PROJECT DESIGN DOCUMENT

Efficient Cookstoves to mitigate global warming and contribute to poverty alleviation in Cambodia

FINAL

CONTENTS

Revision history of this document

Version Number	Date	Description and reason of revision
01	26 Aug 2006	Draft, by Ruy Korscha ANAYA DE LA ROSA
02	22 Nov 2006	First revision, by Minh Cuong LE QUAN
03	05 Dec 2006	Second revision incorporating elements from model PDD of MyClimate, by Minh Cuong LE QUAN
04	09 Dec 2006	Third revision using VER Methodology CC NRB-BSAS[1], by Minh Cuong LE QUAN and Samuel BRYAN
05	12 Dec 2006	Final draft proofreading, by Samuel BRYAN
06	25 Apr 2007	Forward Actions requests by Samuel BRYAN

[1] From Climate Care Trust, "Energy Efficiency applications of Non Renewable Biomass" (based on a previous submission by Bernard SCHLAMADINGER and Anandi SHARAN).

Foreword

This project design document is the result of research and learning on Carbon Finance from 2003 to date. Numerous delays have taken place due mostly to methodology uncertainties.

The last COP/MOP in Nairobi failed to address the issue of Non Renewable Biomass. Hence we boldly affirm that in its current stage, the instruments of the Kyoto Protocol fail to address the poverty and energy linkages, and are of no help to the poor sections of the population especially in Least Developed Countries.

Shortfalls of CDM methodologies include: gaps in available baseline methodologies, unrealistic ceilings for small scale projects, no consideration whatsoever for micro-technologies that reduce NRB.

Hence the present PDD has been prepared for the **Voluntary market**, following the methodology that is considered the best available by stove project developers worldwide.

We request the readers to keep in mind the shortfalls of CDM and the specificities of sustainable development projects when scrutinizing this PDD.

With regards,

Minh Cuong LE QUAN

Climate Change Unit, GERES Cambodia

SECTION A. General description of the project activity

A.1. Title of the project activity:

>>

Fuel-Wood Saving with Improved Cookstoves in Cambodia

A.2. Description of the project activity:

>>

The purpose of the project activity

90 % of the Cambodian population depend daily on fuel-wood for cooking purposes. This dependency has increased considerably in recent years. As a consequence, forest resources are seriously threatened if no action is taken to control wood consumption at a household level.

The objective of the project is to reduce charcoal and thereby fuel wood consumption by introducing improved Lao cook stoves in Cambodia. The new, more energy-efficient cook stoves should be broadly disseminated by a marketing strategy aiming at attracting local traditional cook stove producers to produce the improved stoves, which are then sold to households via wholesalers, mobile vendors and retailers. By including the local producers and merchants in the project activities a technology transfer is achieved.

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

The view of the project participants on the contribution of the project activity to Sustainable Development

Apart from avoiding GHG emissions by reduced wood and charcoal combustion, the project contributes to Sustainable Development in many ways. All three aspects of sustainability are promoted; the environmental, the social and the economic side.

As far as environmental sustainability is concerned, the major gain is the avoidance of overexploitation of the forests. Thus the forest resources are protected and biodiversity is conserved. The protection is based on a long-term strategy, as the introduction of new stoves is accompanied by a national strategy for Cambodia's wood-energy economy elaborated and implemented together with NGOs, the government, and the private sector and forestry communities.

An improvement in social sustainability is achieved in three ways. Firstly, the improved cook stoves emit less airborne particles, which improves the living conditions of the users. Secondly, the spread of more efficient cook stoves is narrowing the gap between the rising fuel wood needs of a growing population and the diminishing forest resources. Therefore, the fierce competition for combustible wood is mitigated. This improves the access to energy, especially for the less wealthy sections of Cambodian society. Thirdly, the project is linked to gender issues. Women's circumstances are improved by reducing the cost in time or money of meeting their energy requirements: saving the time collecting fuel wood and cooking, or reducing the cost of purchased fuel. In cash this saving is marginal, however this takes place in an essential area of the family budget, managed by women and dealing with food, nutrition and child care.

Finally, lack of economic sustainability is tackled. Firewood supply costs are reduced, small-scale businesses such as stove producers and retailers are consolidated, in some cases even jobs are created, especially in rural areas, commercial networks among retailers and distributors are established; and finally improved technology is transferred to the local people.

A.3. Project participants:

>>

Project developer:
Groupe Energies Renouvelables, Environnement et Solidarités (GERES) - Cambodia

Project partners:
WENETCAM - Wood Energy Network of Cambodia (a program of CEDAC - Centre d'Etudes et de Développement Agricole du Cambodge)
DATe – Development and Appropriate Technology
Directorate of Energy, Ministry of Industries Mines and Energy

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>>

A.4.1.1. Host Party(ies):

>>

Host Country Party(ies): Cambodia.

A.4.1.2. Region/State/Province etc.:

>>

The project is carried out in 9 different regions/states/provinces: Phnom Penh, Kandal, Kompong Speu, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham and Kompong Chhnang.

A.4.1.3. City/Town/Community etc:

>>

All cities, towns, communities in the above-mentioned provinces

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity(ies):

>>

Charcoal-consuming households and charcoal-producing kilns in the mentioned provinces

A.4.2. Type and category(ies) and technology of the project activity:

>>

Type and category
UNFCCC category-Type II [Energy Efficiency Improvement Projects]
The Sub-category is part of the voluntary market:
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.

NB: this methodology is the reference for cook stove projects. It is considered most appropriate in the voluntary sector both by project developers and Carbon buyers.

Technology used

	Traditional Lao Stove  	**New Lao Stove**  
Material	Metal covered baked clay	Metal covered baked day
Production	Semi manual	Stove artisans
Size	Multi	25.4 cm height, 30 cm diameter
Weight	3 – 8 kg	approx 12 kg
Fuel	Charcoal	charcoal
Efficiency	25%	29 % (average)

Source: ICS design. - http://www.cfsp.org.kh/ics_design.html, 06/07/06

The New Lao Stove (NLS) is more efficient than the Traditional Lao Stove (TLS) because of the following advantages;

- The low pot rests to prevent heat loss characterize the NLS. In addition, the pot rests are slanted at an incline to accommodate many sizes of pots.
- The NLS grating has 37 air holes, which are good for air circulation and induce more efficient fuel-burn. The grate thickness has also been improved for more durability.
- The NLS has an improved combustion chamber, which is higher than traditional cook-stove and consumes less fuel wood.
- The NLS has improved insulation and a refractory liner to prevent heat loss.
- The NLS has a metal sheet body cover for durability.

Transfer of an environmentally safe and sound technology

The efficiency of the technology results in a lower consumption of charcoal and thus airborne particle emissions are reduced. Furthermore, it does not entail any additional environmental risks. Thus, the technology is environmentally safe and sound.
The efficient NLS are not just distributed to the local people, but a technology transfer to the Host party is achieved by three means: Firstly, traditional cook-stove producers are attracted for the production of the new stoves and are assisted in the production itself. Secondly, an awareness program for wholesalers, retailers and mobile sellers guarantees that the products are really sold and networks between producers, merchants and users are created. Thirdly, a campaign on the utilization of the new stoves builds up the users' knowledge about the technology.

A.4.3. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

When using more efficient cook stoves, the demand for charcoal decreases and GHG emissions are reduced as they are emitted both during the production and combustion of charcoal.
The wood needed for producing charcoal is unsustainably harvested. Therefore, the charcoal in the project area is a non-renewable resource, and thus the GHG emissions from charcoal production and combustion are anthropogenic. (Reference: IGES-CCCO charcoal study, 2005)
The emission reductions would not occur in the absence of the project activity as the improved cook-stoves are slightly more expensive than the traditional ones and were not known in Cambodia before the start of the project.
Although awareness is rising on wood energy in various administrations, a government policy is unlikely in the foreseeable future due to the complexity of the issue across ministry lines. The project will in fact support policy work, to establish a national efficient stove standard, and promote a sustainable biomass energy management plan.

The project started in 2002, but its maintenance and development until market maturity is not guaranteed in the absence of Carbon funds.

A.4.3.1 Estimated amount of emission reductions over the chosen crediting period:

>>

The emission reductions will be verified first for the period May 10th 2003- January 9th 2007, then yearly afterwards.

