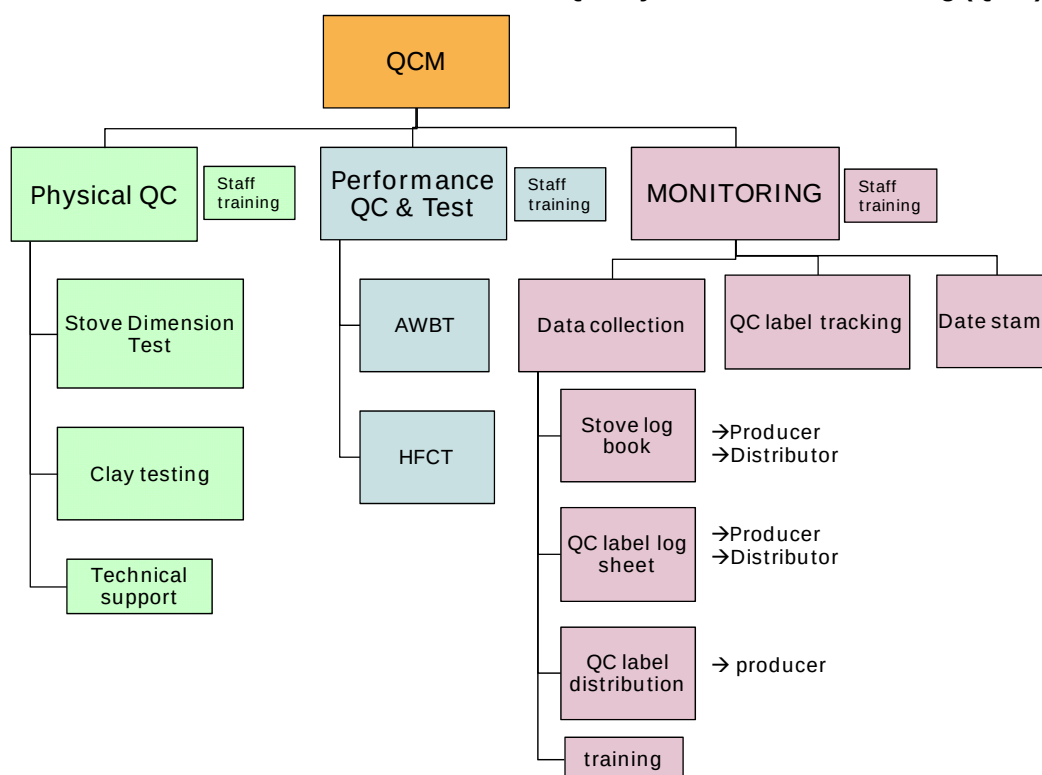


Table 7: NLS Project staffing

Position	Acronym	Name
NLS Project Manager	HSO	HEP Sokhannaro
NLS Project Assistant	HSN	HENG Samnang
NLS Monitoring Team Leader	SSL	SAN Saly
NLS Monitoring Staff (PNH)	NVN	NEANG Vanna
NLS Monitoring Staff (PNH)	DMH	DEM Hoeung

NLS Monitoring Staff (PNH)	LMH	LY Math
NLS Monitoring Staff (PNH)	VAT	VANN Tin
NLS Monitoring Staff (KCN)	KSP	KHIN Sophan
NLS Monitoring Staff (KCN)	NSA	NGET Sereiratana
NLS Monitoring Staff (KCN)	TSN	TEY Sarin
NLS Monitoring Staff (BTB)	CCY	CHY Chanthy
Intern – data entry	SSM	SA Sreymom
NLS Quality Control (Physical) Team Leader	SMR	SREY Makara
Quality Control (Physical) Staff	THA	TU Tha
Quality Control (Physical) Staff	MBA	MEAS Bona
NLS Testing (Performance Quality Control) Team Leader	CTL	CHHEANG Tol
Testing (Performance Quality Control) Staff	TCN	THAN Channy
Testing (Performance Quality Control) Staff	KSA	KONG Samath
Testing (Performance Quality Control) Staff	DET	KEM Tim
Testing (Performance Quality Control) Staff	SCR	SRENG Chamroen

3.3.8 Data collection

3.3.8.1 Monitoring

Frequency	Once per month (at the end of the month)
Sample size	Every accredited NLS producer
Tools/ equipment	- Date stamp - QC labels - Log sheets - Receipt book
Procedure	- Visiting the producer: - Make a copy of the stove producer's log book. - Cross check the stove producer's log book with the QC label logsheet. - For every corresponding entry in the QC label log sheet and stove producer's logbook, award 100 Riel. Issue receipt. - Exchange current date stamp with previous month's date stamp. - Issue new batch of QC labels. - Receive 20,000 Riel payment for ICOPRODAC membership and issue receipt. - Managing the data: - The following data into the corresponding spreadsheets: - stove sales data - financial incentive payment records - QC label issuance - ICOPRODAC contribution - Place hard copies of producer logbooks in relevant folders and file in the QCM Unit office.

3.3.8.2 Adapted Water Boiling Test (AWBT)

Frequency	Once every 4 months for each producer
Sample size	3 stoves for NLS A1 tests 2 stoves for NLS A2 tests 2 stoves for NLS A3 tests
Tools and equipment	- A digital watch with second precision; - An accurate platform scale (ratio between precision of the measure and maximum weight lower or equal at 1%), a simple balance almost available in all villages; - Digital thermometer with thermocouple probes if possible or other type of mercury glass thermometer able to indicate temperature in water until 100°C (accuracy of 1 °C); - A form for recording data (see annex I for record sheet form); - Cylindrical aluminum pots/pans with flat/round bottom; diameter of the pot rim and bottom part 23,8 cm, height: 11 cm and thickness of pot: 2 mm for 3 liters water Two frame supports with thermocouple probes to permit measurement of water temperature, 1 cm above the internal bottom of pot; - Around 15 grams of local resin (from <i>Dipterocarpus alatus</i>) is used traditionally as fire starter and let it burn for 3 minutes ignition; - For charcoal stove we use 400 g of charcoal for the above cooking pots and let combustion process maintain high power phase without intervention.
Procedure	- Weigh the recommended amount of charcoal (400 grams) for 23.8 cm diameter pot. - Note the room temperature for comparative information. - Install the cold and clean stove in a room and protect it from the wind in the direction to the fire door. - Place two similar pots above potholes of two comparing stoves with probe instrumented pot lids 1 cm above the internal bottom of the pot. - Ignite the charcoal with a fixed quantity of resin (15g); - Manage charcoal in the stove in such manner to obtain the maximal power output as possible during the high power phase, to reach as quickly as possible the boiling point. Boiling point is reached when temperature is stabilized, around 99 °C, after 10 seconds. - Record the Time to Boil - Maintain the high power phase after reaching the water boiling point in pot for 5 minutes to respect traditional way of cooking. - Maintain water simmering in the pot in a range of two degrees around boiling point (97-99 °C), avoiding flames to extinguish. - Temperature is recorded at every 3 minutes interval. When all the remaining charcoal is burned and the temperature drop below 97 °C, Total Time Test is recorded. If the range of five degrees is over passed during the simmering period, the test should be rejected. - Weigh the remaining charcoal and water in the pot. - At the end of the test, the maximum charcoal weight has to be less than 20 grams to accept the test. - Using the calculation spreadsheets, calculate Total Time Test (TTT), Useful Power, Useful Energy, Efficiency.

