Dissemination of domestic efficient cookstoves in Cambodia

2009

Looking back on a 10-year programme combining Development, Fight against Climate Change and Environemental Protection

Lessons learned from a large-scale dissemination, impact assessment and terms of access to carbon finance

Agence Française de Développement

geres

Foreword

At present about biomass energy counts for 80% of Cambodia's energy balance and very little has been done to address this issue. Amongst those, family cooking shares the highest percentage in biomass energy consumption. For rural families firewood is an important cooking fuel, whereas for urban families charcoal is considered as the main cooking fuel especially for middle to lower income families as it is much cheaper than kerosene or liquid petroleum gas (LPG).

In 2002, supported by the European Commission, GERES and Ministry of Industry, Mines and Energy (MIME) collaborated to set-up a project promoting large scale utilization of improved cook stove, the New Lao Stove (NLS), for urban areas. The main objective of the project is to commercialize NLS, to promote energy efficiency by reducing charcoal consumption, to reduce indoor air pollution, to mitigate climate change by reducing the emission of green house gases and to create new job opportunity by producing and distributing the NLS.

The chosen strategy to commercialize the NLS has proven to be effective in reaching wide scale users. Now the commercialization is managed fully by private supply chain catering nationwide supply. Until today, more than 800,000 units of NLS have been produced and sold out, and about 300,000 families are enjoying the economic benefit of NLS; time saving and money saving.

Wide utilization of the NLS since 2003 until the end of 2008 has reduced more than 400,000 ton or 600,000 m^3 of wood that is equal to 4,500 ha of forest.

The reduction of wood consumption for cooking fuel also reduced the emission of green house gases by more than 300,000 ton of CO_2 emission. Certainly this project contributes to the climate change mitigation while alleviating poverty. The emission reduction has been credited through voluntary market.

The commercialization of the NLS is considered very successful and it has positive impacts to the environment, social and economic. The success of the project is internationally acknowledged.

I do hope that the collaborative effort of GERES and MIME will pursue other success with the other projects on biomass energy development in Cambodia, and will bring in larger stakeholders to involve.

M. TUN Lean

Director General of Energy
Ministry of Industry, Mines and Energy

Foreword

Climate change poses a novel challenge for developing countries and their partners: they must now reconcile the needs of development according to the Millennium Development Goals with the constraints of climate change, which represents one of the greatest threats to achievement of those goals. This new paradigm has led AFD to place climate change at the heart of its strategies in various sectors: energy, transport, local authorities and urban development, forests and agriculture.

Furthermore, one of the priorities AFD has set itself is to develop its work with companies, local authorities, NGOs and foundations. Partnership with NGOs is mutually beneficial, helping to scale up the innovative experiments they instigate, drawing on their know-how and technical skills and their close ties with the field and civil society. As a result of intensifying the relationship in this way, the NGO Partnership Division (DPO) has been set up to handle the strategic partnership with NGOs.

The GERES programme to set up a local supply chain building and distributing efficient cook stoves provides a perfect illustration of AFD’s climate strategy: the top priority is to improve local communities' living conditions, while offering innovative solutions to combat climate change. It is particularly relevant in Cambodia, where charcoal production is a significant driver in deforestation, in one of the last regions left in Asia where forest cover is still substantial with a high degree of biodiversity.

AFD was keen to support this GERES success story by funding the present capitalization study, which will help to disseminate the experience and know-how developed by the NGO in the Cambodian context.

It was therefore entirely natural that AFD should approach GERES in October 2008 to offset the irreducible emissions involved in its own activities. The 20,000 tonnes of CO_2 emitted annually due to the operation of its headquarters and air travel by its staff are offset by the purchase of the same amount of carbon credits generated by the GERES programme.

M. Eric Beugnot

Country Director
French Agency of Development in Cambodia

Table of content

Stakeholders

GERES – Groupe Energies Renouvelables, Environnement et Solidarités (Renewable Energies, Environment and Solidarity Group) - took the initiative with regard to this publication and co-ordinated its production.

A non-profit-making association set up in 1976 following the first oil crisis, GERES now has 180 associates carrying out innovative sustainable development projects in France and eight African and Asian countries. www.geres.eu

Since 1994, GERES Cambodia has been endeavouring to develop efficient energy solutions with the primary aim of helping to conserve the environment and improving local communities' living conditions. The team includes over 90 specialists focusing on the energy, environment, agronomy, research, rural development and education sectors. A wide range of consultancy services is offered to companies and organizations, especially in the fields of biomass management, reducing greenhouse gas emissions and carbon and energy audits, together with research projects and studies of all kinds on social and environmental topics. www.geres-cambodia.org

L'AFD – Agence Française de Développement- is the financial partner of this publication.

As a public body, it has been combating poverty and promoting development in the South and the Overseas Territories of France for over 60 years. AFD is active in the field in over 60 countries and the Overseas Territories of France and finances and supports projects to improve communities' living conditions, boost economic growth and protect the planet: getting children into school, supporting farmers and small companies, providing water supply, preserving tropical forests, combating climate change… In 2008, AFD earmarked some 4.5 billion euros to finance operations in the South and the Overseas Territories of France. As a result of this funding, 7 million children were able to go to school and 4.4 million people gained access to water supply. Energy efficiency projects for the same year will save 3.3 million tons of CO_2 annually. www.afd.fr

Acknowledgements

This publication has been designed and co-ordinated by the Renewable Energy, Environment and Solidarity Group (Groupe Energie Renouvelable Environnement et Solidarités - GERES) under the responsibility of Swan Fauveaud.

We would like to thank Samuel Bryan (GERES), Vichheka Vorn (GERES Cambodia), Jean-François Rozis (independent expert), Yohanes Iwan Baskoro (GERES Cambodia), Gérard Madon (MARGE) and Marina Brutinel (MARGE), all of whom have contributed to this publication.

Within GERES, our thanks go to: Arnaud Guidal and Minh Cuong Le Quan for proofreading; Charlotte Nivollet, Ouk Pouv and Srey Sinath for support in carrying out the impact study in Cambodia; Elida Delbourg, Caroline Pierret, Thomas Mansouri and Mathieu Van Rijn for their contributions in terms of graphics; and John Paul Nicewinter for editing the English text.

We are also grateful to Bertrand Loiseau and Olivier Grandvoinet, of the AFD Environmental and Social Support Unit for their support throughout the project.

Translation from English to French has been undertaken by Isabelle Guinebault in the case of Chapter 1 and Stéphane Mougenot in the case of Chapter 3. Translation from French into English has been undertaken by Jean Lubbock.

Graphic design and page-setting are the work of Approche Communication.

Finally, this programme to disseminate the New Lao Stove would never have happened without the assistance of the entire GERES team from 1996 to date, support from the Cambodian Ministry of Industry, Mines and Energy and the European Commission, the involvement of domestic cooking stove producers and distributors from Cambodia in disseminating the New Lao Stove and, finally, the confidence of urban households in this new cooking equipment. Our thanks go to all of them.

Photo credits: Kémi Fakambi, Patrick Fourrier, Jean-François Rozis, Nicolas Deburge.
Illustration credits: Hervé Janody, Thomas Mansouri.

Any photographs and diagrams not specifically attributed are GERES photo credits.

Introduction

Almost half of humanity uses biomass on a daily basis for its domestic needs, whether in the form of animal matter, agricultural residues, green waste, wood or wood derivatives. Biomass accounts for more than 90% of the national energy balance sheets of many of the Least Developed Countries, where access is usually free or cheap and where it is used for essential needs like cooking, heating, etc. Deforestation is a consequence of the growing use of biomass energy in the absence of sustainable management of the ecosystems from which it comes.

The experience of GERES in Cambodia, which began more than 10 years ago in 1996, has resulted in nationwide dissemination of an efficient, low-cost domestic cooking stove, known as the New Lao Stove (NLS). Nowadays, around 25,000 NLSs are sold every month. A particular feature of this programme, which saves on so-called non-renewable biomass, is its access to carbon finance. It has also helped to strengthen and structure a cooking stove supply chain and validate standardized cooking equipment.

Following this success, requests to share experience have been coming in from Asia, Africa and Latin America.

In the following document, we therefore look back on the experience with the aim of:

- Sharing innovative methodological tools in the field of biomass energy that have been validated;
- Making a quantitative and/or qualitative evaluation of the socio-economic and health impacts of disseminating efficient cooking stoves in Cambodia;
- Reviewing the programme's links with international mechanisms to combat climate change;
- Demonstrating the importance of taking biomass energy into account in efforts to alleviate poverty, combat climate change and protect natural resources.

This document is meant for all stakeholders involved with Energy-Development-Climate issues: policymakers in the South and North, international bodies (donors, UN agencies, etc.), international solidarity organizations, training and/or research institutes, resource centres, networks and, finally, carbon market operators.

We hope you enjoy reading it

The GERES team

Cookstove in South Countries and lessons learned from the GERES project in Cambodia 1

Jean-François Rozis, a biomass energy expert, is the main author of this chapter. It was in 1996, during an exploratory mission on behalf of GERES, that he met Iwan Baskoro in Kampong Chhnang, Cambodia. Their work together resulted in a national biomass energy programme funded by the European Commission and developed by GERES. Jean-François is now operating as an independent consultant and has responsibility since the beginning for supporting programme design and technology transfer with GERES Cambodia.

Yohanes Iwan Baskoro has contributed to this publication. An Indonesian mechanical engineer, he arrived in Cambodia in 1996. He joined the GERES team in Cambodia at the end of 1997 to launch and manage the full implementation of phase 1 (1998-2001) of the Cambodian woodfuel-saving project and then monitor phase 2 (2002-2006). Appointed as GERES Director in Cambodia in 2005, he is currently managing various projects run by the organisation to develop biomass energy in Cambodia.

The text has been edited by Swan Fauveaud, South-East Asia desk officer at GERES.

In the world today, 2.5 billion people[1] cook their meals using biomass, i.e. by burning wood (branches and crowns of trees), agricultural residues (e.g. sugarcane or coconut waste) or charcoal. In view of the inevitable rise in the cost of so-called fossil fuel replacement energy, greater pressure can be expected on biomass-type fuel in the countries of the South. Household cooking is becoming a major economic, social and environmental, as well as public health, issue for vulnerable communities in these countries.

Working on the energy efficiency of household cooking is vital. In this regard, the GERES programme of support to widespread dissemination of low-cost fuel-efficient stoves is quoted as a remarkable experience in this field.

The purpose of this chapter is firstly to present existing cooking technologies and counter some preconceived ideas, before presenting the background to the project in Cambodia and finally offering some guidelines and lessons learned from the experience.

1 - World Energy Outlook, 2006

Household cooking in developing countries

Traditional combustion technologies

Various terms can be applied to biomass-fuelled household cooking equipment, as detailed in Box 1, but we shall refer to "cooking stoves" here.

The energy features of a biomass cooking stove and the notion of an ideal cooking stove

Cooking with dry biomass involves various constraints which must be taken into account when developing cooking equipment with a view to a sustainable introduction in any given situation.

First of all, it is difficult to "regulate" the heat when cooking with a biomass stove, the best example being frying, which requires a higher temperature over a short period that can be difficult to achieve with a wood fire. In this case, a gas burner may appear more flexible but is rarely accessible to the poorest communities.

The estimated power needed to bring a pot rapidly to the boil or fry food for a family meal for 6-8 people is between 1 and 2 kilowatts. The power needed for the ensuing slow cooking can be divided by between 8 and 10. The stove user achieves this by introducing the load of wood required to produce flames during the high-power cooking phase and then using the bed of embers to maintain simmering. Three quarters of the energy produced goes into the flames and the remainder into the embers.

Furthermore, the exchange of energy between flame and pot is proportional to the surface in contact with the fire. That surface is small, thus implying a substantial loss of energy.