Year	Emission Reductions (Teq.CO2)
2003	2,822
2004	21,833
2005	50,980
2006	95,880
2007	156,759
2008	242,195
2009	282,610
2010	333,999
2011	391,336
2012	453,450
Total estimated reductions	2,031,865
2003-2006 (TCO_2)	171,515
Annual average of estimated reductions 2003-2006 (TCO_2/year)	42,879
Total estimated reductions 2007-2012 (TCO_2)	1,860,350
Annual average of estimated reductions 2007-2012 (TCO_2)	310,058

* We forecast as an eventuality that the improved stove market could reach saturation during the period 2010-2012.
The exact saturation point will depend on the evolution of fuel markets (availability and pricing of charcoal versus other fuels, changes in living standards and cooking practices).
The instruments to monitor such changes are described in a later part of this document.

A.4.4. Public funding of the project activity:

>>

The project has been partly funded by the European Union until 2006. As the European Union is withdrawing its start-up support, the maintenance of the project activity is not guaranteed. Therefore, additional funding is required by selling Verified Carbon Units (VCU's).

Carbon Finance is required for two reasons:

- to cofinance the remaining 20% of the launching period not covered by E.U.
- to ensure the continuity of the project: to solidify the market position, maintain the quality assurance system and scale up dissemination up to market saturation (2007-2012).

The Carbon funds to cofinance the launch and continue running the project is sought from the voluntary market. Therefore there is no diversion of ODA.

A.4.5. Confirmation that the project activity is not a debundled component of a larger project activity:

>>

This project is not a debundled component of a larger project activity. The other activities of GERES Cambodia can not be bundled with this project.

SECTION B. Application of a baseline methodology:

B.1. Title and reference of the approved baseline methodology applied to the project activity:

>>

Title: Voluntary Emission Reductions - Improved Efficiency in Use of Non-Renewable Biomass
Reference: Climate Care Trust, derived from proposed methodology SSC.II.G., amended by the Joanneum Institute and approved by the community of practice (HEDON, Stove and Carbon Special Interest Group).

B.2 Project category applicable to the project activity:

>>

Type II, Demand-side energy efficiency projects.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

>>

Without the project there will be more emissions of GHGs both by the activities of producing and consuming larger amounts of charcoal extracted from non-sustainably harvested wood (see below). The New Lao Stove has a net saving of 21.2% on charcoal and 20.89% on wood compared to the traditional Lao Stove.

There are two different barriers for the introduction of the new technology;

- Investment barrier:
  A New Lao Stove costs between 2.3 and 4 US$, which is about the double of the traditional Lao Cook Stove (1-2 US$) and quite an investment for an average Cambodian household[2].

- Technological barrier:
  The people were not aware of New Lao Stove technology before the project started. The know-how to manufacture this stove is brought by training and regular monitoring of the production.
  Therefore, the traditional technology is believed to carry lower risks for producers, retailers and users than the new one. This also means that a barrier due to prevailing practice exists.

Fuel wood and charcoal used in the urban centers are supplied from the country side, extracted from natural forests, and constitute a non-renewable resource. The report "Wood energy baseline study for Clean Development Mechanism" (E.R.Van MANSVELT & al., IGES CCCO, 2006) states that:

- the fuel wood collection and charcoal production area shift every season further away
- the current rate of wood collected for energy use exceeds the re-growth rate of the forest
- the charcoal production and consumption trends cannot reach sustainability in any foreseeable future.

The Royal Government of Cambodia will elaborate a national strategy for wood-energy economy. However this will not take place until the government staff are trained on the issue, data acquisition instruments are in place at provincial level, the directorate of energy is planning provided will reliable data, and a wood energy policy is passed.
The design of the first aforementioned step is planned in 2007 with support from UNDP. The completion of the entire process is not expected before 2010, while the implementation of the expected regulations will, in all likelihood be, ineffective -unless the country's governance goes through a major overhaul.

[2] The average Gross National Income per capita and year was 320 US$ in 2004 according to http://www.unicef.org/infobycountry/cambodia.html, 20. 06. 06. However, this number just reflects the arithmetic average; the median is expected to be lower.

Given the cost of electricity in Cambodia, an electrification, LPG, or diesel-based baseline has not been preferred, because it would rarely occur in the short term and it will be not be used for cooking purposes. The shift in the fuel use to LPG or Kerosene would rarely happen according to the trend in the energy programmes for the country. (GVEP, 2005)

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

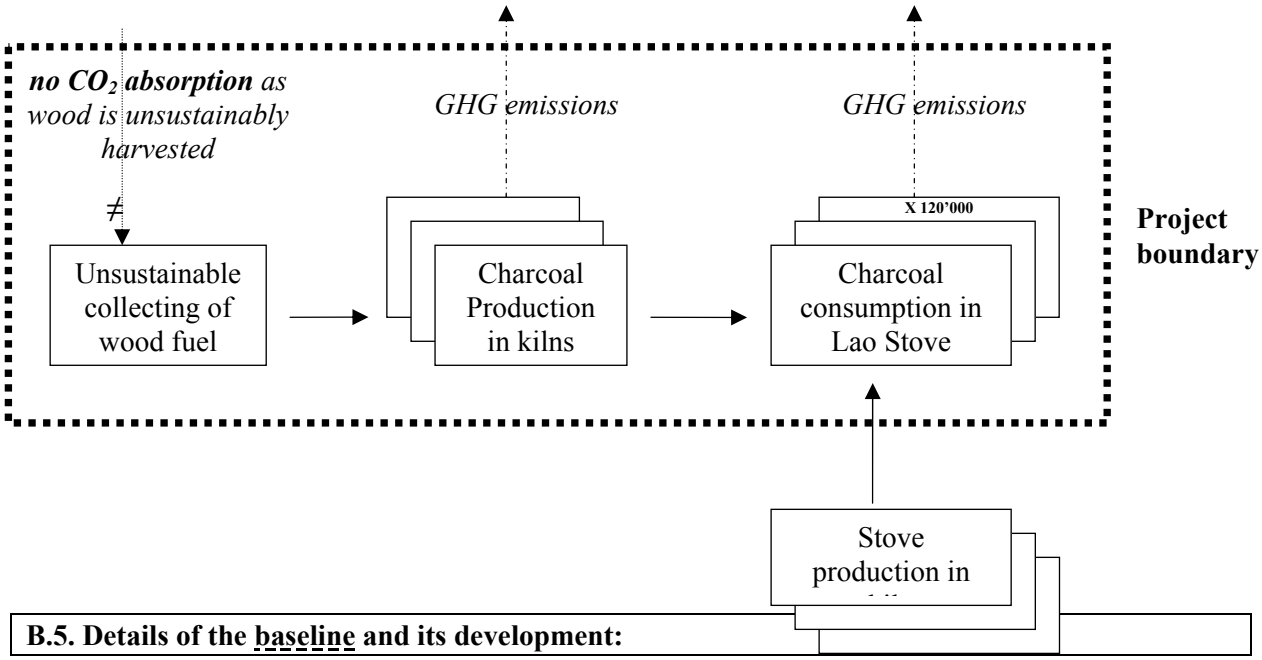
>>

According to the given methodology**,** the project boundary is the physical, geographical area of the use of non-renewable biomass. In this case, the boundaries are Phnom Penh and its suburbs, the provincial capitals and their surroundings in the following provinces: Kandal, Kompong Speu, Prey Veng, Takeo, Siem Reap, Battambang, Kampong Cham and Kompong Chhnang.

These are the areas where the Improved Cookstoves have been disseminated and therefore where the usage of non-renewable biomass and the monitoring activities of the NLS take place.

The project is limited by two parameters;

a) The 6 provinces as specified in A.4.1.2.: Phnom Penh, Kandal, Kompong Speu, Prey Veng, Takeo, and Kompong Chhnang. The fuel wood demand for charcoal production is satisfied from local resources.
b) The project does not only consist of the charcoal consumption sites but also of the production sites as the introduction of New Lao Stoves reduces the emissions emerging from charcoal production as well.



B.5. Details of the baseline and its development:

>>

Non renewability of biomass

Cambodia's increasing population relies heavily on fuel-wood as main energy source, 95.3 % of the households use firewood and charcoal for cooking (National Institute of Statistics, 2005).
In addition for household consumption, charcoal is produced illegally, immeasurably 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).