3.3.8.3 Household Fuel Consumption Test (HFCT)

Frequency	Twice per year (once in rainy season and once in dry season)
Sample size	25 households per test
Tools/ equipment	- an accurate balance (simple 10 kg capacity and 10 g accuracy which is available in villages; - wood moisture meter if wood cannot be distributed. 25 NLS and 25 TLS 5kg of charcoal and 5kg of fuelwood 10-litre containers (for water)
Procedure	<i>Day 0</i> - The day before testing commences, provide each household with: - an NLS (or TLS) - sufficient fuel for 1 day of cooking (5kg kg for wood testing and 5kg for charcoal testing). 40 litres of water in a container. - a log sheet for the family to record its menu - Explain the test to the family, especially: - That they must only use the water and fuel supplied for cooking food - That they must only use the stoves provided for cooking their food - How to fill out the log form for recording the meals cooked during the test <i>Day 2 – 7</i> - Visit each household daily. - Note/ measure: - The remaining wood/ charcoal - The remaining water. - Take away the remaining fuel and replace with a fresh 5kg batch - Top-up the water to 40 litres. - Using the calculation spreadsheets, calculate Field Fuel Saving (FFS) and Specific Fuel Consumption (SFC)

3.3.9 Document storage and control

Clear and appropriate document labeling and storage systems are necessary to preserve the audit trail for verification of the NLS project and to track the project's evolution and monitor its success. The file labeling and storage system outlined in Table 8 below is adhered to.

Table 8: Data storage and control

Record name	Format	Location	Duration	Person in charge	
				Directly	Verifier
Data					
Stove sales data	MS Access database	\\192.168.0.2\proj\ICS\NLS\MONITORING TEAM\	Indefinitely	SANN Saly	HEP Sokhanaro
	Photocopies of producer log books	Filing cabinet	2 years after project end date (9th May 2015)		
	Old producer log books	Filing cabinet	2 years after project end date (9th May 2015)		
QC label distribution	Log sheet filled in by producers	Filing cabinet	2 years after project end date (9th May 2015)	SANN Saly	HEP Sokhanaro
	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\MONITORING TEAM\	Indefinitely		
Water boiling test data	Handwritten log sheets	Filing cabinet	2 years after project end date (9th May 2015)	Tol CHHEANG	HEP Sokhanaro
	MS Excel calculation database	\\192.168.0.2\proj\ICS\NLS\PERFORMANCE QC	Indefinitely		
Household fuel consumption test	Handwritten log sheets	Filing cabinet	2 years after project end date (9th May 2015)	Tol CHHEANG	HEP Sokhanaro
	MS Excel calculation spreadsheet	\\192.168.0.2\proj\ICS\NLS\PERFORMANCE QC	Indefinitely		
Stove Dimension Test (shrinkage factor)	Handwritten log sheets	Filing cabinet	2 years after project end date (9th May 2015)	SREY Makara	HEP Sokhanaro
	MS Excel calculation spreadsheet	\\192.168.0.2\proj\ICS\NLS\PHYSICAL QC\	Indefinitely		
Stove Dimension Test (for AWBT)	Handwritten log sheet stickers		Not retained (placed on stoves)	SREY Makara	HEP Sokhanaro
	MS Excel calculation spreadsheet	\\192.168.0.2\proj\ICS\NLS\PHYSICAL QC\	Indefinitely		
SD test sheets for 5-stage QC procedure for new producers	Handwritten log sheets	Filing cabinet	2 years after project end date (9th May 2015)	SREY Makara	HEP Sokhanaro
Copies of fuel	Paper	Filing cabinet	2 years after project end	HENG	HEP

receipts for travel associated with QCM for NLS	photocopies		date (9th May 2015)	Samnang	Sokhanaro
Logsheet for final approval of new producers	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\PHYSICAL QC\	Indefinitely	HEP Sokhanaro	HEP Sokhanaro
Forms					
Water boiling test form	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\PERFORMANCE QC	End of project lifetime (9th May 2013)	CHHEANG Tol	HEP Sokhanaro
SD test form (for AWBT)	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\PHYSICAL QC\	End of project lifetime (9th May 2013)	CHHEANG Tol	HEP Sokhanaro
SD test form (shrinkage factor)	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\PHYSICAL QC\	End of project lifetime (9th May 2013)	SREY Makara	HEP Sokhanaro
HFCT forms	MS Excel spreadsheet	\\192.168.0.2\proj\ICS\NLS\PERFORMANCE QC	End of project lifetime (9th May 2013)	CHHEANG Tol	HEP Sokhanaro
Training attendance sheets	MS Word document	\\192.168.0.2\proj\ICS\NLS\INDUCTION PROGRAMME	End of project lifetime (9th May 2013)	CHHEANG Tol, SREY Makara and SANN Saly	HEP Sokhanaro
Training evaluation sheets	MS Word document	\\192.168.0.2\proj\ICS\NLS\INDUCTION PROGRAMME	End of project lifetime (9th May 2013)	CHHEANG Tol, SREY Makara and SANN Saly	HEP Sokhanaro

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

		No of units sold	Number of units retired	Number of units in use	Biomass wood (t)	Biomass charcoal (t)	Total biomass cons. (t)	Total baseline emissions (tCO ₂)
01-Jan-11	31-Jan-11	31125	262275	693399	21174	108644	129818	226818
01-Feb-11	28-Feb-11	32512	27719	459801	14041	72043	86084	150406
01-Mar-11	31-Mar-11	31258	23686	463546	14155	72630	86785	151631
01-Apr-11	30-Apr-11	28365	23559	472066	14415	73965	88380	154417
01-May-11	31-May-11	27756	28768	479058	14629	75060	89689	156705
01-Jun-11	30-Jun-11	28171	24045	478506	14612	74974	89586	156524
01-Jul-11	31-Jul-11	25273	32830	482319	14728	75571	90299	157771
01-Aug-11	31-Aug-11	32349	24753	476951	14564	74730	89295	156016
01-Sep-11	30-Sep-11	27499	26816	479201	14633	75083	89716	156751
01-Oct-11	31-Oct-11	27292	22501	483548	14766	75764	90530	158173
01-Nov-11	30-Nov-11	29944	32162	488496	14917	76539	91456	159792
01-Dec-11	31-Dec-11	34892	24253	484274	14788	75877	90666	158411
		356436	553367		181423	930879	1112302	1943414

4.2 Project Emissions

		No of units sold	Number of units retired	Number of units in use	Biomass wood (t)	Biomass charcoal (t)	Total biomass cons. (t)	Project emissions (biomass cons.) (tCO ₂)	Transport emissions (tCO ₂)	Total project emissions (tCO ₂)
01-Jan-11	31-Jan-11	31125	262275	693399	16751	85611	102362	178847	2	178849
01-Feb-11	28-Feb-11	32512	27719	459801	11108	56770	67878	118596	0	118596
01-Mar-11	31-Mar-11	31258	23686	463546	11198	57232	68430	119562	2	119563

01-Apr-11	30-Apr-11	28365	23559	472066	11404	58284	69688	121759	1	121760
01-May-11	31-May-11	27756	28768	479058	11573	59147	70720	123562	2	123564
01-Jun-11	30-Jun-11	28171	24045	478506	11560	59079	70639	123420	1	123421
01-Jul-11	31-Jul-11	25273	32830	482319	11652	59550	71202	124403	2	124405
01-Aug-11	31-Aug-11	32349	24753	476951	11522	58887	70409	123019	2	123021
01-Sep-11	30-Sep-11	27499	26816	479201	11576	59165	70741	123599	2	123601
01-Oct-11	31-Oct-11	27292	22501	483548	11681	59702	71383	124721	1	124722
01-Nov-11	30-Nov-11	29944	32162	488496	11801	60313	72114	125997	1	125998
01-Dec-11	31-Dec-11	34892	24253	484274	11699	59791	71490	124908	1	124909
		356436	553367	5941165	143524	733533	877056	1532393	16	1532409