Ideal cooking stove have to produce flames at high temperature, let them completing its combustion before any exchange and after giving exact power to the pots reject the combustion gases at the lowest temperature as possible.

Consequently, if all these constraints are brought into the picture, along with construction restrictions imposed by, for example, the thermal characteristics of the materials used, the maximum energy yield for a biomass cooking stove can be estimated at around 60 to 70%.

Setting a target of 30-40% efficiency for household biomass cooking stoves in the South is therefore a reasonable objective.

The "three stones", the most widespread cooking system in the South

The well-known "three-stone" stove is still the most common household cooking technology in developing countries for the vast majority of families using biomass as fuel. Its great strength lies in its marginal cost. Usually built by the woman who uses it, it may be installed inside and/or outside the house without fear of theft or damage. It suits all the family's pots. In the evening, it gives warm light at meal times, while producing smoke that repels insects.

In the "three-stone" stove, wood is simply arranged between the stones and power is regulated by adding or removing wood. Its combustion temperature is between 650 and 700°C. Very widespread in rural areas, it is therefore a serious competitor when any attempt is made to introduce new stove models and has been the cause of many failures in these areas.

A "three stones" stove in Benin

A Siam Stove so called a commercial "three stones" stove

Apart from poor ergonomic quality and risk of setting a blaze, its two main drawbacks are its low energy yield[2] (between 10 and 15% under normal circumstances), meaning that a minimum of four fifths of the energy supplied is wasted, and the serious indoor air pollution it causes (particulate matter), which can be carcinogenic.

Box 1- ***Household cookstove terminology in the South.***

*The term **fuel efficient stove** is now out of date. To begin with, it was applied to cooking stoves offering fuel savings in relation to the stoves they were supposed to replace for the same use.*

*This view was subsequently much disparaged as a result of the serious indoor air pollution that could be caused by a so-called fuel efficient stove. As a result, the notion of improvement was somewhat tenuous, so the only term to use was **fuel efficient stove**.*

Moreover, in situations where biomass was not paid for (being collected in the surrounding area), the trigger for purchase was no longer the fuel saving but the results obtained with the same quantity of biomass, better ergonomics, no smoke, greater durability or a modern appearance, so the stove could still be improved but not necessarily economical.

*These days we can also speak of **efficient stoves**, which have both high energy yields and substantial environmental benefits (low rate of particulate matter and pollutants).*

All of them are fuel efficient stoves but their pedigrees are quite different.

Upward combustion on a grate ("Jiko", "New Lao Stove", "Sewa", etc.)

This type of cooking stove is primarily designed for charcoal. At present, it is the most widely distributed fuel efficient stove model in the South, mainly in urban areas, where fuel has to be purchased.

The fuel is placed on a grate, a ventilated stand for the charcoal. In theory, the air maintaining the bed of embers passes through the grate (primary air) and the air to ignite the combustible gases comes from above the grate if wood or poor quality charcoal (with a high proportion of volatile matter) is used. In practice, everything is mixed. The attraction of the grate is that it focuses the heat better, the primary air being preheated to some extent, consumes all the embers (if the holes in the grate retain the embers until they are completely consumed) and forms the base of an insulated combustion chamber.

However, combustion temperatures are still similar to those of the "three-stone" stove and the quality of wood combustion is only slightly improved in relation to the latter. It is recommended for charcoal only. Energy yield is around 35%.

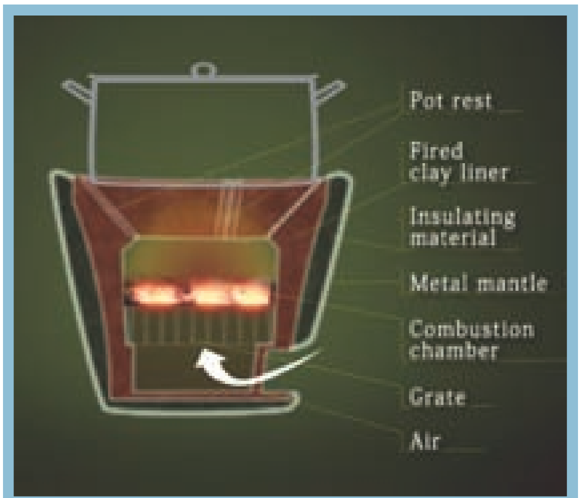

Figure 1: diagram of updraft combustion on a grate, GERES (2009)

2 - Energy yield: expressed in percentage terms, this is the ratio between the energy actually used to cook the food, known as useful energy, and the total energy supplied by wood during cooking. It is not actually possible to calculate useful energy simply during cooking, so the energy needed to heat water to boiling point is calculated instead, together with the energy used to evaporate some of that water while simmering to cook the food. Although this is very controversial, we prefer to speak of real savings, measured in the field, produced by improved in comparison with traditional cookers.

A New Lao Stove in Cambodia

Sewa cooking stoves in Benin (© K. Fakambi)

To reduce costs, the materials used are often heat-resistant clay[3], sand, ashes or fire-clay (fired clay that has been crushed and sieved), with metal parts for external protection. The maximum cost of this technology should not exceed ten euros or so, to ensure widespread distribution without subsidy.

The L-shaped chamber or "rocket stove"

This type of combustion chamber was developed by Aprovecho (Larry Winiarski), a technical centre based in the United States. This stove also operates on the principle of updraft combustion, but the flames are confined to maintain a high temperature and limit the amount of excess air. The fuel is introduced horizontally in the lower part, hence the characteristic "L" shape. It is placed on a stand under which the air is drawn towards the bed of embers which usually stands on a baseplate.

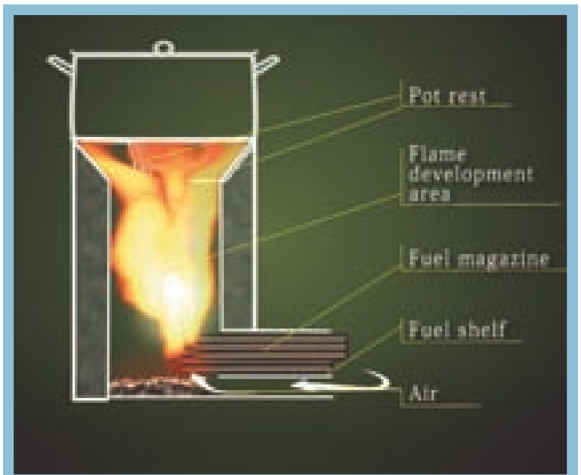

Figure 2: diagram of rocket stove combustion, GERES (2009)

A Rocket Stove in Benin (© Patrick Fourrier)

Combustion quality is better in relation to technology using a simple grate and combustion temperature is around 800°C. Energy yield is still close to that using a grate, around 35%. Better results can be obtained with a well insulated combustion chamber. This means producing insulating, heat-resistant material. If this stage can be achieved at low cost, the final price will be similar to that of updraft combustion stoves with simple grates. Dissemination of this type of stove is currently fairly successful for household cooking and small-scale catering applications.

3 - After firing at a certain temperature, heat-resistant or refractory clay can resist cooking cycles below that temperature without any alteration to its internal structure

Towards efficient combustion

T-LUD (Top-Lit Up Draft) stove

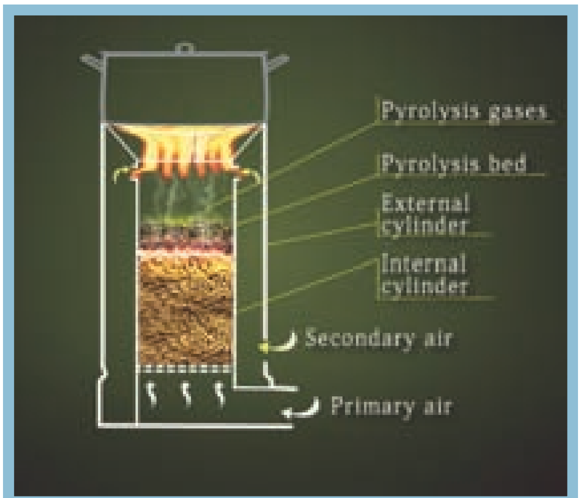

Figure 3: diagram of T-LUD wood combustion, GERES (2009)

View of the upper part of a T-LUD stove – flames and charcoal formation

T-LUD is based on the principle of gasification in which separation between the gas production and combustion phases is more marked. For the household size, it's dedicated to wood chips, pellets. Although still improved in comparison with the rocket stove, combustion remains not totally complete and the temperature is around 800°C. Energy yield is around 35%. This stove technology is in the process of validation in various urban situations and has been popularized due to a large extent to the efforts of Paul Anderson. More success is expected in the coming years in view of the substantial efforts made in India in particular.

Combustion Latérale Inversée Performante (CLIP)

Developed by Planète Bois, this technology for burning pieces of wood (logs, bundles of sticks, etc.) is mainly being tested for small scale activities. This type of equipment is in the process of validation in Morocco with GERES for heating stoves and in the process of dissemination in Cambodia, with a simplified version to produce palm sugar.

The wood is put into the stove vertically through the top of the pyrolysis chamber before the lid is closed. The bottom part of the wood comes up against a bed of embers maintained through the entry of primary air at this level. Combustible gases are given off as a result of decomposition by heat (pyrolysis) in the absence of flames and sucked towards a nozzle where they encounter the oxygen from the secondary air. The flame then occurs downstream of the injection of secondary air. The wood goes down as it is consumed so that the bed of embers is renewed. Power is regulated through the primary air flow as well as according to the diameter of the pyrolysis chamber.

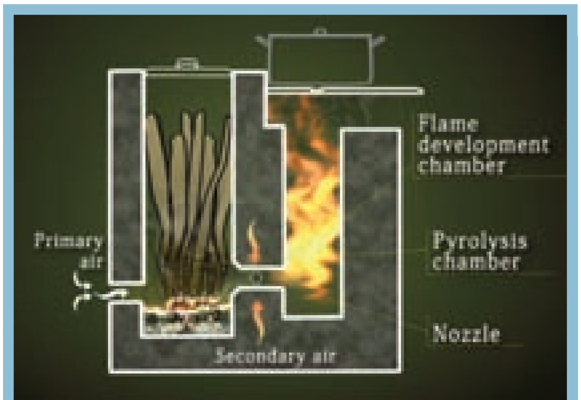

Figure 4: diagram of CLIP wood combustion, GERES (2009)

Multi-function cooking stove with CLIP technology in rural Morocco (© JF Rozis)

Combustion temperature is between 950 and 1 000° C. The carbon monoxide emissions and particulate matter are fairly well controlled in this case, providing much better air quality than when using earlier types of stove.

Speaking of preconceived ideas ....

Many preconceived ideas are going around concerning projects to disseminate improved cooking stoves in the South. We would like to look at these ideas again in the light of our own experience in this field.

"Fuel efficient stove distribution programmes always fail"

Much criticism has always been levelled at programmes supporting the dissemination of fuel efficient stoves, arguing that this type of project never succeeds or that distribution collapses when the project ends and support is withdrawn.

On the contrary, large-scale dissemination projects can be sustainable and, what is more, have consistent social, economic and environmental impacts. This usually involves consolidating a traditional cooking stove production and distribution chain and helping it to get on a genuinely professional footing. Standardized, high-quality equipment using less fuel can then be disseminated, with greater benefits for all stakeholders. Producers can increase their profits per stove produced, as can wholesalers and retailers. Finally, users can rapidly defray the cost of the purchase and save money in the long run.

This "win-win" approach is potentially reproducible, especially when wood and charcoal come at a price and encourage thrift. This is essentially the case in urban and peri-urban areas.

Efficient equipment is now available for rural areas. It remains to set up the associated distribution channels in what can seem like a less favourable context. However, reducing the impact on health of cooking with biomass constitutes in itself a wholly adequate justification for disseminating fuel efficient stoves in these areas.