The prevailing trends show that this will not improve in the foreseeable future. The "Wood Energy Baseline Study for CDM in Cambodia" (E.R. VAN MANSVELT, CCCO-IGES 2006) states that:

- the total woodfuel demand of Cambodia was estimated at 4.5 MT of wood in 2004, expected to cross 5 MT in 2009.
- While charcoal demand in Phnom Penh is stabilizing or softly regressing, the scale of demand is such that it remains unsustainable as far as projections allow. Moreover, the charcoal demand in other urban areas and in the countryside is rapidly growing, further tipping the fuel sustainability issue in the wrong direction. Under prevailing conditions, properly managing the established forests or energy plantations cannot happen fast enough at the scale required for a sustainable supply of woodfuel for Phnom Penh. Undoubtedly, a sustainable charcoal supply will not take place in the current situation without proactive project intervention, possibly making use of Carbon Finance.
- […] currently the amount of fuel wood flowing into Phnom Penh is 88.119 tons of charcoal and 55.620 tons of wood per year. Charcoal combustion for cooking produces 2,74 kg of CO2 per kilogram of charcoal and 1,56 kg CO2 per kilogram of wood (Smith, KR, 2000). Per year 241.000 tons of CO2 from charcoal and 86.767 tons of CO2 from wood (total 327.767 ton CO2) is exhausted into the air. The transport of the woodfuel is consuming another 1 million liters of petrol resulting in an additional emission of 3.700 tons CO2. (Shobhakar Dhakal, 2001).

The study concludes:
"The potential wood left in the area could never supply total wood demand for charcoal estimated at 369.000 ton per year, which is resulting in the clear-cutting of at least 45 km2 per year of deciduous forest. These analyses show clearly that current charcoal production practices are not sustainable. The natural regeneration of forests is far too slow to produce enough woodfuel for demand."

In fact, the natural forests of Cambodia, host to immense biodiversity kept regressing by 3%/year since the 1990s, or an average loss of 197.000 ha per year from 1995-2005 (Cambodia Independent Forestry Sector Review Report, World Bank 2004).

Cooking fuels and technology

Cooking activities are traditionally performed in the rudimentary Traditional Lao Stove.
Market surveys show that this stove is sold in the urban centres, where charcoal users are concentrated. The nominal retail price of charcoal has been more or less stable increasing from 400 Riels/kg to 550 Riels/kg since 1997, while the relative value of the currency has halved compared to US$, making other cooking fuels –imported fossil fuels such as kerosene, LPG and electricity- utterly uncompetitive.
Given the market conditions and technologies available, the cost per useful energy unit is obviously in favour of charcoal, an imbalance that is further tilted by New Lao Stoves:

Stove-fuel option	**Cost of useful energy (US$/MJ/kg)**
LPG stove	0.0276
Kerosene stove	0.0230
Traditional wood stove	0.0159
Traditional charcoal stove	0.0153
Charcoal in New Lao Stove	0.0128

(Source: S.Y BASKORO, GERES 2005)

As a consequence, studies and field observations show that under these circumstances movement up the energy ladder does not happen. There is no switch to kerosene, and a limited switch to LPG for the wealthiest sections of the population in the few cities where it is available. In fact, there is a fuel-poverty divide in Cambodia (GERES Cambodia for World Bank, GVEP 2004):

- the rich people in Phnom Penh are inclined to very slowly switch to LPG over the next decades,
- in other urban centres and rich rural areas, charcoal use is fast increasing
- while the rural poor switch to inferior fuels in case access to wood rarefies

Equipment ratio

In Cambodia food prepared for daily meals usually consists of two or three dishes, rice as the staple, vegetables and fish/meat. These foods have different thermal requirements. To produce these different types of food often more than one stove is required. A CFSP study conducted in 1998 found that 66% of families utilized more than one stove every day (CFSP, 1989). The other 34% or 277 families of the sample utilize only one stove

Number of stoves owned by Interviewees (CFSP, 1998)

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

STSS = same type same size
STDS = same type different sizes
MTS = multi types stoves

The above table shows 61% of total sample families utilizing two stoves at once every day, and the other 5.1% utilizing three stoves. From stove combination point of view, 40.2% of all sample families utilize multi stove in STSS pattern and 12.1% utilize multi stove in STDS. What is important from the perspective of emissions reductions is that the replaced low efficiency devices do not continue to be used. These pattern shows most of the families prefer to utilize similar stove model either all in same size or in different size. A further CFSP study (Van Mansveld, 2006) calculated the average number of NLS per family. A total of 1561 households were interviewed, 670 were using one or more NLS. According to the data, 33.50% of households use NLS. Households using NLS own 1.28 stoves, on average.

Total NLS used by households interviewed.

# NLS	# Households	Total NLS
0	1038	0
1	395	395
2	113	226
3	11	33
4	4	16
TOTAL	**1561**	**670**

Fuel saving

Fuel saving is calculated in two steps. Firstly to establish the daily consumption using the traditional stoves and secondly to establish the actual savings of biomass that result from using the NLS
Not only do users use more than one stove but often they will use a mix of wood and charcoal depending on the thermal requirements of the meal, availability and a number of other socio-economic considerations. The fuel mix is derived from the stove utilization survey in 2006. The survey showed the monthly consumption of charcoal and wood in traditional stoves is 25.31 kg and wood 37.64kg respectively (GERES, 2007).

Average consumption of Charcoal

Stove Type	Number of units	Weighted Average Consumption	Kg/ Month	Kg/ Day	Tones/month
NLS	128.98	3264.61	25.31	0.83	0.02531
TLBS	256.03	8223.97	32.12	1.06	0.03212
	385.00	11488.57			

Average consumption of Wood

Stove Type	Number of units	Weighted Average Consumption	Kg/ Month	Kg/ Day	Tones/ Month
NLS	128.98	4504.63	29.55	0.97	0.02955
TLBS	256.03	8942.02	37.56	1.24	0.03756
	34.93	13446.65			

The fuel savings generated by the NLS have been calculated using Real Cooking Tests (RCT). RCTs are used to replicate actual conditions of use as opposed to a laboratory environment. Tests are conducted in both rainy and dry seasons and the average of both results are used.
The main results are that
- the charcoal saving when switching to NLS is 21.2 %
- the wood saving when switching to NLS is 20.89 %

Wood to charcoal conversion

For simplicity of calculations between charcoal and wood, charcoal figures are converted back into wood equivalent. Charcoal in Cambodia is produced in earth kilns. GERES Cambodia conducted a survey of charcoal producers to assess the technology level and yields of traditional kilns. The average conversion factor is 6.54 kg wood / kg charcoal. (IGES-CCCO, 2006). However in order to ensure conservativeness of emissions reductions the IPCC default value of 6kg wood/ kg of charcoal has been used.

Stove lifetime, replacement, and heavy duty users

User surveys from 2003 to 2006 have not provided enough occurrences of broken or replaced NLS, instead, anecdotal evidence and surveys point to a very long lasting product:
“it is impossible to determine the live span of the NSL as none of the families did stop using the stove. This proves at the same time that the stoves are of high quality and according to the respondents very convenient to use. The life expectancy can be at least up to 3 and 4 years, but probably even higher!” (E.R.VAN MANSVELT, WINROCK 2006)
The same survey demonstrates that in the few cases of broken stoves, the NLS is purchased as a replacement. In some cases a second or third stove is owned by the family, and the NLS is gradually replacing the traditional stoves as they become obsolete: consumers are satisfied and do not revert back to the old technology.

Therefore the project conducted an additional study in 2006 to estimate the lifetime of the NLS from a specific category of users (heavy duty users) and assess the importance of this category of stove buyers. (ref. “ICS share between Households and Restaurants in urban areas in Cambodia”, E.R. VAN MANSVELT, GERES 2006).

The study conducted 2015 interviews nationwide. It found out specifications from micro-businesses such as restaurants, street vendors, etc.

- share of heavy duty users: 9.4% of all users (90.6% are domestic users)
- average time of use per day: 7 hours 9 minutes
- heavy duty lifetime before replacement: 19.28 months
- stove lifetime (in usage hours): 4195.87 hours

Given the traditional usage of 3.5 hours per day for domestic cooking this provides the stove lifetime figure of 3.28 years.