4.3 Leakage

		Project emissions (biomass) (tCO₂)	ERs (biomass) (tCO₂)	Leakage (15%) (tCO₂)
01-Jan-11	31-Jan-11	178847	47971	7196
01-Feb-11	28-Feb-11	118596	31810	4771
01-Mar-11	31-Mar-11	119562	32069	4810
01-Apr-11	30-Apr-11	121759	32658	4899
01-May-11	31-May-11	123562	33142	4971
01-Jun-11	30-Jun-11	123420	33104	4966
01-Jul-11	31-Jul-11	124403	33368	5005
01-Aug-11	31-Aug-11	123019	32996	4949
01-Sep-11	30-Sep-11	123599	33152	4973
01-Oct-11	31-Oct-11	124721	33453	5018
01-Nov-11	30-Nov-11	125997	33795	5069
01-Dec-11	31-Dec-11	124908	33503	5025
		1532393	411021	61653

4.4 Summary of GHG Emission Reductions and Removals

		Total baseline emissions (tCO2)	Project emissions (biomass) (tCO2)	ERs (biomass) (tCO2)	Leakage (15%) (tCO2)	Project emissions (transport) (tCO2)	Total Ers (tCO2)
01-Jan-11	31-Jan-11	226818	178847	47971	7196	2	40773
01-Feb-11	28-Feb-11	150406	118596	31810	4771	0	27038
01-Mar-11	31-Mar-11	151631	119562	32069	4810	2	27257
01-Apr-11	30-Apr-11	154417	121759	32658	4899	1	27758
01-May-11	31-May-11	156705	123562	33142	4971	2	28169
01-Jun-11	30-Jun-11	156524	123420	33104	4966	1	28137
01-Jul-11	31-Jul-11	157771	124403	33368	5005	2	28361
01-Aug-11	31-Aug-11	156016	123019	32996	4949	2	28045
01-Sep-11	30-Sep-11	156751	123599	33152	4973	2	28178
01-Oct-11	31-Oct-11	158173	124721	33453	5018	1	28434
01-Nov-11	30-Nov-11	159792	125997	33795	5069	1	28725
01-Dec-11	31-Dec-11	158411	124908	33503	5025	1	28477
		1943414	1532393	411021	61653	16	349352

5 ADDITIONAL INFORMATION

5.1 Sustainability of the project

Data from the biennial National User Surveys (2007, 2009 and 2011) and NLS sales data indicate that the NLS 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 (NUS), conducted in August 2011, found that 44% of the urban/peri-urban population use NLS (compared to 41.7% in the 2009 NUS and 31.3% in the 2007 NUS). Furthermore, the percentage of people using TLS decreased from 68.8% in 2007 and 67.9% in 2009, to 63% in 2011. This indicates that users are not switching back to inefficient stove technologies.

Table 9: National User Survey data on number/ proportion of respondents using NLS

	Frequency	Percent
Yes	731	43.9
No	933	56.1
Total	1,664	100

Stove sales data indicate that the NLS is accounting for an increasing proportion of total stoves produced (by production centres that make both TLS and NLS), 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 3 and 4 below illustrate this trend.

Figure 3: Number of NLS and TLS produced by NLS producers, 2003-2011

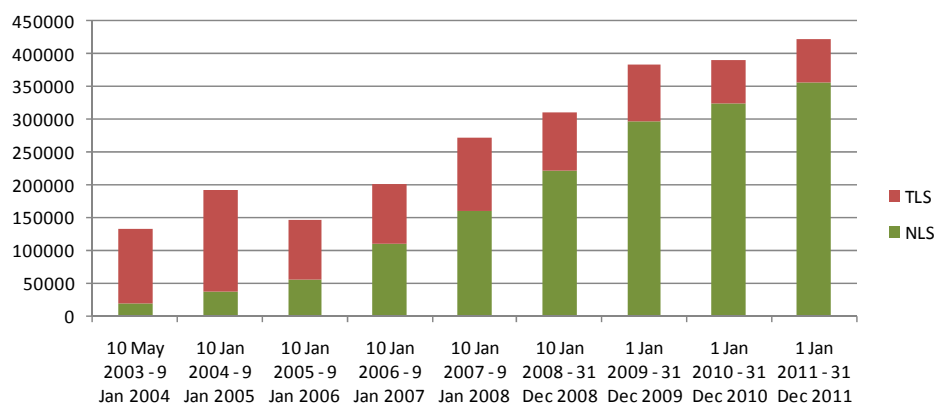
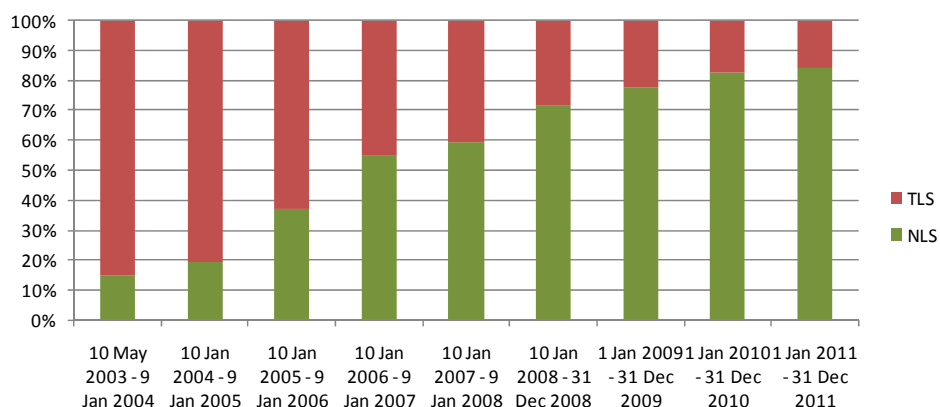


Figure 4: Proportion of NLS and TLS sold by NLS producers, 2003-2011



5.2 Environmental impacts

Aside from the environmental benefits of GHG emission mitigation, the project activity directly contributes to efforts to reduce unsustainable fuel wood consumption. Based on the total amount of wood and charcoal saved by the NLS project, it is estimated that during the 2011 monitoring period, the project saved the equivalent of 1,705 ha of forest⁵ (see Table 10).

Table 10: Biomass saved by NLS project, 1st January - 31st December 2011

Date		Number of units in use	Biomass saving wood (t)	Biomass saving charcoal (t)	Total Biomass saving (t)	Total Biomass saving (m3)	Total Biomass saving (ha)
01-Jan-11	31-Jan-11	693399	4423	23032	27456	45769	199
01-Feb-11	28-Feb-11	461499	2933	15273	18206	30350	132
01-Mar-11	31-Mar-11	468663	2957	15398	18355	30597	133
01-Apr-11	30-Apr-11	472805	3011	15681	18692	31159	135
01-May-11	31-May-11	481523	3056	15913	18969	31621	137
01-Jun-11	30-Jun-11	473601	3052	15894	18947	31584	137
01-Jul-11	31-Jul-11	474560	3077	16021	19098	31836	138
01-Aug-11	31-Aug-11	469036	3043	15843	18885	31482	137
01-Sep-11	30-Sep-11	483337	3057	15917	18974	31630	138
01-Oct-11	31-Oct-11	485255	3085	16062	19147	31917	139
01-Nov-11	30-Nov-11	490465	3116	16226	19342	32244	140
01-Dec-11	31-Dec-11	487750	3089	16086	19175	31965	139
			37899	197346	235246	392154	1705

5.2.1 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.