"Biomass is not clean energy"

This view is now out of date. Wood burning know-how has come a long way in the last few years in the industrialized countries as a result of emission quality regulations. If the combustible gas production phase (pyrolysis/gasification) is separated from the high temperature combustion phase for long enough, it is possible to produce emissions of a quality similar to those of a modern gas burner. In actual fact, it is not the fuel but the stove/fuel combination which is dirty. Burning paraffin or ethanol or even liquefied petroleum gas (butane, propane) can result in appalling quality emissions if the technologies and/or stove adjustment are inappropriate. A huge leap in the quality of biomass combustion can be achieved in the South by distributing efficient cooking stoves.

"Biomass is an energy source of the past"

On the contrary, biomass is an energy source of the future for the countries in the South which will be the first to suffer from the rising cost of fossil fuels as they become increasingly scarce.

Of course, it is essential to ensure the sustainability of the biomass resource (e.g. through forestry, wood energy plantations or recycling agricultural waste) in accordance with the land area available, climate and soil quality.

The establishment of rural markets (with margins more fairly shared out) in Africa has, for example, resulted in a significant increase in biomass productivity in the rural areas concerned. Many promising initiatives involving village communities can be widely duplicated to produce biomass energy on a sustainable basis, whilst also creating a substantial employment pool in rural areas.

It remains to be seen to what extent biomass, which can efficiently meet the need for heat at a fixed point with no need of heavy processing (just drying, carbonization, compacting or crushing), can avoid the fate of oil and gas... becoming an energy source to which the surrounding communities have little access.

Sustainably covering a country's food and energy requirements (cooking, agro-processing and heating) through access to land for rural communities will always be a major environmental and social challenge.

"You just have to come up with an efficient stove and dissemination will take care of itself"

It is important to understand that simply improving traditional cooking stoves or proposing a new model is not enough to ensure dissemination. This will require setting up a system based on a well-trained team that is completely dedicated to the activity and has the required long-term resources.

Validation of a new model is in fact just the start of the support process, whose rationale and overall features we shall present later on in the light of experience with the New Lao Stove in Cambodia.

In addition, it may be thought that one particular type of equipment needs a particular type of dissemination and support process. In this paper, we are only considering unsubsidized dissemination of a fuel-efficient, low-cost cooking stove intended for users who pay for fuel and, if possible, relying on an existing production/distribution chain.

If equipment is too expensive (more than one year to recoup the outlay), work will have to be done on access to credit, ongoing subsidy to take account of the environmental cost (carbon finance[4] or other) or the health cost (public health campaign against the impact of harmful smoke or to promote equipment simultaneously producing clean drinking water after boiling) and "social business" type mechanisms. When it comes to dissemination in rural areas, there is still room for innovation…

Disseminating fuel-efficient cooking stoves in Cambodia, GERES experience

This part goes back over the most important stages in the fuel saving cooking stove programme from 1996 to date.

1996 - 2001, Kampong Chhnang province

Cambodia in 1996

In 1996, Cambodia was emerging from 20 years' civil war. As reconstruction got under way, the international response focused on infrastructure, administrative services, education, health and humanitarian assistance. The country, which experiences recurrent famines, had to deal with the return of displaced people, pacify areas still occupied by the Khmer Rouge and eliminate the antipersonnel mines strewn throughout a large part of its territory.

Figure 5: Map of Cambodia including Kampong Chhnang province

4 - CDM (Clean Development Mechanism) funding.

In 1995, according to data supplied by the Ministry of Energy (MIME), biomass accounted for 82% of the energy consumed in the country by all sectors combined. At the same time, natural resources were coming under ever-increasing pressure.

Kampong Chhnang province has been known historically for its large-scale production of good quality fired clay cooking stoves. In 1996, the existing cooking stove production sector was informal but well established. Each potter produced cooking stoves on demand for individuals or stove distributors or retailers. For example, an individual might require a tailor-made model with a specific diameter or shape. The fuel efficiency of the stove was only a secondary consideration. The producer was chosen for the quality of his finishing, the low price he was prepared to offer and the soundness of his product (well-prepared, good quality clay). Producers, usually men, were trained on the job by their parents and there was no collective organization. In this situation, the opportunities for sustained, regular production, diversification of their products or access to secure large-scale markets were very limited.

Launching a programme to spare biomass energy

The first phase of the project, which started in 1997, was therefore designed to focus on the Kampong Chhnang area and test different types of household and small-scale cooking equipment using less wood energy.

A rapid assessment of the province was made during the first year. Household cooking, the leading consumer of wood energy, was identified as a priority. Research and development work validated the first fuel-efficient stove models. The second year was devoted to testing and validating methods of dissemination and their potential for the various selected models. In the third and fourth years, the project was able to facilitate the establishment of a national network, ensure the sustainability of the process and prepare for a second phase scaled up to nationwide distribution.

Box 2- ***Introduction and improvement of the New Lao Stove (NLS)***

In 1999, the project instigated the introduction of the New Lao Stove in Cambodia, supported by trainers from Thailand (RWEDP programme, FAO) where it was already being marketed under the name "Thai Bucket". After training a group of cooking stove producers who were already operating, the initial comparative tests were begun with the competing traditional model known as the Traditional Lao Stove.

Traditional Lao Stove (TLS)

New Lao Stove (NLS)

The performance of each range (small, medium and large models) was improved through an experimental approach. The critical parameters were identified: grate, height of combustion chamber, insulation, height of stand and openings. Experimentation was undertaken on the basis of a cooking protocol representing the local situation. The results led us to set a standard associated with performance for each range. The tests were reproduced on the spot by Cambodian families to validate the models developed.

On completion of this improvement phase, comparative tests of the Traditional Lao Stove and New Lao Stove demonstrated consumption reductions ranging from 20 to 25%.

Mid-term review in 2001

On completion of this first phase, around a dozen producers in Kampong Chhnang were trained in the manufacture of two models of household cooking stoves, the so-called "twin stove" and the New Lao stove.

In rural areas, technicians from local associations were trained to distribute two self-built models using the same twin pot principle: a household cooking stove known as "Samaki" and a palm sugar kiln.

Commercial twin pot cooking stove known as the "Twin stove"

Self-built twin pot cooking stove known as the "Samaki" stove

As of 2002, a national scale project

Scaling up of the cooking stove dissemination

In 2002, political stability in Cambodia seemed to be holding, the last Khmer Rouge commanders having surrendered in 1998. Despite a sustained 6% growth rate, the return of tourists and expanding private investment, Cambodia was still one of the poorest countries in the world with GDP per capita of US$270 per annum. 36% of the population were said to be living below the poverty line, 90% of them in rural areas[5]. In addition, the bulk of charcoal for household cooking was sourced from the natural forest, despite this being declared illegal. The city of Phnom Penh alone was consuming 90,000 tonnes of charcoal[6] extracted from the natural forest every year.

GERES launched a second project phase and the Ministry of Energy, Mines and Industry became the regulatory authority, signifying its commitment in respect of the issue of wood energy. As part of this project, a national dissemination strategy was worked out, relying on the existing commercial distribution network for the densely populated urban areas and the voluntary sector for the more isolated rural areas. Other components beyond the scope of this paper were also launched: sustainable clean charcoal production with forest communities, efficient small-scale cooking equipment, etc.

An assessment in 2006 reporting failures...

We learn by doing and of course there were failures but these were always instructive.

Despite the interest expressed by users, dissemination of the twin stove was not a success because it was blocked by middlemen who found the stove too difficult to transport, too fragile and offering too small a profit margin.

5 - World Bank Indicators, end 2001
6 - Wood Energy Baseline Study for CDM in Cambodia, 2005, MOE-IGES

As for the "samaki" stove, dissemination was very slow. Local associations were interested in distributing it in rural areas but the results were not encouraging: the pace of dissemination was slow and of uneven quality, while fuel savings were not guaranteed. Moreover, dissemination was overly dependent on the involvement of local associations.

This proved that marketing saving fuel stoves in a rural environment is not easy and requires a specific approach, involving more widespread distribution, control of final costs and production of very low-cost models.

... and successes with the emergence of a production and distribution chain for the New Lao Stove

The NLS made unprecedented progress with urban families using charcoal as energy for cooking.

The difficulty during the second phase was to convince stove producers that producing nothing but the NLS (a powerful psychological barrier) was not risky and that, with the same amount of work, their income would increase substantially. The fact that demand at the time was always greater than their production capacity helped to persuade them.

The project aimed at standardizing production at national level, implementing a price policy beneficial for everyone. it also encouraged "copy-cats" to join the group of trained producers and comply with a "quality charter" so as not to undermine the image of the new stove model.

The choice of decentralized production at small units did, however, make things more difficult. Having producers scattered in this way meant finding human resources for quality control and distinguishing the different types of clay available according to the location of the production centres.

On completion of this phase, producers and retailers received support in setting up an interprofessional association known as ICOPRODAC (Improved Cookstove Producers and Distributors Association in Cambodia) to protect their mutual interests *(see box 3)*.

By 2006, despite its recent establishment, the sector was sufficiently strong to pursue its course without the GERES support, although there was some uncertainty about its ability to react if the situation changed quickly. This seems unlikely, given that decentralized production with materials little affected by external fluctuations remains sound and, what is more, the market is a long way from saturation in the medium term.

As of 2007, access to carbon finance and capacity building

At the end of the process conducted since 2004 by the Climate Change unit of GERES Cambodia, the programme of support to large-scale marketing of fuel saving NLS stoves carried out its first "verification" in 2007 *(Chapter 3)*. The consultancy Det Norske Veritas confirmed that 182,402 tonnes of CO_2 were spared by the project up to spring 2007.

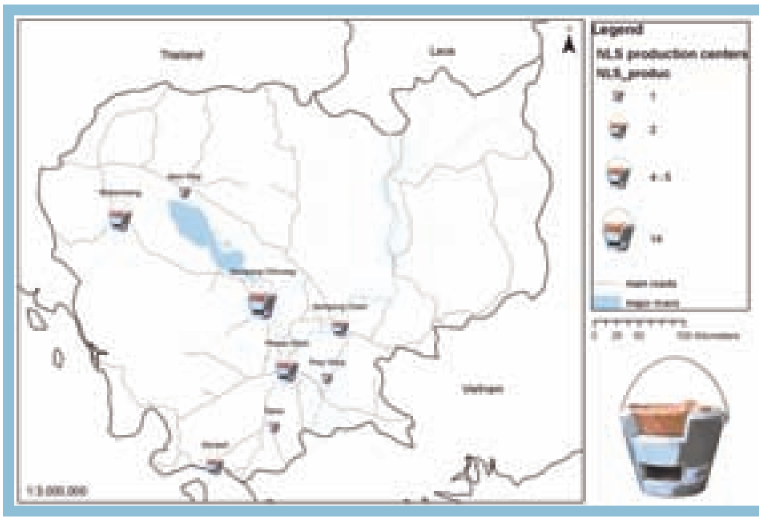

Figure 6: Map of the NLS productions areas in Cambodia, GERES (2009)

Box 3- ***Establishment of ICOPRODAC, Improved Cookstove Producers and Distributors Association in Cambodia (2003-2004)***

The first trained producers could see the advantage of having an association like this to protect their output (preserving quality, maintaining the selling price and bringing in new producers in an organized way).

Subsequently, the association expanded to bring in distributors involved in disseminating the NLS, so it became an inter-professional organization.

In 2004, its members included 9 producers and 6 distributors. Its Articles of Association were formally approved by the Ministry of the Interior at the end of 2004.