Relevance of fuel saving for heavy duty users

In the above study:

- of the 227 restaurants surveyed, they own an average 1.76 stoves.
- restaurants that use charcoal consume on average 7.32 kg charcoal/day

An additional study was conducted to ascertain the specific fuel saving of this category of users: the Real Fuel Saving Test was applied during 10 days to a sample of 8 restaurants. The real fuel saving is 24.88% ("Restaurant Charcoal Consumption Test", C.CHET et al., GERES 2006)

As a conservative estimate, to account for the 9.4% heavy users with higher rotation of stoves, and given their higher fuel saving (therefore their higher emission reductions), the project will retain as a conservative estimate a stove lifetime value of 3 years instead of 3.28.

Stove Shelf Lifetime

Emission reductions from this project activity are calculated through monitoring the monthly sales of stoves being sold by producers. However, the NLS purchased by distributors are not necessarily immediately being sold to end users. It can be assumed that once the stoves reach the end users; they are utilized and emission reductions can accrue. However, emissions reductions will not accrue during the time that stoves take to reach the end user. Two points in the supply chain can affect the length of this period.

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

The statistically robust Point of Sale Time (POST), the time between stoves being sold by the producer and utilized by end users, is 25.2 days. It can be asserted with 95% confidence that any given stove will have been sold within 25.2 days of arrival at any given retailer. Combined with an estimated travel time of five days a period of one month is adopted as the average POST for New Lao Stoves (GERES, 2007[1]).

Sales at producer gate, Market Observation System and Usage Surveys

These components are detailed in section D.

SECTION C. Duration of the project activity / Crediting period:

C.1. Duration of the project activity:

>>
10 years

C.1.1. Starting date of the project activity:

>>
January 1st 2003

C.1.2. Expected operational lifetime of the project activity:

>>
10 years

C.2. Choice of crediting period and related information:

>> Fixed Crediting Period

Please state whether the project activity will use a renewable or a fixed crediting period and complete C.2.1 or C.2.2 accordingly.

C.2.1. Renewable crediting period:

>>N/A

C.2.1.1. Starting date of the first crediting period:

>>N/A

C.2.1.2. Length of the first crediting period:

>>N/A

C.2.2. Fixed crediting period:

>>

C.2.2.1. Starting date:

>>
10th May 2003

C.2.2.2. Length:

>>
10 years

SECTION D. Application of a monitoring methodology and plan:

D.1. Name and reference of approved monitoring methodology applied to the project activity:

>>

The project activity applies the methodology:

Voluntary Emission Reductions: Improved Efficiency in Use of Non-Renewable Biomass.[3]

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

>>

The methodology is chosen as it is relatively straightforward to apply, and because it is grounded in field measurements. As a result the emission saving outcome is accurately assessed.

It does not rely on laboratory measurements of an improved stove, but instead on field measurements of wood-fuel mass use before and after introduction of the stove. Such field measurements give a very accurate guide to carbon dioxide savings, for three reasons:

- mass is easily measured with precision
- the efficiency of the traditional stove compared to the improved stove is measured in actual conditions of use, by virtue of measurement of mass. This approach eliminates the risk that laboratory conditions differ from field conditions, for instance with respect to fuel wood humidity content, thermal load of the cooking process, application of the fuel, amount of residue, and so on.
- no account is taken of the potential savings made in non-CO2 green-house gases, simplifying the measurements and so assuring the accuracy and conservatism of the results

The methodology is therefore particularly well suited to provision of conservative assessments of emission reductions.

D.3 Data to be monitored:

>>

The project activity applies methodology *'Improved Efficiency in Use of Non-Renewable Biomass'*.

Under the proposed methodology monitoring shall include the following:

- Monitoring shall measure representative samples of mass of biomass used before and after installation of devices and efficiency measures, ensuring that the measurements are taken for the same loading and thermal effect. It will include descriptions of the before and after technologies.
- Monitoring will measure representative samples of the moisture content of the biomass at the time it is burnt
- Monitoring shall consist of an annual check of all appliances and new measures installed or a representative sample thereof to ensure that they are still operating or replaced by an equivalent in service appliance or measure.
- Monitoring shall include the efficiency of the appliances.

[3] this builds on the methodology proposed in July 2006 to the CDM EB by Bernard Schlamadinger of Joanneum Research, Graz, Austria, in collaboration with Anandi Sharan of CERINDIA.

Climate Care amended the section on identification of non-renewability of biomass by drawing from the submission to the Gold Standard by Anandi Sharan, entitled Switching from Non-Renewable Biomass for Cooking and water heating to Cooking and water heating Energy from Renewable Sources for the Individual Domestic User, and Conserving Fuel wood for cooking and water heating by the Individual Domestic User - version 1 22/06/2006.

- Monitoring shall ensure that the replaced low efficiency appliances are not used within the boundary.
- Monitoring will include measurement of the quantity of alternative fuels (such as agricultural waste) used by project participants and an assessment will be made as the aggregate biomass renewability status of the project region
- If the leakage deduction of 15% is not applied, monitoring shall demonstrate that greater use of non-renewable biomass outside the project boundary does not occur.

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

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

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

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

Data / Parameter:	**Ensure replaced low efficiency appliances are not used within the boundary**
Data unit:	
Description:	Bi-annual survey data on user behaviour in addition the Stove sales data demonstrates the increasing market share of the NLS over time.
Source of data to be used:	Stove sales data (2003-2006) User surveys (2003-2006)
Value of data	Ensure the accuracy of emissions reductions calculations
Description of measurement 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:	Statistical analysis External evaluation
Any comment:	

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

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

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

be applied:	
Any comment:	

D.4. Qualitative explanation of how quality control (QC) and quality assurance (QA) procedures are undertaken:

>>

QC and QC are considered essential, and manifested on the products by a QC label.

Quality Control

The efficiency of a representative sample of the NLS produced in all the production centers is tested in the laboratory every four months ensuring that the efficiency does not drop and production quality remains the same. If the results provide evidence that one or more cookstoves are performing inadequately immediate action is taken. The production centers from which the cookstoves were released are visited, the problem is distinguished and technical assistance is supplied to the artisans. If there are still more faulty cookstoves in stock they are destroyed

Quality Assurance

A system of labelling was initiated for quality assurance of NLS. Producers whose construction standards have consistently met the required specifications are provided with labels to attach to the finished product. Quality control labels are issued on the basis of observed sales and only once the stock has been monitored.

To assure the strength of the QC and QA procedures, GERES Cambodia is in the process of double certification ISO 9001/14000.

D.5. Please describe briefly the operational and management structure that the project participant(s) will implement in order to monitor emission reductions and any leakage effects generated by the project activity:

>>

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

A MULTI-LAYER MONITORING SYSTEM

In order to keep track of the Improved Cookstoves (ICS) throughout the supply chain, training is provided to all producers, a representative number of retailers and monitoring staff together with tailor-made notebooks. Middlemen are appointed with a less strict control. The majority of the NLS are being sold to the end user through the official retailers. Nonetheless, several middlemen have been identified and it is well-known their whereabouts and regular customers. Producers, retailers and monitoring staff are instructed on the way to record in their respective notebooks the most important aspects for monitoring purposes.

Production Side

Data Collection.-The producers are taught to write down in the notebook the following factors for production activities: date on which the stoves were produced, kind of stove (traditional or improved) and amount of stoves produced. And for selling activities: date on which the stoves were sold, kind of stove, amount of stoves sold, price and to whom they were sold (retailer or middleman).

Frequency. - Trained staff pays a monthly visit to the production centers situated within the range of personal visit. It is quite difficult to visit all the production centers especially the ones sited far away from that range every month. Therefore, the data is collected via telephone interviews every month and a personal visit takes place every four months.

Output of this stage.-Besides the data of the inventory recorded in the producers' notebook and explained above, the producer identity and the location of the retailers and middlemen are captured in the monitoring database.

Quality Control. - Moreover, the efficiency of a representative sample of the NLS produced in all the production centers is tested in the laboratory every four months ensuring that the efficiency does not drop and production quality remains the same. If the results provide evidence that one or more cookstoves are performing inadequately immediate action is taken. The production centres from which the cookstoves were released are visited, the problem is distinguished and technical assistance is supplied to the artisans. If there are still more faulty cookstoves in stock they are destroyed.

Intermediaries

Middlemen

Data Collection. -These intermediaries have been detected to be transporting NLS and working generally from production side to retail side. They hardly ever sell to the final user. Their usual clients, recognized retailers, are identified together with their work's whereabouts.