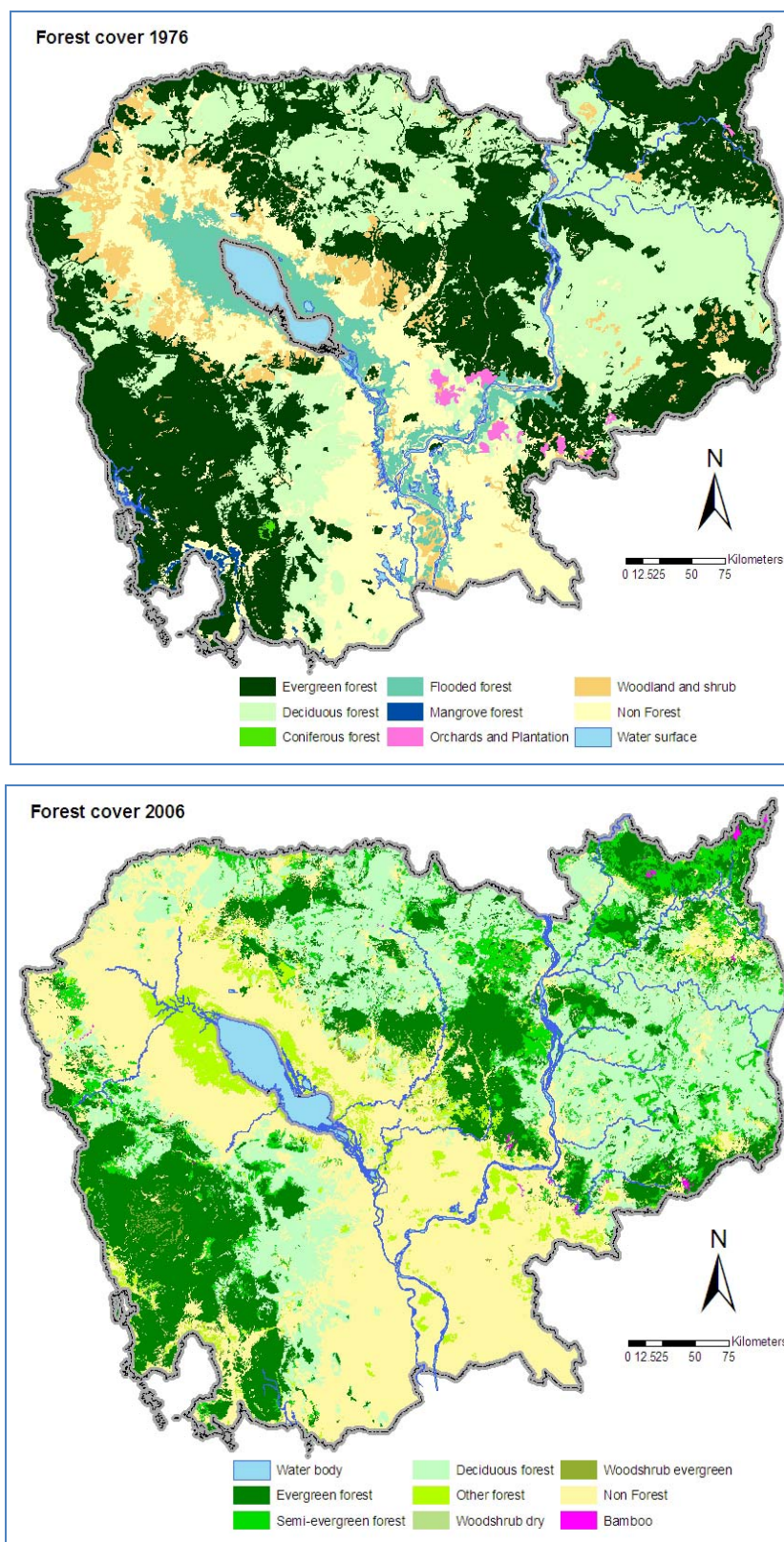
The main forested areas are located in the north and south of the country. The maps⁶ below illustrate the depleting carbon stocks in Cambodian forests, as certain changes in forest cover can indicate a reduction in carbon stocks (for example, evergreen forest contains a higher amount of carbon sequestered than semi-evergreen forest⁷).

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

⁶ SCW (Save Cambodia's Wildlife) 2006

⁷ Top N., Mizoue N., Kai S., 2004; Kapos *et al.* 2010.
v3.0

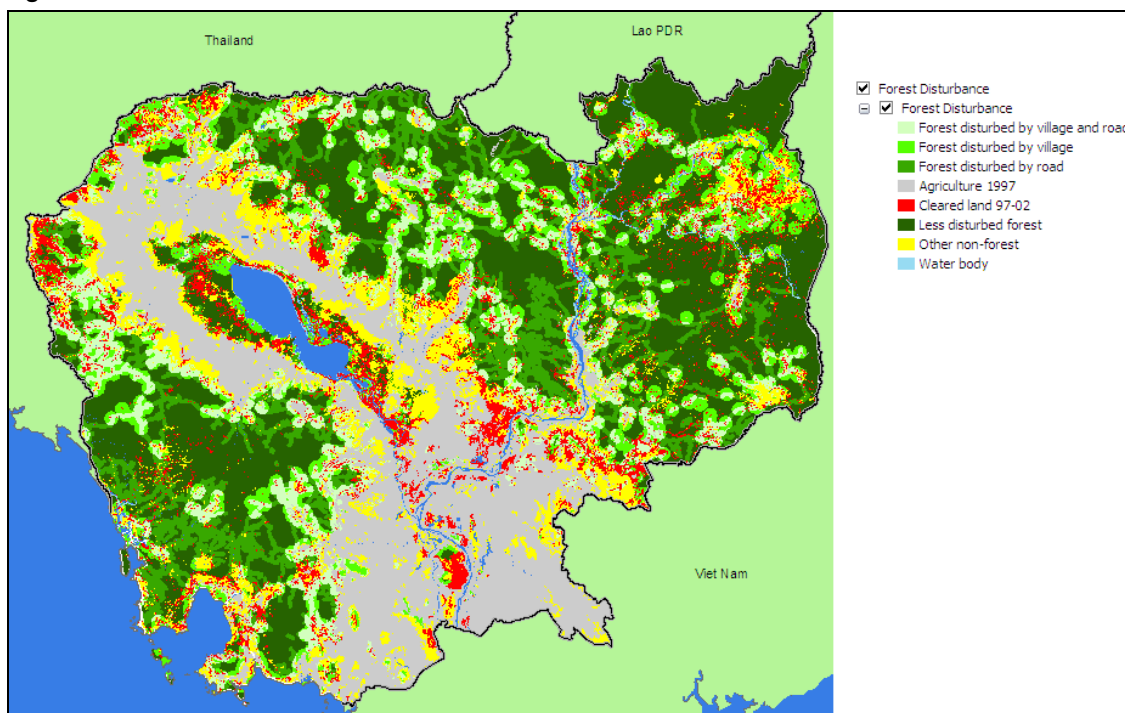
Figure 5: Distribution of forest cover in Cambodia in 1976 and 2006⁸



⁸ SCW (Save Cambodia's Wildlife) 2006; FAO 2010 v3.0

GIS mapping allows the overlay of different themes of data and a spatially explicit representation of the “woodfuel frontier” (where woodfuel is being produced); deforestation and forest degradation areas; and areas where the forest is being disturbed. The map below⁹ represents a GIS map of forest disturbance in Cambodia from 2002. The red colour on the map is the forest cleared over 1997-2002. It clearly shows the fragmentation of primary and less disturbed forest by roads, logging, woodfuel production and land conversion to agriculture and human settlements.