Its stated objectives are to:

- *foster close co-operation between producers and distributors to expand the market (new geographical areas, increased sales, etc.);*
- *control production and selling prices to avoid any unfair competition to the detriment of final product quality;*
- *demand and enforce the agreed quality standard with producers (setting up a quality seal system);*
- *bring in new producers who become eligible for the quality seal, ensuring long-term monitoring;*
- *support members in building their management and organizational capacity and ability to work together (training, visits, etc.)*

By 2009, 31 producers of NLS and 48 distributors had joined ICOPRODAC.

An evaluation is conducted every year to quantify carbon credits in proportion to the number of cooking stoves distributed. Their sale on the voluntary market brings in the necessary co-funding to continue supporting this sector. Full details of this appear in chapter 3.

In 2009, GERES Cambodia is employing a team of around 80 people organized into eight sections to carry out its own projects but also to assist partners in connection with biomass energy. Skills exchanges have been initiated between South-East Asia and Africa to facilitate dissemination of the acquired experience. Concerning the NLS stove, support must be continued to ensure mass marketing throughout the country at the present rhythm of 25,000 units per month, but also help establish a national industrial standard in partnership with the Institute of Standards of Cambodia (ISC). At the same time, capacity-building for ICOPRODAC is ongoing so that it can oversee the stove production and distribution sector in Cambodia.

Remarkable results

Dissemination of the NLS grew exponentially between 2003 and 2009

Figure 7: annual Sale of NLS, GERES (2009)

In 2009, 31 production centres were registered NLS producers, including 5 exclusively producing this type of cooking stove.

The number of families using the NLS is estimated at 160,000. This represents a theoretical saving of US$2,500,000 on charcoal purchase for these families since the start of the project. The 32,000 tonnes of charcoal saved would represent 212,000 tonnes of green wood not cut, i.e. 620 ha of natural forest preserved.

This success has been rewarded on three occasions. In 2006, the project won the Ashden Award for Sustainable Energy in London; it won the award given by the US Environmental Protection Agency in Phnom Penh in 2007 and, in 2008, an Energy Global Award in Brussels.

Lessons learned

In the light of this experience with sustainable large-scale dissemination of low-cost household cooking stoves, some guidelines can now be suggested for preparing and implementing this kind of support programme.
We must draw the reader's attention to the very specific features of this kind of dissemination: it applies to low-cost household biomass cooking stoves, which use less fuel than the traditional model and operate mainly with purchased biomass. This dissemination targets urban and peri-urban areas in least developed countries (Africa, South East Asia, etc.), mainly in tropical and saharian regions.

At present, there seem to be two models appropriate for this kind of dissemination:

- the updraft combustion stove with a grate, using charcoal (e.g. NLS, Sewa, Jiko, etc.); and
- the L-shaped updraft combustion or rocket stove, using kindling

Apart from reducing consumption in relation to traditional models, they offer "acceptable" combustion quality for hot regions where kitchens are usually well ventilated.

Planning for a five-year operation is a good compromise between programming capacity, the potential for obtaining dedicated funding and the minimum time needed to obtain tangible evidence of the sustainability of the dissemination system based on experience acquired. We do not start from the assumption that no traditional cooking stove production and distribution chain exists, because that would mean adding at least a further five years to our operational planning.
The stages of a dissemination programme and their indicative timeframe are shown below:

1. Diagnostic study, assessment, choice of pilot area, project components **[6 months]**
2. Development/Validation of interest and production of the new equipment **[2 years]**
3. Preliminary dissemination, promotional activities, validation of distribution system **[2 years]**
4. Evaluation, preparation for large-scale dissemination **[1 year]**
5. Large-scale dissemination, sector becomes self-supporting **[2 years]**

Initial diagnostic study

Looking at a commercial cooking stove production chain

This stage begins with a rapid but sufficiently accurate diagnostic study to determine the operational strategy and identify the basic "project components": choice of the pilot area, resources to put in place, technological work to be done, training and support phases, network of partners, etc.
The aim is to get a picture of the existing distribution chain in its entirety. This is the proper starting point to identify its strengths and weaknesses and the potential for rapid improvement. This initial "snapshot" will also help us to assess the progress and impact of the activities undertaken.

This flow chart *(Figure 9)* shows the range of activities that can be undertaken, focusing for example on:

- energy for cooking, through promoting production of more efficient fuel (carbonization) or renewable fuel (e.g. charcoal briquettes based on plant residues);
- the cooking stove that is the easiest to optimize, to be replaced with a more efficient model;
- customers, by identifying the socio-economic category which uses the cooking stove and tackling the health issues related to cooking (smoke), charcoal purchase costs, etc.;

Stages	Year 1	Year 2	Year 3	Year 4	Year 5
Diagnostic study - Project design	✔				
Validation of interest and production of the new equipment	✔	✔			
Preliminary dissemination in pilot area		✔	✔		
Evaluation and preparation for large-scale dissemination			✔		
Supporting large-scale dissemination				✔	✔

Figure 8: the timeframe for a stove project implementation

- cooking stove production units, with the aim of improving productivity and stove quality and eventually encouraging producers to form an inter-professional association.

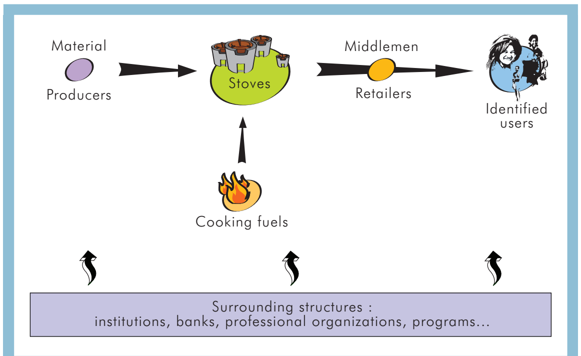

Figure 9: Flow chart of aspects to take into consideration when analysing a cooking stove marketing chain

In this chart, retailers and wholesalers make up the group of "distributors" who will be regularly mentioned in the rest of the section. They are the key link in the chain ensuring dissemination of the stoves. In Cambodia, wholesalers specialize in selling stoves to retailers and are mainly found in Kampong Chhnang province. Retailers are usually small hardware type shops found in markets or along the roads.

It would be difficult for one programme to work in all the relevant fields, so it must be given an initial focus to avoid making the diagnostic study too cumbersome. In any given geographical area, there will in fact be several types of production units, biomass energies used for cooking (wood and charcoal at the very least), cooking stoves, customers and indeed middlemen. There will therefore be several production/distribution chain flow charts.

The diagnostic tools developed by GERES

A group of four studies was established to launch a project to disseminate fuel-efficient cooking stoves. These studies are designed to remain accessible to local development organizations and be simple to implement.

Daily household cooking: energy profiles

Any analysis of a commercial supply chain must logically start by analysing the energy that households use in cooking. To do this, a representative sample is selected and a so-called socio-energy survey is carried out.

Questionnaires ask households to detail the different types of cooking equipment in the home (biomass or butane cooking stove, rice cooker, etc.) and the corresponding type of energy (charcoal, wood, gas or electricity). The study then identifies energy behaviour by asking about the frequency of use of equipment, the quantities of fuel used and the respective costs, the time spent in the kitchen every day, etc. This helps to understand how families make their choices when acquiring equipment and to identify the factors which will make it possible to improve the socio-economic conditions of daily cooking.

Characteristic features of commercial cooking energies

This study considers all commercial cooking energies available to households. It estimates their costs, development, provenance and purchasing procedures (sales outlets, packaging, etc.). In the case of biomass, the data are often difficult to obtain because the marketing circuits are very informal or even illegal (making charcoal is illegal in Cambodia). Work must therefore be done upstream to establish provenance (forests, agriculture, coppice), quantify the flows supplying the target towns and then assess whether the production of this biomass is a cause of deforestation. Downstream, the study will look at fuel price structures, how marketing is organized and the relationships between stakeholders. The study relies on a combination of:

- spatial analysis (GIS map, satellite photography) to describe the forest cover;
- interviews with local official representatives (forest guards, etc.);
- analysis of biomass flows (wood or charcoal lorries);
- interviews with charcoal makers;
- interviews with small middlemen (retailers, shops and dealers).

Characteristic features of the biomass cooking stove production/distribution chain

This socio-economic study involves in-depth analysis of cooking stove supply chains from production through to distribution. It is mainly based on individual interviews and focus group meetings with stakeholders in the sector.

The study identifies the features of stove production units. It endeavours to describe the production technology and the associated range of cooking stoves, raw materials used and cost breakdown. Where they exist, it highlights quality control, standardization and traceability procedures for products. It also aims to see producers in the overall context of the cooking stove sector and market by looking at links between wholesalers, retailers and users. Analysis of technological, organizational, commercial and financial constraints and problems helps to identify the operational priorities. This can be done as a participatory exercise where an external facilitator brings together focus groups of producers and teases out the issues. Complementary analysis of the institutional and financial environment of the production chain shows whether any guilds or inter-professional structures exist and what external support is received (e.g. micro-credit). Finally, establishing the typology of production units allows a target production profile to emerge as a starting point for the future programme.

At the same time and in liaison with producers, distributors are approached to find out their modes of organization, margins, expectations, difficulties and interests in any future programme. The structure of their turnover is established in direct relation to the distances covered and the type of roads used to transport and market cooking stoves. In the same way, their constraints and problems can be analysed as a participatory exercise.

Characteristic features of the cooking stove and its use

The "controlled cooking test" serves to measure the fuel consumption of the different traditional biomass cooking stoves encountered and see to what extent they can be improved. This test takes account, first of all, of the context of use because this has a huge influence on performance. This test is based on monitoring the quantities used (weighed) over several days by a small sample of families

In addition, a typical day's use is defined (from sunrise to sunset) during which fuel consumption is monitored to have a better figure of cooking habits and stoves use..

Moreover, to supplement these four studies, it will be helpful to assess past experiments with household cooking in the programme area. What were the successes and failures and what lessons were learned?

Which government bodies were involved and what was their experience in this field? Where are the resource people and experts who worked in the area? Who are the local partners on whom the future project will rely?

Research and development in the laboratory to optimize the cooking stove

This R&D work is designed to determine the range of cooking stoves and increase their efficiency. It must be done before any attempt at standardization. The first step is a comparative test based on a water boiling test corresponding to the context of use, i.e. taking account of the most common type of pot, fuel and cooking method, the equivalent quantities of water for a representative family, etc. GERES Cambodia has developed a test protocol adapted for the NLS, applying a degree of methodological and experimental rigour.

The international standard water boiling test was not used because it does not fit the context of use. The aim of GERES in Cambodia was to develop a cooking stove appropriate to its context of use rather than to be in a position to compare a traditional Cambodian cooking stove with a so-called standard model which is no more than a theoretical concept. The selected test can of course be adapted to each situation encountered, which seemed to be the most rigorous approach to optimizing a cooking stove.

This optimization work can be conducted at the diagnostic study stage or at the start of the programme. As the relevance of the future programme depends on it, we advise doing it at this early stage.

Box 4- *The need for a highly skilled multidisciplinary team*

The success of a project like this is dependent on having a multidisciplinary team to work in the following fields:

- *studies and surveys, field tests;*
- *laboratory testing and development of the range of cooking stoves, production of low-cost heat-resistant materials, stove production techniques;*
- *support and organization;*
- *quality control, monitoring dissemination of the new model;*
- *communication, promotion*

Two to three years is the time felt necessary for a team to reach a good level of skill, provided that it has been involved since the diagnostic study stage.

Final development of the new equipment

Introducing the stove to users

At the end of the preparatory phase, the interest of users representing the target audience must be validated. Consequently, laboratory testing is followed by introducing the fuel-efficient cooking stove in a real-life situation. Comparative fuel consumption tests are then conducted with families to establish the difference in biomass consumption between traditional cooking stoves and the new model. These protocols are similar to those of the controlled cooking test presented in "Initial diagnostic study" but more accurate as they are implemented under similar conditions (same families, same types of fuel, same climatic period, same types of cooking). The most accurate marker has been statistically determined as the water used for cooking (which is easy to quantify), because the number of people eating the meal is too random and a source of errors.