Frequency.- Just as the retailers, middlemen are questioned kindly about their activities every month.

Output of this stage. – The most important information needed to be taken into account as far as middlemen are concerned is their habitual work location and typical customers.

Retail Side

Recognized Retailers

Data Collection.-The acknowledged retailers participate in the monitoring activity taking note of the following factors at the time of acquiring the NLS: date on which the stoves were bought, amount and kind of stoves bought, buying price, from which production centre or middleman the stoves were bought. And similarly at the time of selling the NLS: date on which the stoves were sold, amount and kind of stoves sold, selling price, to whom they were sold (middleman or individual).

Frequency. - A considerable sample of retailers, which rotates each month, is selected from the information obtained out of the producers' inventory. Monitoring personnel stops every month by their location to compile the data from their notebooks. It is worth mentioning that there have been negotiations with these sellers and they have been told to encourage their customers to get rid of their old traditional cookstoves.

Output of this stage. - At this stage, market share together with penetration rate are detected and captured in the monitoring database.

User Side

Data Collection. From the retailers' data mentioned above, a sample of people who acquired NLS is chosen. This choice is based on the location of the merchants who sold the most. Our skilled promoters go to these areas and visit people's homes to check their NLS. They sit and talk with them, in a friendly way, about their experience with their NLS. They make sure that the traditional cookstoves are not used at their home.

Frequency. - Monitoring at the users side consists of an annual survey of a significant sample of families thereof to ensure that the Improved Cookstoves are still operating or replaced by an equivalent in service appliance. Despite of the fact that people prefer the NLS over the traditional ones; users are reminded about the advantages of using their NLS and discouraged of switching back to the harmful traditional cook stoves.

Output of this stage.-Equipment ratio, replacement rate, satisfaction and cookstove lifetime are important factors obtained out of this survey and captured in the monitoring database.

Leakage effects will be considered with the methodology's default value of 15%. See Section E.1.2.2 for further information.

D.6. Name of person/entity determining the monitoring methodology:

>>

Samuel Bryan
Carbon and Technology Analyst
GERES Cambodia
#422, street 310, Boeung Keng Kang 3,
Phnom Penh

SECTION E.: Estimation of GHG emissions by sources:

E.1. Formulae used:

E.1.1 Selected formulae as provided in appendix B:

E.1.2 Description of formulae when not provided in appendix B:

E.1.2.1 Describe the formulae used to estimate anthropogenic emissions by sources of GHGs due to the project activity within the project boundary:

>>

The anthropogenic emissions due to the project activity have been calculated (ref. "CFSP Carbon Balance", E.BUYSMAN & al., 2006): emissions from transport, office and research and development total less than 100 TCO2 per year.
However these emissions are compensated by GERES with an external Carbon Offset company.

Besides, there are no anthropogenic emissions due to the project activity as the GHG emissions resulting from the combustion of charcoal in New Lao Stoves (and from the production of this charcoal) would have occurred without the project activity as well. Therefore, only the emission reduction is considered here, see E.1.2.4.

E.1.2.2 Describe the formulae used to estimate leakage due to the project activity, where required, for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities

The methodology guidelines states:

"If there is a possibility that the savings of non-renewable biomass due to the project activity lead to greater use of non-renewable biomass outside the project boundary, then a leakage deduction of 15% is made to the projected gross emission reduction estimate."
Therefore a 15% leakage deduction is applied.

E.1.2.3 The sum of E.1.2.1 and E.1.2.2 represents the project activity emissions:

>>

The project activity emissions amount to 15% of emission reductions discarded to address leakage.

E.1.2.4 Describe the formulae used to estimate the anthropogenic emissions by sources of GHGs in the baseline using the baseline methodology for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities:

To ensure conservative quantities of emissions reductions, this document does not include:

- methane emissions avoided from the charcoal production process, even though an approved methodology exists[4]
- reduction of transport emissions from the transport of charcoal, the transport of raw materials and cook stoves.[5]

[4] AM0041, "Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production"

- reduction of non-CO2 emissions from better quality combustion at the user side.

Only CO² emissions are taken into account. Therefore the emission reductions that will result can be considered a conservative estimate.

The formula used follows the CC NRN BSAS methodology that states:

$$ER_y = B_{y,savings} \cdot NCV_{biomass} \cdot EF_{non-renewable\ biomass,CO2} \cdot 10^{-3}$$

where:

ERy	Emission reductions during the year y in t CO_2e
By,savings	Quantity of non-renewable biomass that is saved in tonnes In the case of charcoal the quantity of non-renewable biomass going into the charcoal making process should be used (IPCC default: 6 kg wood per kg charcoal, 2006)
NCVbiomass	Net calorific value of the non-renewable biomass that is substituted (IPCC (2006) default for wood fuel, 15.6 MJ/Kg).
EFnon-renewable biomass, CO_2	Emission factor for the substitution of non-renewable biomass by similar consumers locally in t CO_2 / TJ biomass.

$$B_{y,savings} = B_{y,woodsaving} + B_{y,woodcharcoalsaving}$$

in other terms:

$$B_{y,savings} = B_{y,wood} \cdot (1 - \frac{\eta_{old}}{\eta_{new}})_{wood} + B_{y,woodcharcoal} \cdot (1 - \frac{\eta_{old}}{\eta_{new}})_{woodcharcoal}$$

where:

$B_{y,wood}$ and $B_{y,woodcharcoal}$	Quantity of non-renewable biomass used in the absence of the project activity for wood users and wood equivalent for charcoal users **Actual local data available from baseline surveys.**
For wood and charcoal users η_{old} and η_{new}	Efficiency of the system being replaced, use 20% as default value or local data if available. Efficiency of the system being deployed as part of the project activity. **The Real Saving Cooking Test provides the efficiency improvement rates switching from old to new stoves:** **1. 20.89% for wood users** **2. 21.2% for charcoal users**

$$EF_{non\text{-}renewable\ biomas,\ CO2} = \frac{1}{2} \cdot (EF_{CO2,\ start} + EF_{CO2,\ end})$$

$$EF_{CO2,\ start} = EF_{CO2,\ biomass}$$

$$EF_{CO2,\ end} = X * (\frac{\varepsilon_{stoves,\ biomass}}{\varepsilon_{stoves,\ fossil}} \cdot EF_{CO2,\ fossil}) + (1 - X) * EF_{CO2,biomass}$$

where:

$EFCO_2$, start	CO_2 emission factor of the baseline at the start of the project
$EFCO_2$, end	CO_2 emission factor of the baseline at the end of the project

[5] The diesel consumption of charcoal transporters supplying Phnom Penh alone is estimated at 1 million liters per year ("Wood Energy Baseline Study for CDM in Cambodia", E.R. VAN MANSVELT, CCCO-IGES 2006).

$EFCO_2$, fossil	CO_2 emission factor for the fossil fuel; 71.9 tCO_2/TJ for Kerosene, 63.1 tCO_2/TJ for LPG (IPCC 2006) or the IPCC default value of the fossil fuel commonly observed with local consumers
$EFCO_2$, biomass	CO_2 emission factor for the biomass fuel; 112 tCO_2/TJ (default for biomass from IPCC 2006).
X	Share of fossil fuel used, in the baseline, by the "in-project" consumers at the time when the project ends, according to historical and/or current trends. X is to be determined as part of the PDD. By definition, at the beginning of the project all "in-project" consumers use non-renewable biomass.
Estoves,biomass	Average efficiency of stoves fired with biomass, use 20% as default value or local data if available
Estoves,fossil	Average efficiency of stoves fired with fossil fuels, use 50% as default value or local data if available

As per the baseline study results showing a drastic increase of charcoal use, the above reference to fossil fuel switch is not applicable to our project area. The value retained for X is "0".