Figure 6: Forest disturbance 1997-2002

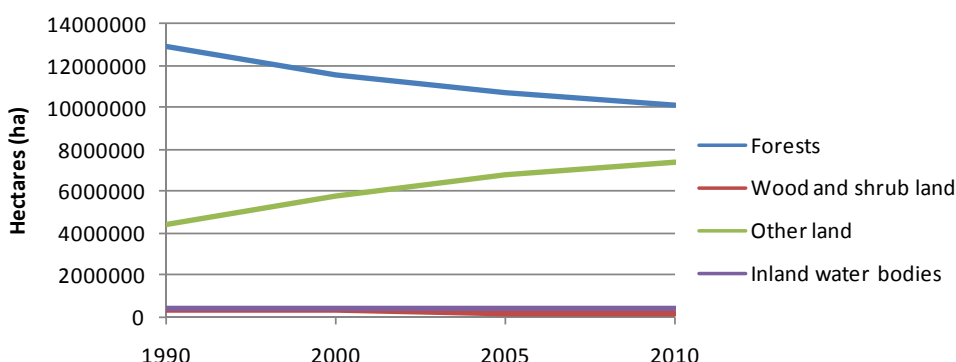


Other recent evidence available to demonstrate non-renewability of biomass resources is provided by national forestry statistics. The latest Forest Resource Assessment¹⁰ for Cambodia, released in 2010, revealed that Cambodia's deforestation rate is 1.22% per year. Forested area in the country decreased by 22% (2,850,430 ha) during 1990-2010 and wood/ shrub land area decreased by more than 60% (more than 200,000 ha) during the same period. Indeed, in recent years, deforestation rates in Cambodia being among the highest in the world¹¹.

⁹ SCW (Save Cambodia's Wildlife) 2006

¹⁰ FAO, 2010.

¹¹ Kapos, V., Ravilious, C., Leng, C., Bertzky, M., Osti, M., Clements, T., Dickson, B., 2010.

Figure 7: Decrease in forested area in Cambodia, 1990-2010¹²

Evidence from GERES' National User Survey conducted in August 2011 also reflects the impacts of deforestation on wood fuel availability. Wood fuel costs can serve as a proxy indicator for wood fuel availability; the survey found that on average, households estimate that the price of fuelwood increased by 61 riel/kg (14%) compared to 2010 and the price of charcoal increased by 152 riel/ kg (22%).

Causes

The principle causes of deforestation in Cambodia are agriculture, shifting cultivation, fuelwood harvesting and logging¹³. 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. Forest degradation was considered as a significant factor contributing to loss of forest quality.¹⁴

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 exerts pressure on environmental resources. Cambodia's increasing population relies heavily on fuel-wood as main energy source. Indeed 91% of the households use firewood or charcoal for cooking.¹⁵

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".¹⁶

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.¹⁷

¹² FAO, 2010.

¹³ Ministry of Environment, 2010.

¹⁴ Ministry of Environment, 2010.

¹⁵ National Institute of Statistics, 2008

¹⁶ World Bank, 2004.

¹⁷ Van Mansvelt et al., 2006b

In 2006 GERES conducted a wood energy baseline study¹⁸. 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 of some 30,750 ha – a proposition which is unfeasible in present day Cambodia.

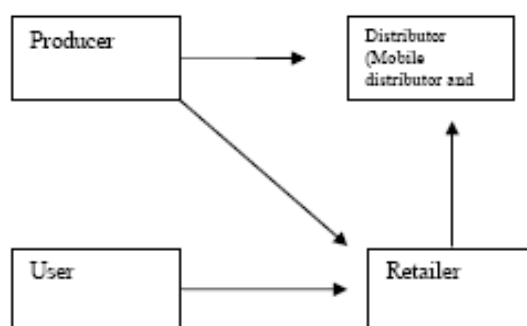
An FAO study in 2001¹⁹ explicitly linked fuelwood collection with localized deforestation:

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.

5.3 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. The stove distribution network in Cambodia is illustrated in Figure 8.

Figure 8: Stove distribution network²⁰



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 stove²¹. Indeed, a study conducted in 2009 found that NLS production generates income per producer almost four times higher than TLS production²².

The number of stoves sold throughout the monitoring period is 356,436, which means producers made an additional²³ \$135,445 during the period. So far, during the lifetime of the project, producers have made an additional \$ 601,518 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 durability of the NLS extend economic benefits of the stove to end users²⁴.

¹⁸ Van Mansvelt et al., 2006b

¹⁹ FAO, 2001.

²⁰ Atukorala, 2006.

²¹ Winrock, 2006.

²² Agence Francaise de Developpement (AFD) and GERES, 2009.

²³ Compared to exclusive sale of TLS.

²⁴ Winrock, 2006.

Finally, NLS production is more labour-intensive and consequently requires more workers and generates employment; NLS producers employ between 10 and 14 workers, as opposed to just three for TLS producers²⁵.

5.4 Social impacts

5.4.1 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, as demonstrated in Figures 9 and 10 below, during the 2011 National User Survey, the majority of households reported positive impacts from the NLS in terms of cooking time and fuel consumption. On average, respondents reported that cooking time was reduced by 9 hours per month.

Figure 9: NLS users' satisfaction with NLS performance in terms of cooking time

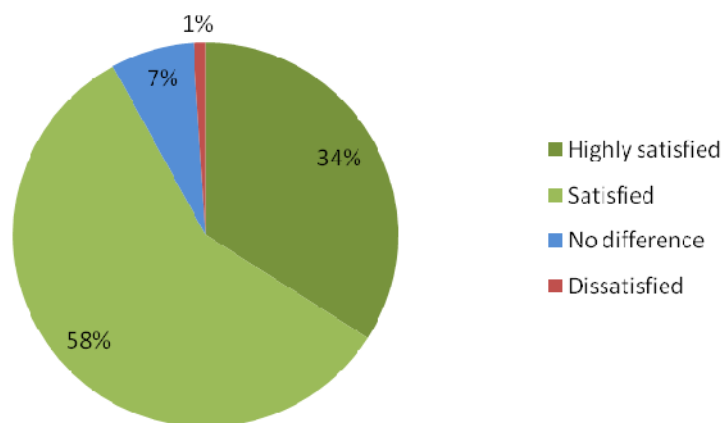
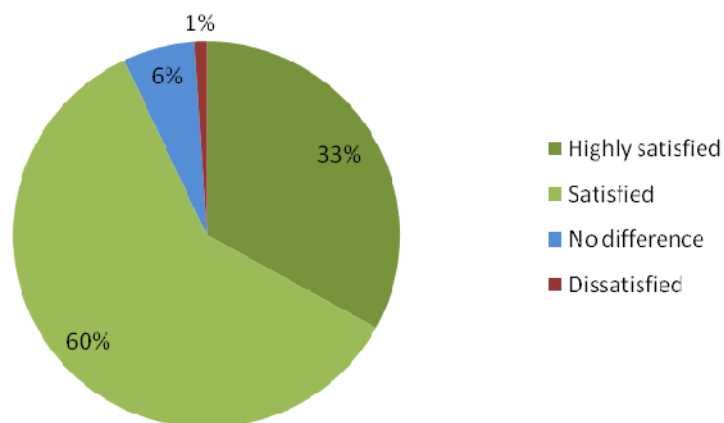


Figure 10: NLS users' satisfaction with NLS performance in terms of fuel consumption



5.4.2 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

²⁵ Agence Francaise de Developpement (AFD) and GERES, 2009
v3.0

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 reduces the cost of meeting energy requirements due to its improved efficiency and allows the financial 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 areas²⁶. In rural areas, fuel is often free to collect and home-made three stone fires are used to burn it.