This experiment is also designed to promote the cooking stove and start its dissemination. In addition, it allows cooks to give critical feedback about its operation. At this stage, the stoves are usually made available free of charge, in exchange for agreement to take part in field tests and answer satisfaction surveys.

Improving the cooking stove in permanent liaison with a pilot producer

In parallel to introducing the cooking stove in a real situation, one or several "pilot producers" will be chosen to carry out the final cooking stove production tests, validate the technique and decide on a range of stoves.

Once the stove standards have been determined, work with the pilot producer will continue to:

- guarantee constant quality in the templates and moulds used for the ceramics;
- make sure of the quality of preparation of the materials and their provenance, as well as the lifetime of the final product;
- reduce production costs by paying attention to tooling and work organization (task specialization, subcontracting certain parts if necessary, etc.);
- ensure the aesthetic appeal and modern appearance of the cooking stove (colour, external covering, etc.)

The above work begins at this stage, but can be perfected as expertise is acquired and as quality, standardization and improved productivity needs emerge. Figure 10 describes the full process for the NLS manufacture.

Figure 10: illustration of the NLS manufacture

Initial work with producers and distributors

The first fuel-efficient cooking stoves will be produced and disseminated in a pilot area. This area must have easy access and not be too large at this stage. Ideally, it should be known for the skills of the production units and include a fair number of producers. In the case of Cambodia, there was no desire to move away from the existing supply chain disseminating the traditional model but, on the contrary, to induce producers to take ownership of the new cooking stove.

Fixing a fair price for the cooking stove, one of the keys to success

The price structure of the cooking stove must allow for fair distribution of the proceeds between producers, middlemen and retailers, thereby validating the win-win concept of the supply chain. In Cambodia, the selling price of the NLS was fixed in such a way that the outlay could be recouped due to the fuel savings within six months at the most. This seems to be an essential condition for viable marketing of the equipment.

By working the cost structure back from the customer to the producer, the margin for middlemen and producers can be established. Each party must get something out of it, in other words earn more money for the same amount of work.

This is an important stage of negotiation with producers, wholesalers and retailers in which the organizational skills of the project team play a vital role. Having accurate knowledge of the traditional supply chain lays a sound foundation for negotiation. There is a great temptation, for example, to establish a high selling price to motivate producers, but that means running the risk of restricting the future potential for large-scale marketing.

Identifying "pioneer producers"

"Pioneer producers" are selected on a voluntary basis (a maximum of two or three units). They are assisted in producing the new model according to a production schedule that establishes the quantity of stoves to be produced over the coming months in liaison with the "pilot producer". A clear arrangement must be made with the initial producers to leave the field open for other production units to undertake large-scale dissemination in future. The same pioneer producers will be asked to be the future trainers and will always be the beneficiaries of innovations, improvements in productivity and long-term promotional support.

We think it is a good idea not to expand the group of producers of these new cooking stoves too soon. On the contrary, resources should be concentrated on limited areas and stakeholder groups for a while to make sure that stove production quality is consistent. The phase of gradual extension will be much easier once small groups have total control over the quality of their production.

Experience in Cambodia shows that well-crafted standard production can be achieved with very little mechanization. Unless it results in substantial improvements (e.g. a sharp rise in productivity; releasing people from physically arduous tasks such as crushing and mixing; or better quality, more precise, finishing of certain parts), mechanization cannot be justified. Producers must be able to stick to a depreciation plan for the new equipment and to maintain and repair it as necessary.

An embryonic dissemination system and inter-professional structure

The so-called pre-dissemination phase consists of disseminating a few thousand cooking stoves. In the case of GERES Cambodia, it lasted from one to two years and targeted an average-sized town or a few districts of a large town (Kampong Chhnang province).

While it is advisable to control the number of pioneer producers during the initial phase, it is, conversely, useful to extend the dissemination area to test the geographical limits. Where these exist, they may be due to excessive transport costs, lack of retailers or poor-quality road networks. Extension also helps to identify the distributors with the most motivation to undertake dissemination of the new model.

The pre-dissemination period is critical for several reasons.

Some producers will try to copy the new model, which is a good sign in itself but can damage the sector. Copies are often made to the detriment of quality, at lower cost, in order to get into the market and prevent the producers of "authentic" fuel-efficient cooking stoves from achieving the necessary margins. Consequently, it is important that producers understand the notion of quality and fair remuneration for a product. The new-style cooking stove is undoubtedly more expensive, but also longer lasting and will eventually be successful with their traditional customers. This means showing all producers the advantages of joining the new system: monitoring of training, quality control and specific support.

Once an inter-professional organization for the producers and distributors of the new cooking stove has been established, it will be possible to introduce the notions of quality seals, quality control and promotional strategy, as well as training services and access to credit to purchase equipment. The establishment of ICOPRODAC in Cambodia is a good example of this *(Box 3)*.

Promotional strategy

A very commercial approach was taken to stove dissemination in Cambodia, involving extremely varied promotional tools that drew on the classic advertising campaigns for consumer products such as washing powder. The project made use of video clips, posters, cartoons, demonstrations, etc. Regularly criticized in Western societies due to their sometimes intrusive nature and omnipresence, advertising campaigns nevertheless proved extraordinarily effective in disseminating the NLS. The campaign created a visual identity for the cooking stove which became known to a maximum number of potential users.

The TV advertising campaign undertaken during the initial phase in Cambodia not only played a promotional role but also had a strong impact on pioneer producers, reassuring them and showing them the seriousness of the business of marketing the new cooking stove. As one producer said: "From then on, you had to be careful about quality... this was serious!!"

Putting up posters at retailers selling the new model was an easy means of identifying the retailers concerned. Demonstrations at markets in the pilot area were also organized to demonstrate differences in the time taken to cook meals and in fuel consumption.

Sponsorship of sporting and cultural events helped to link the image of the new cooking stove to the notion of quality, environmental protection and so on.

Preparing for large-scale dissemination

On such a firm foundation, with well-established demand, a product that has become well-known, a small group of well-trained producers almost exclusively producing the new model, firmly established and respected quality control procedures and an embryonic inter-professional organization, everything is in place for large-scale dissemination. The fuel-efficient cooking stove sector has become broadly self-supporting, although training of new producers must still be carefully supervised *(Box 5)*.

The project is moving towards a monitoring and oversight function focusing on key issues concerning the links in the chain:

How do users perceive the cooking stove?
A satisfaction survey will show whether its cost, durability and ease of use satisfy cooks. This will be backed up by an annual or two-yearly market survey to identify dissemination potential, categories of users and geographical areas not yet reached and the reasons for these shortcomings.

Have monitoring and quality control tools been put in place?
Regular checks on production per centre, along with quality control, can provide an up-to-date view of dissemination potential. The post-project support structure plays a vital role in ensuring the reliability and proper use of monitoring tools, while establishing a training model for future producers is essential.

The tools used to monitor dissemination are explained more fully in section 3 *"Carbon Finance: a new financial lever for fuel efficient stove projects"* and are essential when the project has to comply with the CDM rules and monitoring requirement.

Box 5: ***Monitoring model adopted in Cambodia for new producers following training***

After receiving training to produce high-quality NLS, producers go back to their workshops. Support is needed during this initial production phase to encourage them to produce the new model and comply with the quality standard.

Stage 1: Firm order for 20 NLS

When the models have been produced, the project's quality control service will visit the workshop. After the products have been examined, a critical review is carried out, clearly explaining which points require attention. The order will be paid for, but stoves considered unacceptable will be destroyed before the producer's eyes, explaining that the product must be of the required standard if he wants to join the quality seal system.

Stage 2: Second firm order for 20 NLS

The procedure is the same, except that only 75% of the price will be paid for stoves considered to be of poor quality, with the others receiving the full price. Rejected stoves will be destroyed as before.

Stage 3: Third firm order for 40 NLS

The procedure is the same, except that only 50% of the price will be paid for stoves considered to be of poor quality, with the others receiving the full price. Rejected stoves will be destroyed as before.

Stage 4: Fourth firm order for 40 NLS

The procedure is the same, except that only 25% of the price will be paid for stoves considered to be of poor quality, with the others receiving the full price. Rejected stoves will be destroyed as before.

Stage 5: Final firm order for 50 NLS

The procedure is the same, except that stoves considered to be of poor quality will not be paid for, with the others receiving the full price. Rejected stoves will be destroyed as before.

This is the end of the monitoring/training phase in which support is provided for between 3 and 4 months.

If the producer is considered fit to produce high-quality NLS, the project will order a series of 100 or 200 units from him and pay him in advance without setting a delivery time, to enable the producer to honour his current orders.

Conclusion

In the case of the GERES project, where an existing cooking stove production chain received support over many years, the main challenge now is to develop the inter-professional structure of the production/distribution network. This is to ensure that rigorous stove quality control is maintained and foster a national dissemination strategy. The government's involvement in quality control in particular seems to have strategic value. In Cambodia, the regulatory authority, MIME, seems to be especially well-placed as it covers Industry (standards office), Energy (efficiency, rational energy use) and Mines (development of clay resources). This Ministry should be able, in liaison with ICOPRODAC, to establish a cooking stove standard complying with the specifications for the improved model and ensuring consumer confidence.

A wealth of lessons has been learned from this experience and its success is due to a large extent to a motivated team that has put in a long-term effort. Innovations are continuing in respect of the NLS: testing new materials and production methods, using new communications technologies to monitor dissemination and establishing a dedicated laboratory.

On the basis of these achievements, GERES is now endeavouring to extend this know-how and develop an integrated approach to take up the challenge of biomass energy in developing countries.

In Cambodia, the team is working on dissemination of cooking stoves in rural areas and promoting sustainable production of energy biomass for the benefit of villages. Efficient kilns with a reduced environmental impact (built from local materials, clean combustion, etc.), known as "Vattanak" stoves, have been disseminated to preserve the traditional palm sugar production sector. Using a "sister company" to market the resulting high-quality palm sugar means that efficient kilns can be funded without resort to credit schemes for producers. The risks are taken by the partner company and profits are shared (the "social business" model[7]).

7- A notion dear to Muhammad Yunus, "social business" is the way forward suggested by the Nobel Peace Prize winner who came up with the idea of a bank for the poor, the Grameen Bank, to enable the poorest communities to make a decent living from their skills, and who designed "win-win" economic approaches.

Again in Cambodia, GERES is also working in partnership with a forest community in Takeo on charcoal manufacture. Officially illegal, this is an intensive practice on the fringes of natural forests and largely responsible for their degradation. The introduction of efficient charcoal-making equipment can, using the same amount of wood, achieve a better conversion yield and higher calorific value for the charcoal obtained, resulting in a 35% energy saving compared with the traditional process. However, in certain cases, this is not sufficient to make "sustainable charcoal" economically competitive in relation to traditional charcoal. In these cases, the additional profits generated by marketing wood vinegar (condensate of the pyrolysis gases) can consolidate the cost-effectiveness of these sustainable charcoal production units.

In Indonesia, a study has been launched on the island of Java in the central province to explore the feasibility of introducing fuel-efficient cooking stoves. With a population of 35 million, this area is experiencing heavy pressure on its natural resources, particularly due to families collecting wood energy.

Finally, in Africa, GERES is currently carrying out an exploratory mission in Mali and Burkina Faso to assess the feasibility of setting up a regional professional support unit for the household energy sector on the basis of results obtained in South-East Asia particularly. In view of the many initiatives that have already been undertaken, the objective of this mission is to determine how targeted support could be provided in respect of low-cost clean combustion technologies in small scale activities, standardization/certification of efficient household cooking stoves and charcoal and access to new funding mechanisms such as carbon finance.