Henceforth the key component B_y is derived from calculations combining baseline data and monitoring data:

$B_{y,wood} = \sum B_{wood\ m,y}$ with $B_{wood\ m,y} = n_{stoves\ in\ use,\ m}/RA\ .\ m_{HH\ wood}.share_{wood\ users}$
and
$B_{y,charcoal} = \sum B_{charcoal\ m,y}$ with $B_{charcoal\ m,y} = n_{stoves\ in\ use,m}/RA\ .\ CTW\ .\ m_{HH\ charcoal}.share_{charcoal\ users}$

Where:

$B_{wood,m,y}$	Mass of wood used during month m of year y
$B_{charcoal\ m,y}$	Mass of wood equivalent from charcoal used during month m of year y
$n_{stoves\ in\ use,\ m}$	Number of stoves in use during month m.
RA	Equipment Ratio, i.e. number of stoves in use per household
$m_{HH\ wood}$	Mass of wood used in a household per month (84.464 kg wood/month from baseline studies)
CTW	Charcoal To Wood conversion factor = 6 T wood / T charcoal (from baseline studies)
$m_{HH\ charcoal}$	Mass of charcoal used in a household per month (64.467 kg charcoal/month from baseline studies)
$share_{wood\ users}$	2.6% from baseline studies
$share_{charcoal\ users}$	97.4% from baseline studies

Given that stoves are replaced after a conservative 36 months of use, we have:
$n_{stoves\ in\ use,\ m} = \sum n_{stoves\ sold,\ m} - n_{stoves\ sold,\ m-36}$

E.1.2.5 Difference between E.1.2.4 and E.1.2.3 represents the emission reductions due to the project activity during a given period:

>>

The annual emission reduction ER is calculated as

ER = BE - leakage
= BE – 15% of BE

E.2 Table providing values obtained when applying formulae above:

>>

The details are provided in annex 4.

The summary table is as follows:

Year	Baseline Emissions	Leakage 15%	Emission Reductions
2003	3,320	498	2,822
2004	25,686	3,853	21,833
2005	59,977	8,996	50,980
2006	112,800	16,920	95,880
2007	184,423	27,663	156,759
2008	284,936	42,740	242,195
2009	332,482	49,872	282,610
2010	392,941	58,941	333,999
2011	460,395	69,059	391,336
2012	533,471	80,021	453,450

SECTION F.: Environmental impacts:

F.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

According to the Designated National Authority (DNA) of the Kingdom of Cambodia, no Environmental Impact Assessment is required.

SECTION G. Stakeholders' comments:

G.1. Brief description of how comments by local stakeholders have been invited and compiled:

>>

Institutional stakeholders were involved in the project design (Directorate of Energy, Ministry of Industry Mines and Energy). Their comments were integrated in the design of the EU co-funded project document.

As it is a decentralized installations project, where Cambodian families are the main technology investors, the stakeholders in the field are not formally consulted as in industrial projects. Their views and comments are integrated in the baseline studies and monitoring studies (user surveys, etc.).

The upstream stakeholders are gathered on a quarterly basis: the stove producers, distributors and retailers meet to provide feedback on the way the project is run, to improve the relevance and effectiveness of the technical assistance. These comments are available in quarterly activity reports.

G.2. Summary of the comments received:

>>

Not Applicable (see above)

G.3. Report on how due account was taken of any comments received:

>>

Not Applicable (see above).

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	GERES (Groupe Energies Renouvelables et Environnement)
Street/P.O.Box:	2, cours Maréchal Foch
Building:	
City:	Aubagne
State/Region:	
Postfix/ZIP:	13400
Country:	France
Telephone:	33 (0)4 42 18 55 88
FAX:	33 (0)4 42 03 01 56
E-Mail:	geres@free.eu
URL:	www.geres.eu
Represented by:	
Title:	Executive Director
Salutation:	Mr
Last Name:	GUINEBAULT
Middle Name:	
First Name:	Alain
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	GERES Cambodia
Street/P.O.Box:	422 st.310 (corner 95)
Building:	
City:	Phnom Penh 3
State/Region:	
Postfix/ZIP:	Po Box 2528
Country:	Cambodia
Telephone:	855 (0)23 986891
FAX:	855 (0)23 221314
E-Mail:	admin@cfsp.org.kh
URL:	www.cfsp.org.kh
Represented by:	
Title:	Director
Salutation:	Mr
Last Name:	BASKORO
Middle Name:	
First Name:	Iwan
Direct tel:	
Personal E-Mail:	iwan@cfsp.org.kh

Organization:	Ministry of Industry, Mines & Energy
Street/P.O.Box:	Nº 45, Preah Norodom Boulevard / P.O. Box 1118
Building:	
City:	Phnom Penh
State/Region:	
Postfix/ZIP:	
Country:	Cambodia
Telephone:	(855) 23 211 141
FAX:	(855) 23 428 263
E-Mail:	info@mime.gov.kh
URL:	www.wenetcam.net
Represented by:	
Title:	Director of Energy
Salutation:	H.E. Dr
Last Name:	TUN
Middle Name:	
First Name:	LEAN
Department:	Directorate of Energy
Mobile:	
Direct FAX:	(855) 23 428 263

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The public funding received in the initial years of the project comes from EU DG 6 – Environment, under the scheme for the protection and promotion of tropical forests.
This funding covers 80% of the project costs of these particular years.
It does not involve any obligation towards EU besides the regular procedures and regulations of the use of EU development aid through NGOs. It therefore does not constitute a diversion of ODA.

- - - -

Annex 3

Real charcoal saving of New Lao Bucket Stove compared to Traditional Lao Bucket Stove

GERES Cambodia develops a specific procedure to validate in the field the real charcoal saving of the improved model after dissemination in the field. This procedure is based on standard international stove testing with maximum accuracy (reducing external parameters variation).

Household Comparative Charcoal Consumption Test Procedure for Charcoal stoves in Cambodia

Justification

To estimate real fuel saving of the NLS, we conducted Standard Kitchen Performance Test with one hundred households during the first phase of Cambodia Fuel-wood Saving Project in 1999. It was found that this procedure was quite complicated to undertake, as it had to use large human resources, with various sources of errors (cooking different types of food, charcoal quality, ratio adult/children, and data collecting errors) and consequently low accuracy.

By statistic approach we proved it's more accurate to:

- reduce the sample because of population homogeneity in cooking habits
- fix the characteristics of the charcoal (providing the charcoal is not changing the level of consumption)
- establish the fuel-wood saving ratio by comparing the amount used by amount of water used for boiling (food and drinking water) more accurate than try to establish an amount of wood used by an equivalent adult ratio like in standard test.

Taking into account regular outside temperature all over the year, for Cambodia, it's not necessary to conduct a test for cold and hot season (a well insulated stove will be more efficient in winter compared a non insulated one).

The absolute data is only interesting for estimating the global consumption of a population; it's obtained by large sampling survey to obtain a statistically valuable averaged mean. But it's not the objective of comparative testing after introducing an improved stove.

Procedure

To conduct the test, 20 sample households are identified based on the number of stoves distributed in that particular area which should be statistically significant.
It lasts two weeks by family, one week cooking with traditional one, one week with improved one. That means we obtained 140 daily tests with one stove model, and 140 daily tests with other model.

Before performing the test, a typical schedule of meals, water used especially for cooking, is to be established in both traditional and improved stoves. Whatever the foods (breakfast, lunch and dinner) are cooked in the traditional stove should be cooked in the improved stoves. In that way, we can compare the averages of the daily ratio of kg of wood by kg of water for traditional model and for new model.

Daily consumption of wood and water used for boiling (food and drinking) is measured by help of 1% accuracy balance, and containers dedicated for water to be boiled.

The **Household Fuel Saving (HFS)** is calculated based on the following formula:

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

Where,

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

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

The HFS can be calculated for each family, an average is calculated for representing all the families (statistic analysis help to eliminate extreme values, we consider acceptable when the ratio of standard deviation/average mean is maximum 5 %).

Test made in Phnom Penh during two weeks: 15-21/01/2004 and 25/31/01/2004

The test results are given in table below:

: **Household fuel saving with respect to Water per Family per Day**

Stove type	Experiment conducted area	Fuel type	Rice (kg)	Water (kg)	Fuel (kg)	HFS (%)
TLS	Phnom Penh	Charcoal	1.943	13.459	2.118	
NLS	Phnom Penh	Charcoal	1.948	13.336	1.657	21.8

It has then been proved that NLS could save **21,8 %** of charcoal in the real field conditions towards Traditional Lao Bucket Stove (TLS).
The quantity of water used per family is almost the same in both traditional and improved stoves confirming the homogeneity of the sample. Database is available.