5.4.3 Gender implications

Almost all (around 98%) of 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 socializing²⁷.

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 household²⁸.

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 women²⁹.

5.4.4 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 discuss pricing issues and share information to produce better quality stoves. The quality control and assurance of the stoves is also coordinated through ICOPRODAC; 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 (around US\$5) per month to fund the association.

²⁶ Autokorala, 2006.

²⁷ See National User Survey, 2007.

²⁸ Winrock, 2006.

²⁹ GERES, 2005.

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7 APPENDIX 1: NATIONAL USER SURVEY –OBJECTIVES AND METHODOLOGY

7.1 Background & objectives

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:

- Equipment ratio
- Stove lifetime
- NLS usage
- TLS usage
- User satisfaction
- Social/ economic impacts on families

7.2 Methodology

7.2.1 Site Selection

The National User Survey focuses on urban and peri-urban areas of Cambodia, which reflects the main market for NLS. The 2011 NUS focused on the same provinces as earlier NUS (from 2007 and 2009). The selected provinces are:

- Preah Sihanouk
- Kampot
- Kampong Speu
- Kampong Chhnang
- Phnom Penh
- Kampong Cham
- Kampong Thom
- Siem Reap
- Battambang

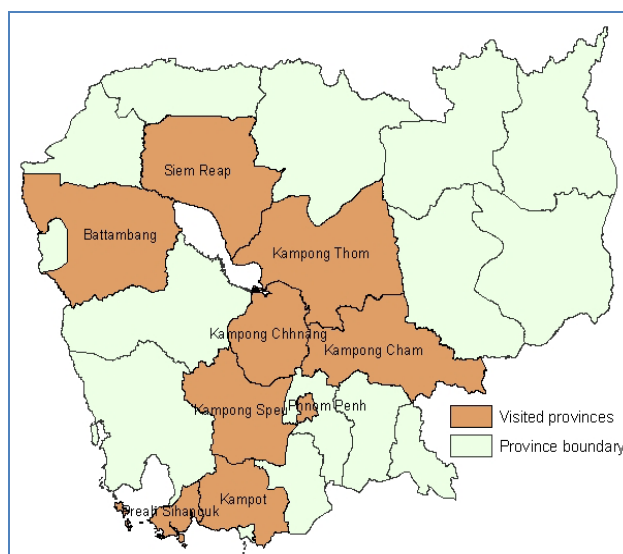


Figure 11: Map of selected provinces

In line with the 2009 National User Survey, within these provinces, “urban” and “peri-urban”³⁰ areas were identified and then the main roads of each area were identified. After the roads were identified, preliminary field assessments were conducted in order to ensure residential areas were selected, as opposed to areas with a large concentration of businesses/ offices. Houses were then randomly selected in these areas.

7.2.2 Sampling

Researchers interviewed members of 1,664 families; the calculated minimum sample size was 1,594 and an additional 70 households were interviewed to compensate for any invalid surveys. Sample size was calculated

³⁰ 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 peri-urban areas

through the Yamane equation (because the population was known) and with a confidence level (c) of 97.5%. The calculation is outlined below.

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

Where:

N = total population = 421,191 households

e = 0.025 (confidence level = 97.5%)

Sample sizes for each target area (province/city) were calculated based on demographic distribution of Cambodia's population (see Table 11).

Table 11 Sample sizes by province/city

Province	Provincial town	Households 2008 ³¹	Pop. growth rates (%) ³²	Pop. growth/year	Households 2010	% of sample	Samples
Phnom Penh	Krong Phnom Penh	260,468	2.83%	7,371	275,210	65.3%	1,042
Kampong Speu	Krong Chbarmon	9,139	1.26%	115	9,369	2.2%	35
Kampong Chhnang	Krong Kampong Chhnang	8,411	0.33%	28	8,467	2.0%	32
Preah Sihanouk	Krong Preahsihanouk	19,157	2.93%	561	20,280	4.8%	77
Kampot	Krong Kampot	7,358	0.64%	47	7,452	1.8%	28
Kampong Thom	Krong Stueng Sen	11,510	0.15%	17	11,545	2.7%	44
Kampong Cham	Krong Kampong Cham	9,726	0.05%	5	9,736	2.3%	37
Siem Reap	Krong Siem Reap	45,717	5.28%	2,414	50,545	12.0%	191
Battambang	Krong Battambang	28,468	0.21%	60	28,588	6.8%	108
		399,954			421,191	100.0%	1,594

7.2.3 Data gathering

Data was gathered through face-to-face interviews using a structured questionnaire. During the field survey, four research teams consisting of five researchers and a team leader were deployed. Surveyors underwent one day of training and were provided with survey guidelines written in Khmer. Essentially, the guidelines advised surveyors to (1) follow the junction road identified for the survey, (2) survey every third household in the preselected area, and (3) interview households that use biomass fuel (do not continue the questionnaire if biomass fuel is not used in the household). All data existing in the questionnaire was entered into an SPSS file. Data was checked for consistency, reliability and input error.

³¹ National Institute of Statistics, 2008.

³² Annual growth rate in urban areas, from National Institute of Statistics (2008).

8 APPENDIX 2: HFCT RESULTS, 2011 WET SEASON

8.1 Wood

Test conducted 15-28 August 2011 in Ta Khmao, Kandal Province.

For NLS (25 families), 7 days			
Average	Rice	Water	Wood
Consumption/week for the family(kg)	421.80	3591.80	801.50
Consumption/day for the family(kg)	60.26	513.11	114.50
Consumption/week/eq.adult	76.06	654.15	142.05
Consumption/day/eq.adult	10.87	93.45	20.29

For TLS (25 families) 7 days			
Average	Rice	Water	Wood
Consumption/week for the family(kg)	422.37	3617.10	1007.00
Consumption/day for the family(kg)	60.34	516.73	143.86
Consumption/week/eq.adult	75.44	647.47	177.68
Consumption/day/eq.adult	10.78	92.50	25.38

For an average of 1 family		
Rice	Water	Wood
16.87	143.67	32.06
2.41	20.52	4.58
3.04	26.17	5.68
0.43	3.74	0.81

For an average of 1 family		
Rice	Water	Wood
16.89	144.68	40.28
2.41	20.67	5.75
3.02	25.90	7.11
0.43	3.70	1.02

Real Fuel Saving %	20.05
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Total Fuel (Kg)	1808.50
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8.2 Charcoal

Test conducted 5-18 July 2011 in Boeung Tumpun, Phnom Penh

For NLS (25 families), 7 days			
Average	Rice	Water	Charcoal
Consumption/week for the family(kg)	299.60	3140.90	376.25
Consumption/day for the family(kg)	42.80	448.70	53.75
Consumption/week/eq.adult	61.15	662.80	79.74
Consumption/day/eq.adult	8.74	94.69	11.39

For TLS (25 families) 7 days			
Average	Rice	Water	Charcoal
Consumption/week for the family(kg)	298.38	3110.00	489.60
Consumption/day for the family(kg)	42.63	444.29	69.94
Consumption/week/eq.adult	59.04	626.70	99.36
Consumption/day/eq.adult	8.43	89.53	14.19