These promising approaches in the field of biomass energy have come about as a result of mobilizing appropriate skills in the North and South. They also depend on consistent political and financial support from policymakers in Southern countries and donors. This support needs to be expanded to meet the present challenges posed by the increasing scarcity of fossil fuels, climate change and the fight against poverty. We hope that this look back at the experience of the GERES project in Cambodia will show that it is possible to replicate this type of work in other countries heavily dependent on biomass energy and will draw policymakers' attention to the advantages of such approaches.

Main websites on cooking stoves in South countries:

- *www.bioenergylists.org*
- *www.iapnews.wordpress.com*
- *www.hedon.info*
- *www.pciaonline.org*
- *www.geres-cambodia.org*

The socio-economic and sanitary impacts of disseminating the New Lao Stove 2

The study of the socio-economic impacts of disseminating the NLS presented in this section is the work of the "Policy and study Unit" (PSU) of GERES Cambodia. The unit, which comprises Pouv OUK (Manager), Vichheka VORN (research co-ordinator) and three Cambodian associate researchers, conducts economic, social and environmental studies in the fields of energy and climate change, based on sampling techniques, surveys and statistical analysis of data.

MARGE assisted the RPU in carrying out the socio-economic impact study. MARGE is an independent consultancy company set up in 1995, which now has internationally recognized expertise in sustainable development dealing with topics such as natural resource management, domestic energy, rural electrification, poverty reduction and gender discrimination. MARGE now has 16 associate experts.

Jean-François Rozis, an independent expert, produced the last part of this section looking at the health impacts of biomass cooking stoves.

On completion of a 10-year GERES programme to disseminate efficient cooking stoves, it could not be denied that there was not enough economic and social data available to determine the project's impact on the direct and indirect beneficiaries.

As a result, GERES launched an evaluation of the socio-economic impacts of its project with a view to publicizing the findings at the United Nations Climate Change Conference (COP 15) to be held in Copenhagen in December 2009.

Greatly constrained by the production schedule (4 months), this evaluation has taken the form of a qualitative and quantitative study focusing on two target groups, namely stove manufacturers and the final users in urban areas. The major findings are presented in the first three parts.

The fourth part, which has been deliberately kept separate, deals with the impact on air quality and health of using biomass cooking stoves. This is because the measuring methods are very different from socio-economic analysis and require specific, complex implementation protocols. Measurements of air quality have been taken in the laboratory by GERES Cambodia, but no analysis has yet been done in the field. This last part therefore looks at the general health impacts of cooking with biomass and presents the initial findings of tests carried out in Cambodia.

Methodology of the socio-economic impact assessment

The following study has been conducted by GERES Cambodia (Policy and Study Unit) with support from MARGE France. GERES and MARGE worked together to define the overall study methodology. GERES was responsible for field investigation, data entry, processing and analysis, and report writing. MARGE took charge of sample selection and questionnaire design, advised on data processing and analysis, validated the findings and contributed to final report editing.

This study aims primarily to assess the socio-economic impacts of New Lao Stove dissemination on two target groups, namely stove users and stove producers. Due to time and financial constraints, the study's geographical scope was restricted to Phnom Penh, where the largest numbers of NLS users are currently found.

Two similar cooking stoves have been compared: the New Lao Stove and the Traditional Lao Stove. There are other kinds of traditional "unimproved" cooking stoves in Cambodia (e.g. the Siam stove). However, respondents (users and producers) were not questioned about them so as to focus the study on stoves with very similar features in terms of their production and use.

For the stove producers, the specific research questions raised were:

- have there been any changes in cooking stove sale prices and profits? If so, can they be measured and explained?
- have there been any changes in labour costs and employment due to NLS production? If so, can they be measured and explained?
- what are the initial investments required for starting NLS and TLS production respectively? How do the producers finance them?
- have there been any changes in the sector's organization and financing due to ICOPRODAC[1]?

For the stove users, the specific research questions raised were:

- have there been any changes in household expenditure on fuel and the use of money saved on firewood thanks to the NLS? If so, can they be measured?
- have there been any changes in the time spent on meal preparation? If so, can they be measured and how is the extra free time used?
- have there been any changes in cooking chores and safety?

Multiple-choice questionnaires were designed for the end-users and producers. They were divided into many sections which aimed to address the research questions raised. The producer questionnaire was administered directly by PSU researchers. End-users were questioned face-to-face by interviewers recruited, trained and supervised by the RPU. The field investigation lasted four weeks.

In total, approximately 1 600 end-users and 58 NLS and TLS producers were randomly selected and interviewed for this survey.

Data entry, clearing and processing (frequency, mean, cross-tabulations and other statistical calculations) were carried out using statistical analysis software (SPSS). In cross-tabulations, only subsamples of more than 20-30 respondents were taken into account for the analysis.

Three case studies of leading producers were also carried out to provide qualitative inputs. This was done through face-to-face interviews with NLS producers based on an open questionnaire.

1 - Improved Cookstove Producers and Distributors Association of Cambodia, cf. Chapter 1: Looking back on biomass cooking in the South and lessons learned from the GERES project in Cambodia

Impacts on stove producers

Sampling

The survey focused on NLS and TLS producers, while producers of other kinds of stoves were disregarded. A total of 27 TLS producers and 31 NLS producers were selected and interviewed for this survey. Selection criteria applied to producers included the number of years they have produced NLS and TLS and, for NLS producers, also their registration with the producers' association ICOPRODAC and participation in regular quality control and monitoring by GERES Cambodia.

NLS producers frequently produce both kinds of stoves; this applies to 13 of them in this study. However, the study shows that TLS production is only a minor part of their business, supplementing NLS production, although the surveys did, where possible, differentiate between the economic results of NLS and TLS production.

Producer interviews were conducted in 8 provinces: Phnom Penh, Takeo, Kandal, Kampot, Kampong Chhnang, Kampong Cham, Battambang, Siem Reap and Prey Veng. Despite widespread distribution of producers around the territory, a majority of them can be found in Kampong Chhnang Province.

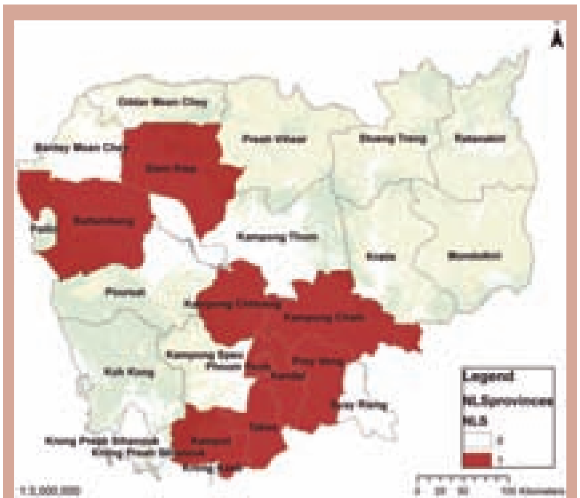

Figure 1: Map of Cambodia highlighting the provinces where producers were interviewed

Historically, cooking stoves have been produced in Kampong Chhnang and distributed widely throughout Cambodia because clay, the main material used in stove production, is easily acquired, of high quality and particularly cheap in that area. Traditional techniques for cooking stove production have also been passed down from generation to generation.

Producers' economic results

Sale price of the cooking stoves

Stove prices vary depending on the province of origin. The study showed that stoves produced in Kampong Chhnang province are much cheaper than those manufactured in Siem Reap, Kampong Cham and Battambang provinces. This is probably due to the fact that labour and raw materials are cheaper in Kampong Chhnang.

Figure 2 below shows the average prices found by the study across all provinces, for various sizes of stoves including or excluding delivery. There are different standard stove sizes. The most commonly used cooking stoves are NLS "size 1" and "size 2", chosen by 70 to 80 percent of cooking stove users. The biggest NLS sizes 00 and 0 are rarely used by households, but frequently used by the restaurants and produced on special order only.

There is no standard size of TLS; it is usually determined by each individual producer. Consequently, it is the size of the combustion chamber rather than the stove itself that needs to be considered when comparing NLS and TLS sale prices. On this basis, NLS size 0 would be equivalent to TLS size 1, NLS size 1 to TLS size 2, and NLS size 2 to TLS size 4.

The study revealed that, in general, for cooking stoves with similar combustion chambers, the NLS is sold at a price almost three times higher than the TLS. The greater final price for consumers is the result of higher production costs incurred for the NLS in terms of raw materials and labour costs, as well as retailers' higher margins[2]. It reflects the aim of the project to ensure that producers and retailers have an equal share in the benefits of selling NLSs, whilst raising wage levels.

2 - Quality and Monitoring Unit survey, GERES, 2007

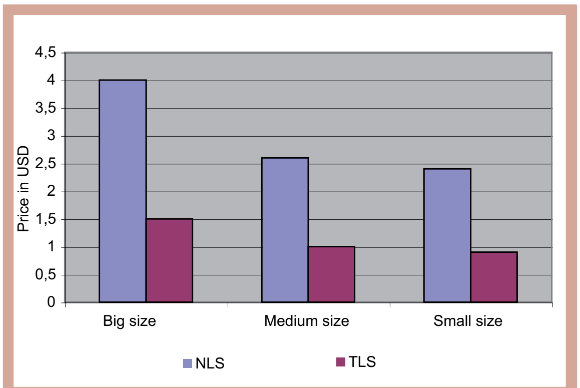

Figure 2: Price by type of stove

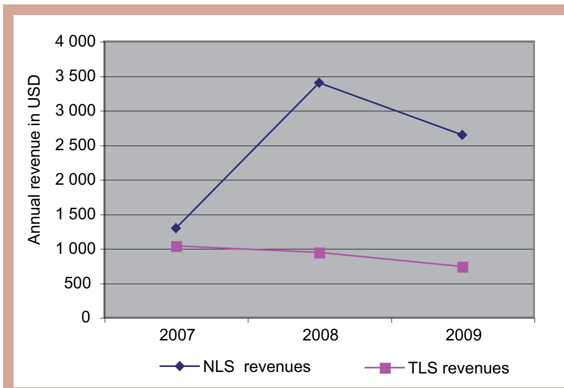

Figure 3: TS and NLS Capital Source of Initial Investment

Sales

Monthly and yearly sales by producers of both types of cooking stove (TLS and NLS) were investigated during the study in order to compare the income generated by these two activities over the last three years.

According to figure 3, income from NLS production is almost four times higher than from traditional stove production. Moreover, the trend observed over the last three years is a clear decline in income from TLS production whereas the level is more sustained, if irregular, for NLS production. The drop of 29.3 percent in income from TLS production between 2007 and 2009 is apparently due to the introduction of the NLS.

On the other hand, the study revealed a sharp increase of 61.3% in income from NLS production in 2008 followed by a quite significant drop of 28.7% the following year. A possible explanation for this decrease is the growing competition among NLS producers whose increasing number has been reported in 2008[3]. The stiffer market competition for NLSs per producer led to a fall in production per producer and less frequently to a reduction in sale prices. Furthermore, raw material and labour costs were affected by a strong inflation rate in 2008[4] that caused profit margins to decline drastically.

Investment and Own Capital

Both NLS and TLS producers were interviewed about the amount invested to start in the cooking stove production business and about the source of funding.

Investment capital is the outlay required to start production, covering raw materials, production equipment (dryers, etc.) and means of transport (carts, vans, etc.) for raw materials and finished products.

The study shows that the average starting capital invested, for all producers taken together, lies between US$5,000 and US$10,000. However, NLS producers invested on average over 4 times more ($6,520) than TLS producers ($1,328) to start their business. This is because NLS producers follow a standardized production process and have to invest in dryers, specific machines for clay preparation that are much more expensive.