Annex 4 – ER calculations

y	m	monitoring period		$n_{stoves\ sold}$	$n_{stoves\ sold,\ m-36}$	$n_{stoves\ in\ use,\ m}$	$B_{wood\ m,y}$	$B_{charcoal\ m,y}$	$B_{m,woodsaving}$	$B_{m,charcoalsaving}$	$B_{m,saving}$	NCV biomass	Efbiomass	leakage 15%	
												15.6	112		
		from	to	Qty sold								ER m	temp BE		**ER y**
1	**1**	10-May-03	9-Jun-03	2205	0										
	2	10-Jun-03	9-Jul-03	2331	0	2205	64.7	332.01	13.5	70.4	83.9	147			
	3	10-Jul-03	9-Aug-03	2362	0	4536	133.1	683.0	27.8	144.8	172.6	302			
	4	10-Aug-03	9-Sep-03	2630	0	6898	202.4	1038.6	42.3	220.2	262.5	459			
	5	10-Sep-03	9-Oct-03	2341	0	9528	279.6	1434.6	58.4	304.1	362.5	633			
	6	10-Oct-03	9-Nov-03	3035	0	11869	348.3	1787.1	72.8	378.9	451.6	789			
	7	10-Nov-03	9-Dec-03	2261	0	14904	437.3	2244.1	91.4	475.8	567.1	991	3320	498	**2822**
2	**8**	10-Dec-03	9-Jan-04	2251	0	17165	503.7	2584.5	105.2	547.9	653.1	1141			
	9	10-Jan-04	9-Feb-04	2742	0	19416	569.7	2923.5	119.0	619.8	738.8	1291			
	10	10-Feb-04	9-Mar-04	2709	0	22158	650.2	3336.3	135.8	707.3	843.1	1473			
	11	10-Mar-04	9-Apr-04	2463	0	24867	729.7	3744.2	152.4	793.8	946.2	1653			
	12	10-Apr-04	9-May-04	1498	0	27330	801.9	4115.1	167.5	872.4	1039.9	1817			
	13	10-May-04	9-Jun-04	3097	0	28828	845.9	4340.6	176.7	920.2	1096.9	1917			
	14	10-Jun-04	9-Jul-04	4046	0	31925	936.8	4807.0	195.7	1019.1	1214.8	2122			
	15	10-Jul-04	9-Aug-04	3491	0	35971	1055.5	5416.2	220.5	1148.2	1368.7	2391			
	16	10-Aug-04	9-Sep-04	3056	0	39462	1157.9	5941.8	241.9	1259.7	1501.6	2624			
	17	10-Sep-04	9-Oct-04	4112	0	42518	1247.6	6402.0	260.6	1357.2	1617.8	2827			
	18	10-Oct-04	9-Nov-04	3459	0	46630	1368.3	7021.1	285.8	1488.5	1774.3	3100			
	19	10-Nov-04	9-Dec-04	3319	0	50089	1469.8	7541.9	307.0	1598.9	1905.9	3330	25686	3853	**21833**
3	**20**	10-Dec-04	9-Jan-05	3487	0	53408	1567.1	8041.7	327.4	1704.8	2032.2	3551			
	21	10-Jan-05	9-Feb-05	4206	0	56895	1669.5	8566.7	348.8	1816.1	2164.9	3783			
	22	10-Feb-05	9-Mar-05	3440	0	61101	1792.9	9200.0	374.5	1950.4	2324.9	4062			
	23	10-Mar-05	9-Apr-05	4508	0	64541	1893.8	9718.0	395.6	2060.2	2455.8	4291			

	24	10-Apr-05	9-May-05	2747	0	69049	2026.1	10396.7	423.3	2204.1	2627.4	4591			
	25	10-May-05	9-Jun-05	4222	0	71796	2106.7	10810.4	440.1	2291.8	2731.9	4773			
	26	10-Jun-05	9-Jul-05	4165	0	76018	2230.6	11446.1	466.0	2426.6	2892.5	5054			
	27	10-Jul-05	9-Aug-05	4770	0	80183	2352.8	12073.2	491.5	2559.5	3051.0	5331			
	28	10-Aug-05	9-Sep-05	5039	0	84953	2492.8	12791.4	520.7	2711.8	3232.5	5648			
	29	10-Sep-05	9-Oct-05	4509	0	89992	2640.6	13550.1	551.6	2872.6	3424.3	5983			
	30	10-Oct-05	9-Nov-05	5207	0	94501	2772.9	14229.1	579.3	3016.6	3595.8	6283			
	31	10-Nov-05	9-Dec-05	5408	0	99708	2925.7	15013.1	611.2	3182.8	3794.0	6629	59977	8996	**50980**
4	**32**	10-Dec-05	9-Jan-06	6016	0	105116	3084.4	15827.4	644.3	3355.4	3999.7	6988			
	33	10-Jan-06	9-Feb-06	6469	0	111132	3260.9	16733.2	681.2	3547.4	4228.7	7388			
	34	10-Feb-06	9-Mar-06	6301	0	117601	3450.8	17707.3	720.9	3753.9	4474.8	7818			
	35	10-Mar-06	9-Apr-06	7596	0	123902	3635.6	18656.0	759.5	3955.1	4714.6	8237			
	36	10-Apr-06	9-May-06	6849	2205	131498	3858.5	19799.7	806.0	4197.5	5003.6	8742			
	37	10-May-06	9-Jun-06	8221	2331	136142	3994.8	20499.0	834.5	4345.8	5180.3	9051			
	38	10-Jun-06	9-Jul-06	7681	2362	142032	4167.6	21385.8	870.6	4533.8	5404.4	9443			
	39	10-Jul-06	9-Aug-06	10771	2630	147351	4323.7	22186.7	903.2	4703.6	5606.8	9796			
	40	10-Aug-06	9-Sep-06	13383	2341	155492	4562.6	23412.5	953.1	4963.5	5916.6	10337			
	41	10-Sep-06	9-Oct-06	11238	3035	166534	4886.6	25075.1	1020.8	5315.9	6336.7	11072			
	42	10-Oct-06	9-Nov-06	12,680	2261	174737	5127.3	26310.3	1071.1	5577.8	6648.9	11617			
	43	10-Nov-06	9-Dec-06	9,750	2251	185156	5433.0	27879.0	1135.0	5910.4	7045.3	12310	112800	16920	**95880**
5	**44**	10-Dec-06	9-Jan-07	8,517	2742	192655	5653.1	29008.2	1180.9	6149.7	7330.7	12808			
	45	10-Jan-07	9-Feb-07	9543	2709	198430	5822.5	29877.7	1216.3	6334.1	7550.4	13192			
	46	10-Feb-07	9-Mar-07	9744	2463	205264	6023.0	30906.7	1258.2	6552.2	7810.4	13646			
	47	10-Mar-07	9-Apr-07	9946	1498	212545	6236.7	32003.1	1302.8	6784.6	8087.5	14130			
	48	10-Apr-07	9-May-07	10147	3097	220993	6484.6	33275.0	1354.6	7054.3	8408.9	14692			
	49	10-May-07	9-Jun-07	10348	4046	228043	6691.4	34336.5	1397.8	7279.3	8677.2	15161			
	50	10-Jun-07	9-Jul-07	10550	3491	234345	6876.4	35285.4	1436.5	7480.5	8917.0	15580			
	51	10-Jul-07	9-Aug-07	10751	3056	241403	7083.5	36348.3	1479.7	7705.8	9185.6	16049			
	52	10-Aug-07	9-Sep-07	10952	4112	249098	7309.3	37506.9	1526.9	7951.5	9478.4	16561			
	53	10-Sep-07	9-Oct-07	11153	3459	255938	7510.0	38536.8	1568.8	8169.8	9738.6	17015			
	54	10-Oct-07	9-Nov-07	11355	3319	263633	7735.8	39695.4	1616.0	8415.4	10031.4	17527			
	55	10-Nov-07	9-Dec-07	11556	3487	271669	7971.6	40905.3	1665.3	8671.9	10337.2	18061	184423	27663	**156759**
6	**56**	10-Dec-07	9-Jan-08	11757	4206	279738	8208.3	42120.3	1714.7	8929.5	10644.2	18598			
	57	10-Jan-08	9-Feb-08	11959	3440	287289	8429.9	43257.3	1761.0	9170.5	10931.6	19100			
	58	10-Feb-08	9-Mar-08	12160	4508	295808	8679.9	44540.0	1813.2	9442.5	11255.7	19666			