For an average of 1 family		
Rice	Water	Charcoal
11.98	125.64	15.05
1.71	17.95	2.15
2.45	26.51	3.19
0.35	3.79	0.46

For an average of 1 family		
Rice	Water	Charcoal
11.94	124.40	19.58
1.71	17.77	2.80
2.36	25.07	3.97
0.34	3.58	0.57

Real Fuel Saving % 19.74

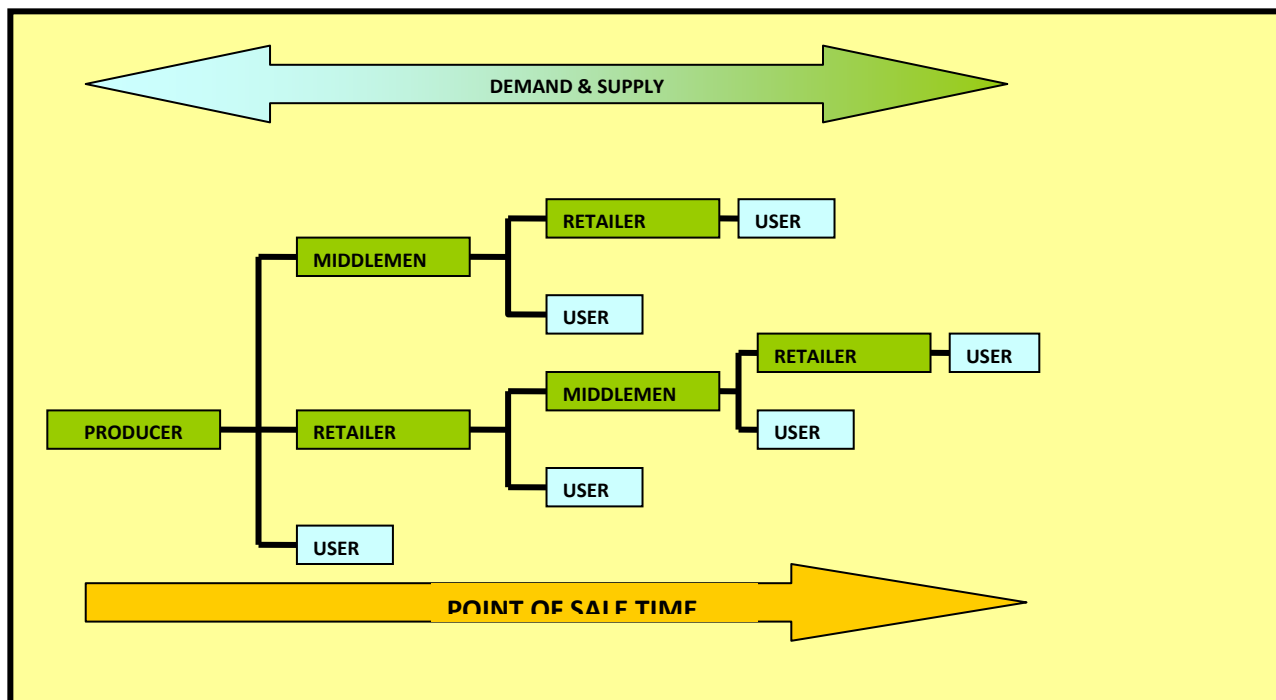
Total Fuel (Kg) 865.85

9 APPENDIX 3: POST TIME CALCULATION

9.1 Background: Supply chain of NLS

Figure 12 below illustrates that the supply chain of the NLS consists of stove producers, middlemen, retailers and end users.

Figure 12: 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 the longevity of the NLS project (which began in 1997) and the observable growth in market share (see Figures 3 and 4). 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 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.

9.2 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 14.

Table 12: 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 15 below.

Table 13: 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 16 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 14³³: 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.

9.3 Results

The average POST in the 5 provinces is 53.4 days with a standard deviation (SD) of 40.7 days. Table 17 below lists the average POSTs per province.

Table 15: Sample sizes and average POSTs in surveyed provinces

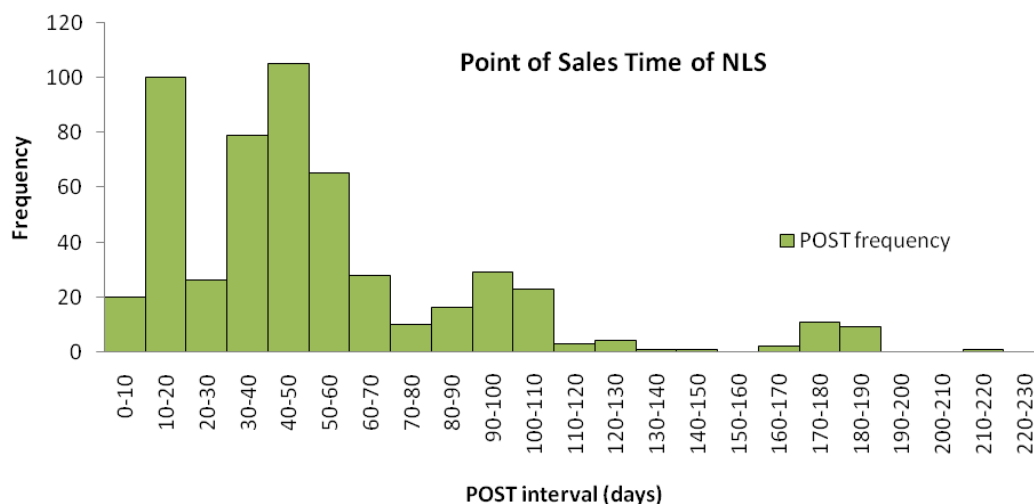
Province	Average POST (days) ³⁴	Sample size
Kampong Chnang	34.5 (18.6)	104
Siem Reap	60.7 (41.3)	128
Kandal	60.2 (40.7)	103
Battambang	65.0 (62.6)	100
Phnom Penh	45.4 (7.0)	95
Average	53.4 (40.7)	535

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 13 below). The large value of the SDs can be explained by the occurrence of extreme values in the number of POST days.