On the other hand, according to Figure 4, the investment pattern remains similar for NLS and TLS producers. In fact, a large majority of both NLS and TLS producers used their own capital to provide the initial investment. A very low percentage of them requested loans from banks, micro-finance organizations or other private sources, as is often the case within the informal sector.

3 - Quality and Monitoring Unit survey, GERES, 2008
4 - Economic Institute of Cambodia (EIC), 2008

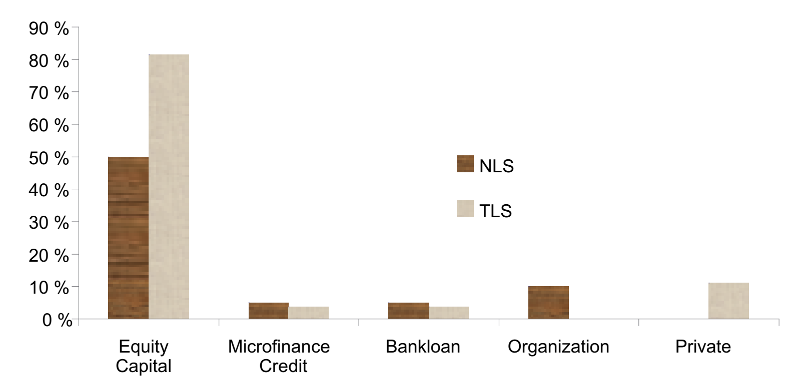

Figure 4: Sources of funding for initial investment

Wages and job creation

Readers are reminded that an explanation and illustration of the NLS production process appears in Chapter 1.

Stoves are largely produced during the dry season as some stages of production depend on appropriate climatic conditions. In particular, the heat of the sun is necessary to dry the stoves.

Workers' wages vary according to the kind and size of stove produced. Figure 5 illustrates labour costs depending on stove size and type.

It can be seen that labour costs for TLS production are lower than for NLS production because TLSs are easier and quicker to produce. Producing NLSs requires greater skill and takes more time (more parts to assemble, metal buckets, etc.). Workers with the necessary skills are therefore better paid for working longer hours. The win-win approach described in section 1 also explains why the payment for labour is higher. It is an incentive for workers to produce NLSs.

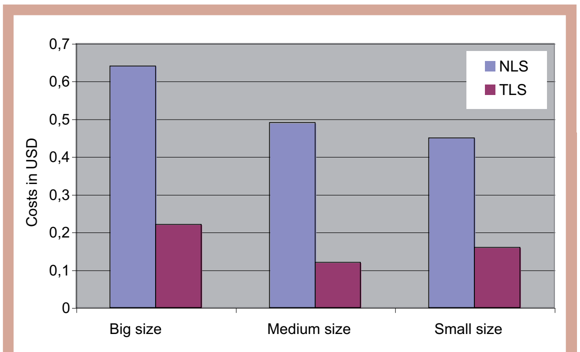

Figure 5 : Labour costs by Stove Size (US$)

According to the survey, the 31 NLS producers currently employ an average of 10-14 workers across a range of six skills: moulding, carving, cutting, punching, bucketing and assembly. These figures do not include family members and the 1 or 2 additional workers who may be employed at peak NLS production times. Comparatively, the 27 TLS producers interviewed employ an average of 3 workers only. A previous report from GERES Cambodia[5] suggests that TLS producers tend to rely largely on workers from the family and to hire few external workers in their business.

The same logic applies to job creation prospects. About 22.5 percent of total NLS producers expressed their intention to take on an average of 3 extra workers for tasks such as moulding, carving, bucketing and assembly, whereas none of the TLS producers had plans to recruit any new workers.

Organization of producers and benefits

At the end, the survey explored stove producers' perception of the organization of their sector through ICOPRODAC (Improved Cookstove Producers and Distributors Association in Cambodia). The aims of the association, set up in 2004, are to:

- foster close co-operation between producers and distributors;
- control production and selling prices;

5 - Quality and Monitoring Unit survey, GERES, 2007

Harmonization of product price	Boost market penetration due to ICOPRODAC label	Receive cooking stove market information easily	Communication with local authorities easier than before
21.4%	14.3%	11.9%	19%

Table 1: Producer perceptions of ICOPRODAC

- set up a quality seal system and bring in new producers;
- support members in building their management and organizational capacity and ability to work together.

Producers were asked to rank the kind of benefits provided by ICOPRODAC in order of importance, as shown in Table 1. The results suggest that the two main benefits identified by NLS producers concern the standardization of ICS (improved cooking stove) prices and improved communications with the local authority (recognition of the activity and profession, lobbying, etc.).

Additionally, the survey invited the NLS producers to give feedback on the credit and saving services put in place by ICOPRODAC in 2009. The savings group was established with the objective of providing producers and distributors with easier access to credit. In this way, individual members can contribute 20,000 riel (approximately 5US$) per month to the savings system and receive 2 percent interest per annum on their investments after 1 year. Loans will be available for members after 1 year of savings at an interest rate of 12% per annum for savings group members and of 24% per annum for other ICOPRODAC members.

The 31 NLS producers interviewed were all members of the savings group, yet 80.6 percent of them indicated no significant change in access to credit. This is because, as the group was only set up one year ago, loans are not yet available for its members.

Discussion of findings

The economic dynamics (in terms of results and number of jobs) accompanying NLS production are undoubtedly stronger than in the case of TLS but their origins are not clear.

Could it be that NLS production has primarily involved production units that were already amongst the largest and most active? Or did the NLS help smaller units to expand? Monitoring changes in the size of TLS and NLS producers over five years should provide further data.

Summary of findings:

- *58 cooking stove producers were interviewed, including 31 NLS and 27 TLS producers.*
- *An NLS is three times more expensive on average than a TLS.*
- *NLS production generates income per producer almost four times higher than TLS production.*
- *Investment in NLS production is four times higher than for TLS.*
- *Producers (of NLSs and TLSs) mostly rely on their own capital and few of them resort to credit or the private sector.*
- *The income of NLS producers rose between 2007 and 2008 before falling in 2009, probably due to competition from increasing numbers of NLS producers.*
- *NLS producers employ between 10 and 14 workers as opposed to 3 for TLS producers.*
- *Not all the services offered by ICOPRODAC have yet been taken up by producers*

The work involved in NLS production is more highly skilled and better paid. This illustrates the win-win strategy that the project has instigated with producers.

Finally, ICOPRODAC does not yet appear to be perceived as a key organization supporting producers and distributors. Efforts must be made to support and improve the awareness-raising which is a priority for ICOPRODAC.

A long-term study would help to get a better picture of developments affecting cooking stove producers. This task could be done by ICOPRODAC, which would inform its members about developments in the sector and the advantages of producing the New Lao Stove.

Impacts on NLS users

Sampling

To obtain a representative sample in terms of social class and economic conditions and to cover all possible fuel mixes, urban and peri-urban areas in Phnom Penh were selected. Sample selection was primarily based on population density in urban and peri-urban areas[6], and socio-economic status.

Field research was conducted in 7 "khans" (districts) in Phnom Penh: Russey Keo, Mean Chey, Doung Kour, Sen Sok, Chamkarmon, Daun Penh and Toulkok. The Planning Department of Phnom Penh Municipality (PDPPM) considers Russey Keo, Sen Sok and Mean Chey to be peri-urban, while the other khans are considered urban.

228-230 households in each khan were interviewed. In each khan, 3 blocks of houses with a mixture of social classes were selected.Respondents were randomly selected based on the road where they lived. Interviewers were required to survey every 5 households along the main and small side roads, administering 70 questionnaires per class to represent socio-economic diversity. The findings summarize the responses from 1045 households (65% of the sample) from urban areas and 555 households (35% of the sample) from peri-urban areas.

Figure 6 below gives an indicative distribution of respondents according to five income categories and the type of area in which they reside. The income categories have been cross-checked with the type of housing and ownership or otherwise of a vehicle.

Types of Equipment and Fuel Used

The "Fuel mix"

Households were questioned about the fuel or fuels they used for cooking, i.e. to prepare meals and to boil water. Readers are reminded that the main cooking fuels used in Cambodia are charcoal, LPG, firewood and, less commonly, paraffin and electricity.

The results shown in figure 7 confirm the prevalence of charcoal and LPG in urban khans and firewood in peri-urban khans:

- LPG is the most widely used fuel for preparing meals and boiling water taken together: 76 percent of all households surveyed use it, rising to 83 percent in urban khans, closely followed by 69 percent using charcoal (76 percent in urban khans) while only 35 percent of all households use firewood, rising to 65 percent in peri-urban khans.

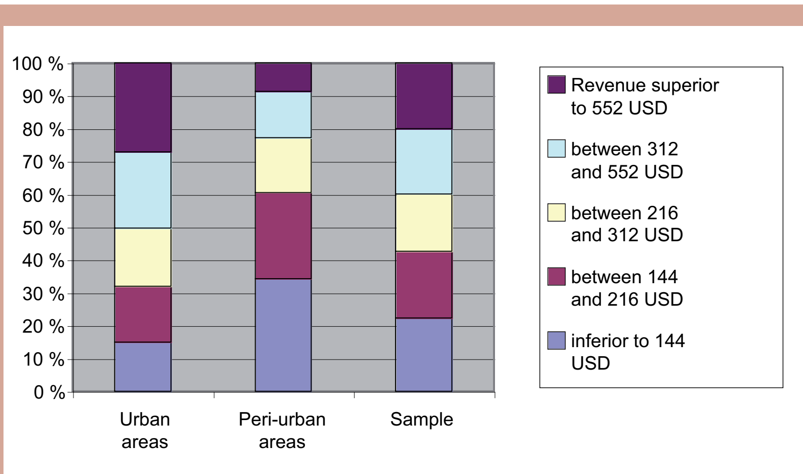

Figure 6 : Distribution of respondents according to Monthly Household Income and Location

Note: US$1= 4165 Riel

6 - Based on a PDPPM report from 2004, population density in Phnom Penh was 17,743 people/km2 in urban areas and 1,471 people/km^2 in peri-urban areas

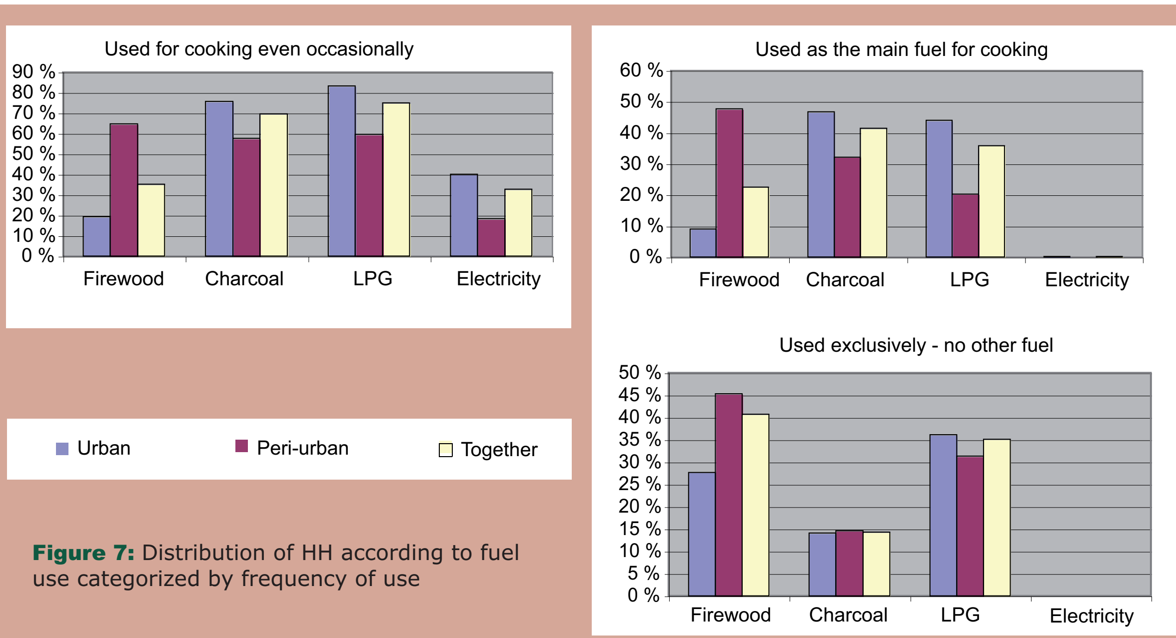

Figure 7: Distribution of HH according to fuel use categorized by frequency of use

- Charcoal predominates as the main fuel (the most used) for preparing meals alone: 42 percent use it, of whom 14.3 percent exclusively, with 36 percent using LPG, of whom 35% exclusively, and 22 percent using firewood, of whom 41 percent exclusively.
- Electricity is used by a third of Phnom Penh households, essentially for cooking rice, but very rarely as the main fuel.
- Paraffin and biomass residue are rarely used (less than 1 percent of households).