	59	10-Mar-08	9-Apr-08	12361	2747	303460	8904.4	45692.1	1860.1	9686.7	11546.9	20175			
	60	10-Apr-08	9-May-08	12563	4222	313074	9186.5	47139.8	1919.1	9993.6	11912.7	20814			
	61	10-May-08	9-Jun-08	12764	4165	321415	9431.3	48395.6	1970.2	10259.9	12230.1	21368			
	62	10-Jun-08	9-Jul-08	12965	4770	330014	9683.6	49690.4	2022.9	10534.4	12557.3	21940			
	63	10-Jul-08	9-Aug-08	13167	5039	338209	9924.0	50924.4	2073.1	10796.0	12869.1	22485			
	64	10-Aug-08	9-Sep-08	13368	4509	346337	10162.5	52148.1	2123.0	11055.4	13178.4	23025			
	65	10-Sep-08	9-Oct-08	13569	5207	355196	10422.5	53482.0	2177.3	11338.2	13515.4	23614			
	66	10-Oct-08	9-Nov-08	13771	5408	363558	10667.9	54741.2	2228.5	11605.1	13833.6	24170			
	67	10-Nov-08	9-Dec-08	13972	6016	371921	10913.2	56000.3	2279.8	11872.1	14151.8	24726	284936	42740	**242195**
7	**68**	10-Dec-08	9-Jan-09	14173	6469	379876	11146.7	57198.2	2328.5	12126.0	14454.6	25255			
	69	10-Jan-09	9-Feb-09	14375	6301	387581	11372.7	58358.3	2375.8	12371.9	14747.7	25767			
	70	10-Feb-09	9-Mar-09	14576	7596	395654	11609.6	59573.9	2425.3	12629.7	15054.9	26304			
	71	10-Mar-09	9-Apr-09	14777	6849	402634	11814.5	60624.8	2468.0	12852.5	15320.5	26768			
	72	10-Apr-09	9-May-09	14978	8221	410562	12047.1	61818.6	2516.6	13105.5	15622.2	27295			
	73	10-May-09	9-Jun-09	15180	7681	417320	12245.4	62836.1	2558.1	13321.2	15879.3	27744			
	74	10-Jun-09	9-Jul-09	15381	10771	424818	12465.4	63965.2	2604.0	13560.6	16164.6	28243			
	75	10-Jul-09	9-Aug-09	15582	13383	429428	12600.7	64659.3	2632.3	13707.8	16340.1	28549			
	76	10-Aug-09	9-Sep-09	15784	11238	431628	12665.2	64990.5	2645.8	13778.0	16423.7	28696			
	77	10-Sep-09	9-Oct-09	15985	12680	436174	12798.6	65674.9	2673.6	13923.1	16596.7	28998			
	78	10-Oct-09	9-Nov-09	16186	9750	439479	12895.6	66172.5	2693.9	14028.6	16722.5	29217			
	79	10-Nov-09	9-Dec-09	16388	8517	445915	13084.4	67141.7	2733.3	14234.0	16967.4	29645	332482	49872	**282610**
8	**80**	10-Dec-09	9-Jan-10	16589	9543	453786	13315.4	68326.8	2781.6	14485.3	17266.9	30169			
	81	10-Jan-10	9-Feb-10	16790	9744	460832	13522.1	69387.7	2824.8	14710.2	17535.0	30637			
	82	10-Feb-10	9-Mar-10	16992	9946	467878	13728.9	70448.6	2868.0	14935.1	17803.1	31106			
	83	10-Mar-10	9-Apr-10	17193	10147	474924	13935.6	71509.5	2911.2	15160.0	18071.2	31574			
	84	10-Apr-10	9-May-10	17394	10348	481970	14142.4	72570.5	2954.3	15384.9	18339.3	32042			
	85	10-May-10	9-Jun-10	17596	10550	489016	14349.1	73631.4	2997.5	15609.9	18607.4	32511			
	86	10-Jun-10	9-Jul-10	17797	10751	496062	14555.9	74692.3	3040.7	15834.8	18875.5	32979			
	87	10-Jul-10	9-Aug-10	17998	10952	503108	14762.6	75753.2	3083.9	16059.7	19143.6	33448			
	88	10-Aug-10	9-Sep-10	18199	11153	510154	14969.4	76814.1	3127.1	16284.6	19411.7	33916			
	89	10-Sep-10	9-Oct-10	18401	11355	517200	15176.2	77875.1	3170.3	16509.5	19679.8	34385			

	90	10-Oct-10	9-Nov-10	18602	11556	524246	15382.9	78936.0	3213.5	16734.4	19947.9	34853			
	91	10-Nov-10	9-Dec-10	18803	11757	531292	15589.7	79996.9	3256.7	16959.3	20216.0	35321	392941	58941	**333999**
9	**92**	10-Dec-10	9-Jan-11	19005	11959	538338	15796.4	81057.8	3299.9	17184.3	20484.1	35790			
	93	10-Jan-11	9-Feb-11	19206	12160	545384	16003.2	82118.8	3343.1	17409.2	20752.2	36258			
	94	10-Feb-11	9-Mar-11	19407	12361	552430	16209.9	83179.7	3386.2	17634.1	21020.3	36727			
	95	10-Mar-11	9-Apr-11	19609	12563	559476	16416.7	84240.6	3429.4	17859.0	21288.4	37195			
	96	10-Apr-11	9-May-11	19810	12764	566522	16623.4	85301.5	3472.6	18083.9	21556.6	37664			
	97	10-May-11	9-Jun-11	20011	12965	573568	16830.2	86362.5	3515.8	18308.8	21824.7	38132			
	98	10-Jun-11	9-Jul-11	20213	13167	580614	17036.9	87423.4	3559.0	18533.8	22092.8	38600			
	99	10-Jul-11	9-Aug-11	20414	13368	587660	17243.7	88484.3	3602.2	18758.7	22360.9	39069			
	100	10-Aug-11	9-Sep-11	20615	13569	594706	17450.4	89545.2	3645.4	18983.6	22629.0	39537			
	101	10-Sep-11	9-Oct-11	20817	13771	601752	17657.2	90606.2	3688.6	19208.5	22897.1	40006			
	102	10-Oct-11	9-Nov-11	21018	13972	608798	17863.9	91667.1	3731.8	19433.4	23165.2	40474			
	103	10-Nov-11	9-Dec-11	21219	14173	615844	18070.7	92728.0	3775.0	19658.3	23433.3	40943	460395	69059	**391336**
10	**104**	10-Dec-11	9-Jan-12	21421	14375	622890	18277.4	93788.9	3818.2	19883.3	23701.4	41411			
	105	10-Jan-12	9-Feb-12	21622	14576	629936	18484.2	94849.8	3861.3	20108.2	23969.5	41880			
	106	10-Feb-12	9-Mar-12	21823	14777	636982	18690.9	95910.8	3904.5	20333.1	24237.6	42348			
	107	10-Mar-12	9-Apr-12	22024	14978	644028	18897.7	96971.7	3947.7	20558.0	24505.7	42816			
	108	10-Apr-12	9-May-12	22226	15180	651074	19104.4	98032.6	3990.9	20782.9	24773.8	43285			
	109	10-May-12	9-Jun-12	22427	15381	658120	19311.2	99093.5	4034.1	21007.8	25041.9	43753			
	110	10-Jun-12	9-Jul-12	22628	15582	665166	19517.9	100154.5	4077.3	21232.7	25310.0	44222			
	111	10-Jul-12	9-Aug-12	22830	15784	672212	19724.7	101215.4	4120.5	21457.7	25578.1	44690			
	112	10-Aug-12	9-Sep-12	23031	15985	679258	19931.4	102276.3	4163.7	21682.6	25846.3	45159			
	113	10-Sep-12	9-Oct-12	23232	16186	686304	20138.2	103337.2	4206.9	21907.5	26114.4	45627			
	114	10-Oct-12	9-Nov-12	23434	16388	693350	20344.9	104398.2	4250.1	22132.4	26382.5	46095			
	115	10-Nov-12	9-Dec-12	23635	16589	700396	20551.7	105459.1	4293.2	22357.3	26650.6	46564			
	116	10-Dec-12	9-Jan-13	23836	16790	707442	20758.4	106520.0	4336.4	22582.2	26918.7	47032	533471	80021	**453450**

ANNEX 5 DATA MANAGEMENT.