³³ University of Florida, 2007

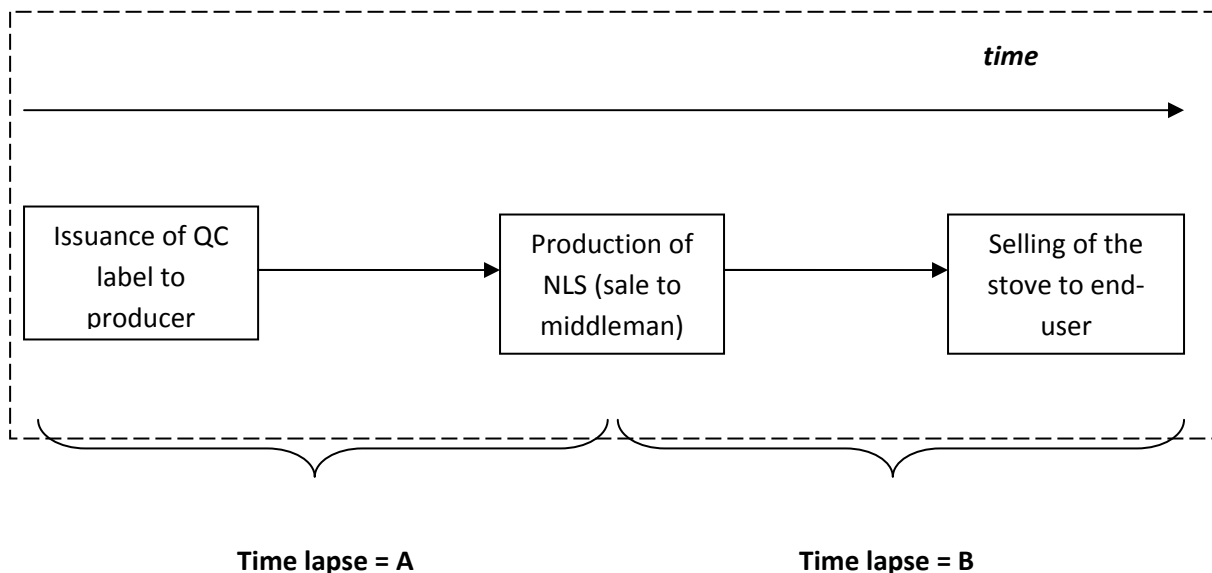
³⁴ Standard deviation is in parenthesis

Figure 13: Point of Sales Time of NLS



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 14 below illustrates the time expenditure between the label issuance, label application and point of sale.

Figure 14: 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.

9.4 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 13. 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.

10 APPENDIX 4: TRANSPORT EMISSIONS

Monthly fuel prices were obtained through the random selection of fuel (gasoline and diesel) receipts from NLS activities during 2011, because publicly-available data on monthly fuel prices in Cambodia could not be located.

Tables 18 and 19 below summarise the details of the randomly-selected receipts.

Table 16: Randomly selected gasoline receipts

Acct Code	Tran. Ref.	Month	Staff (T0)	Description	Period Debt	Price (US\$/litre)
60613	GJ1116	Jan	NVN	G M#7 49093 ICS MS Z2	\$3.00	\$1.13
60613	GJ1187	Feb	VAT	G M#4 03510 ICS MS KCN	\$3.00	\$1.18
60613	GJ1187	Mar	VAT	G M#6 20016 ICS MS Z2	\$3.00	\$1.21
60613	GJ1235	Apr	DMH	G M#5 44388 ICS MS Z3	\$3.00	\$1.24
60613	GJ1269	May	LMH	G M#6 21809 ICS MS Z3	\$4.00	\$1.28
60613	GJ1309	Jun	LMH	G M#6 23201 ICS MS Z2	\$4.00	\$1.25
60613	GJ1353	Jul	VAT	G M#7 60047 ICS MS Z4	\$3.00	\$1.29
60613	GJ1395	Aug	DMH	G M#6 25797 ICS MS Z3	\$4.00	\$1.24
60613	GJ1430	Sep	DMH	G M#6 26375 ICS MS Z2	\$4.00	\$1.30
60613	GJ1475	Oct	DMH	G M#7 62857 ICS MS Z1	\$4.00	\$1.27
60613	GJ1569	Nov	THA	G M#3 33819 QC KCN	\$4.00	\$1.20
60613	GJ1569	Dec	VAT	G M#7 65049 ICS MS Z3	\$4.00	\$1.24

Table 17: Randomly selected diesel receipts

Acct Code	Tran. Ref.	Month	Staff (T0)	Description	Period Debit	Price (US\$/litre)
60613	GJ1116	Jan	KSA	D C#3 293897 AWBT PNH KCN	\$20.00	\$1.06
60613	GJ1187	Feb	MSN	D C#1365915 HFCT PNH	\$47.00	\$1.11
60613	GJ1187	Mar	SMR	D C#3 299848 Carbon Audit	\$50.00	\$1.15
60613	GJ1235	Apr	NVN	D C#1 369342 ICS MS KCM	\$50.00	\$1.18
60613	GJ1269	May	SMR	D C#1 372348 QC KCN	\$40.00	\$1.19
60613	GJ1309	Jun	VAT	D C#3 309788 ICS MS BTB	\$55.00	\$1.17
60613	GJ1353	Jul	SMR	D C#3 310609 QC KCN	\$50.00	\$1.19
60613	GJ1395	Aug	CTL	D C#2 317921 HFCT PNH	\$40.00	\$1.20
60613	GJ1430	Sep	SMR	D C#2 319832 QC KCN	\$55.00	\$1.05
60613	GJ1475	Oct	LMH	D C#1 385378 ICS MS BTM	\$58.00	\$1.11
60613	GJ1569	Nov	NVN	D C#3 322387 ICS MS BTB	\$55.00	\$1.23
60613	GJ1569	Dec	LMH	D C#1 390419 ICS MS KCM	\$55.00	\$1.23

To calculate total consumption of each fuel, the equation below is applied. Table 20 outlines the sources of data used in the equation and Tables 21 and 22 outline 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 18: Sources of data for transportation emissions calculation

	Value		Source
	Diesel	Gasoline	
C	4623 litres	1669 litres	GERES Cambodia Finance Department records
F	1185 litres/ tonne	1350 litres/ tonne	IEA/ OECD, 2004, <i>Energy Statistics Manual</i> .
NCV	0.043 TJ/t	0.0443 TJ/t	IPCC, 2006, <i>2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1: Introduction</i> .
EF	69.3 TJ/t	74.1 TJ/t	IPCC, 2006, <i>2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 3: Mobile Combustion</i> .

Table 19: Gasoline emissions from NLS monitoring/ quality control, 2011

Month	Gasoline price (US\$/L)	Consumption (US\$)	Consumption (litres)	Consumption (tonnes)t	Consumption (TJ)	tCO ₂ e
Jan	1.13	68.55	60.66	0.04	0.00	0.14
Feb	1.18	70.00	59.32	0.04	0.00	0.13
Mar	1.21	120.00	99.17	0.07	0.00	0.23
Apr	1.24	167.16	134.81	0.10	0.00	0.31
May	1.28	194.08	151.63	0.11	0.00	0.34
Jun	1.25	210.17	168.14	0.12	0.01	0.38
Jul	1.29	256.66	198.96	0.15	0.01	0.45
Aug	1.24	256.48	206.84	0.15	0.01	0.47
Sep	1.30	181.39	139.53	0.10	0.00	0.32
Oct	1.27	201.04	158.30	0.12	0.01	0.36
Nov	1.20	153.25	127.71	0.09	0.00	0.29
Dec	1.24	203.50	164.11	0.12	0.01	0.37
			1669.18	1.24	0.05	3.80

Table 20: Diesel emissions from NLS monitoring/ quality control, 2011

Month	Diesel price (US\$/L)	Consumption (US\$)	Consumption (litres)	Consumption (tonnes)t	Consumption (TJ)	tCO ₂ e
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Jan	1.06	624.00	588.68	0.50	0.02	1.58
Feb	1.11	122.02	109.93	0.09	0.00	0.30
Mar	1.15	639.00	555.65	0.47	0.02	1.49
Apr	1.18	404.34	342.66	0.29	0.01	0.92
May	1.19	594.00	499.16	0.42	0.02	1.34
Jun	1.17	372.26	318.17	0.27	0.01	0.86
Jul	1.19	474.15	398.45	0.34	0.01	1.07
Aug	1.20	635.15	529.29	0.45	0.02	1.42
Sep	1.05	471.23	448.79	0.38	0.02	1.21
Oct	1.19	422.00	354.62	0.30	0.01	0.95
Nov	1.23	317.99	258.53	0.22	0.01	0.70
Dec	1.23	270.00	219.51	0.19	0.01	0.59
			4623.44	3.90	0.17	12.43