The significant difference in types of fuel used between urban and peri-urban households can be explained by higher living standards in urban areas. Generally, as household income increases, cooking fuel shifts progressively from firewood or charcoal to LPG or electricity. If firewood is still significant in peri-urban khans of Phnom Penh, this is probably because residents have access to firewood they can collect for free.

In conclusion, the complex fuel mix shows that the relative proportion of each type of energy is not fixed. The fuel mix is probably very sensitive to the price of charcoal and of LPG and to the availability of firewood. Any energy price fluctuation will have an effect (rising cost of LPG or falling charcoal production). This picture of the situation could therefore be very different in 6 months or 1 year.

It would be useful to monitor changes in the fuel mix to get an accurate forecast of the energy requirements of Phnom Penh and the associated demand for stoves.

On the other hand, the fuel pattern in peri-urban Phnom Penh probably is representative of the situation in smaller Cambodian towns, where firewood and charcoal are still widely prevalent.

Correlation between household income and the fuels and stoves used

The survey then asked respondents who use biomass in preparing meals about the type of cooking equipment they used. The results show that 22.2 percent of these households own one NLS (at least) while more than half them own one TLS (at least).

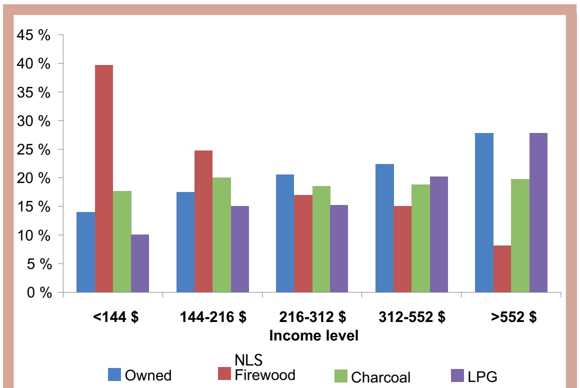

Figure 8: Fuel Used and NLS Owned per monthly income category

Figure 8 above shows a correlation between income level and NLS ownership. Respondents were divided into monthly income categories. As indicated earlier, in Figure 2, an NLS is more costly than a traditional cooking stove. This means that it is likely to be more popular with upper and middle class households, while use in lower class households is restricted due to price and, possibly, a historical tendency to use traditional stoves rather than NLS.

Figure 8 also classes households according to the cooking fuel used. It shows that NLS meets a great success amongst the high levels of income categories while it still has a scope for progress in the middle and poor levels. For these categories, the charcoal consumption is proportionally larger.

Figure 9 shows the correlation between the main cooking fuel and NLS use. 45 percent of households which use charcoal as their main cooking fuel own at least one NLS. Remarkably, the figure is 53 percent in peri-urban khans. On the other hand, the percentage of NLS owners is significantly lower among firewood users, which may be due to the fact that they are generally poorer. Only a few households own both TLS and NLS.

In addition, the project has always recommended using the NLS with charcoal, as it is less polluting and improves kitchen air quality, rather than wood. It is worth pointing out that GERES has designed other kinds of stove which are more suited to firewood, such as the Neang Kongrey Stove (NKS).

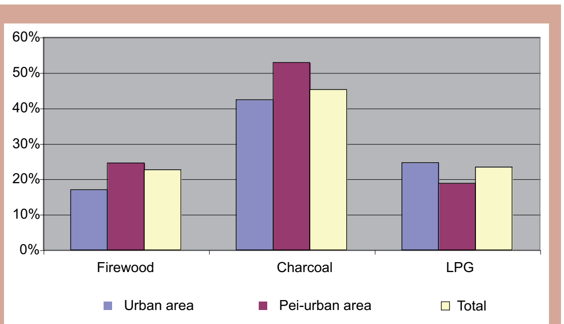

Figure 9: Percentage of NLS Owners according to Main Cooking Fuel

NB: Households using LPG exclusively are not included in this table.

Household savings on fuel and use of the money

Most of the households surveyed purchase 100% of their charcoal from a seller, while firewood users gather some of the firewood they need for free, especially those living in peri-urban khans. The price of charcoal varies between local shops and "trailer[7]" sellers. The average charcoal price is 970 riel (US$0.23) per kilo, while the average firewood price is 300 riel (US$0.07) per kilo.

The survey then asked respondents to estimate how much they spend on purchasing firewood and charcoal respectively, during the rainy and dry seasons. The seasons were distinguished because the price of charcoal and wood rises in the wet season (due to difficulties in drying wood) and can result in differing consumption patterns.

Table 2 shows that NLS owners reduce their wood fuel (firewood plus charcoal) expenditure by 5 percent - approximately US$7 - per year in the case of households using firewood as the main fuel and up to 7 percent – approximately US$12.5 - per year in the case of charcoal users. Such savings amount to less than 1% for the two lowest household income categories defined in this report (<US$216 per month) and can be perceived as small by the households concerned. Nevertheless, they can sometimes be very useful in paying school fees or buying items to improve the family's living conditions. Moreover, considering that there are currently over 250,000 households using NLSs, this adds up to a saving of between 1.75 and 3.5 million US dollars per year, which can have significant socio-economic repercussions in a developing country like Cambodia.

7 - An ox-drawn cart used for mobile charcoal sales

Main fuel used for cooking	NLS Owner expenses (US$)		TLS Owners expenses (US$)		NLS average saving per year
	Rainy season	Dry season	Rainy season	Dry season	(US$)
Firewood	64.7	66.8	71.0	67.4	6.9
Charcoal	78.0	77.4	86.3	81.6	12.5

Table 2: Average Firewood plus Charcoal Expenditure and Savings per Household (US$)

Finally, the reduction of 7 percent per year must be compared with the "controlled cooking tests" carried out by GERES in 2007, which concluded that 22 percent of charcoal could be saved in cooking. The test is part of the standard procedures to be followed by projects in calculating emission reductions and validating the issuance of carbon credits within the framework of the Clean Development Mechanism *(see Chapter 3)*. This test is internationally acknowledged and must be carried out by project operators wishing to prove the emission reductions achieved through their stove projects.

How do we explain this gap between the controlled cooking test and end-users' assessment? The first explanation which comes to mind is the rebound effect which is often observed in energy efficiency projects in LDCs where traditional stove users do not have adequate access to energy. Their demand for energy is limited, or reduced, due to budgetary constraints. This is known as "suppressed demand". Introducing the NLS means that households have greater access to energy. The energy savings are therefore partially cancelled out and the stoves have the effect of improving community living standards. In the case of the NLS in Cambodia, this means for example that households boil water more often.

In addition, the gap may be due to the distortion introduced by the controlled cooking test procedures. Cooks are provided with as much as firewood as they want and their behaviour may therefore be different from usual. Finally, there is a potential bias in the survey questionnaire as regards respondents' assessment of their savings on charcoal.

It is also notable that the majority of households using firewood as their primary fuel save less on wood fuel costs, due to disparities in how households procure firewood. Because TLS users tend to be poorer, they gather firewood locally and use burnable biomass waste as much as they can. Consequently, their expenditure on buying firewood is lower than their actual consumption, which creates distortion when compared with households that purchase 100% of their firewood or charcoal.

Cooking Time Saved and Extra Time Allocation

Less time spent on cooking

According to respondents' estimates, there is a significant difference in time spent on cooking between TLS users and NLS users. When their estimates of the time they spent are compared, it appears that households using an NLS save approximately 4.08 minutes on making breakfast, 3.75 minutes on lunch and 5.13 minutes on dinner in comparison with TLS users. This adds up to 90.72 minutes per week, or about an hour and a half.

Use of extra time saved

Users were then asked what they did with the time saved through cooking with the NLS. The results appear in Table 10. Most of them reported that they used the time to do other domestic chores. An additional one-third of them reported that they used it for income-generating activities, followed by 23 percent who used the time for resting, visiting and talking with neighbours.

Reallocation of time	Percentage of respondents
Domestic chores	73.9
Income-generating activities	34.8
Taking care of children	14.5
Resting, visiting, talking with neighbours	23.2
Don't know	1.4

Table 3: Use of Time Saved by using the NLS

According to the above estimates and percentages, 35 percent of NLS users can devote around 10 additional working days per year to income-generating activities (catering, sewing, etc.). Consequently, with over 250,000 households currently using the NLS, the extra time devoted to income-generating activities amounts to around 0.8 million extra working days, which could have a significant impact on the Cambodian economy and poverty reduction.

Cooking Chores and Safety

Among the households owning an NLS, a majority (61 percent) feel that using it has changed the way they do cooking chores. As shown in Figure 10, 72 percent of them said that the NLS made cooking easier and/or more comfortable. This could be due to the fact that the NLS is specifically designed for charcoal, which produces less smoke; in addition, users do not need to spend time monitoring cooking or adding fuel when using an NLS.
Only a few households perceived that using the NLS is more fun and keeps cooking equipment cleaner. Once again, this is probably because the modified design of the NLS produces less smoke and thus less soot to dirty the cooking equipment. Paradoxically, very few households reported that they were satisfied with using the NLS simply because of its reduced charcoal and firewood consumption.

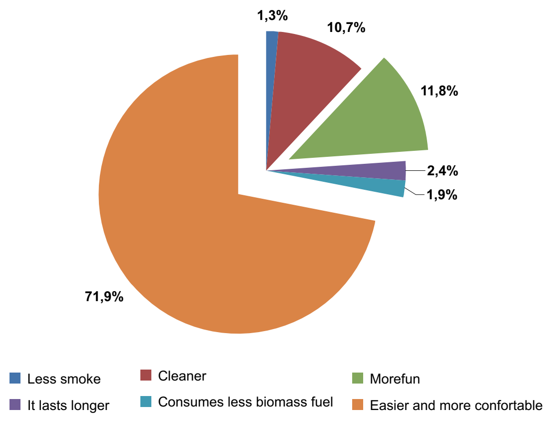

Figure 10 : Perception of Cooking Chore Changes with NLS

The survey also asked users about burns suffered when preparing meals, since such accidents are common. As shown in Table 4, 45 percent of non-NLS users report being burned while using their cooking stove, as against 36 percent of NLS users. From this, we can say that NLS users face less risk than non-NLS users of suffering burns when cooking. On the other hand, many factors other than type of stove can cause burns, including carelessness while cooking, stove location and type of fuel used (charcoal users reported fewer burns than firewood users).

NLS Users		Non-NLS Users		Knows someone burned while using NLS		Knows someone burned while cooking, not using NLS	
Rarely	Several times	Rarely	Several times	Rarely	Several times	Rarely	Several times
30.0 %	5.8 %	30.0%	14.8 %	9.3 %	5.0 %	10.2 %	8.5 %

Table 4: Risks of suffering burns for Non-NLS and NLS Users when Cooking

Discussion of results

Summary of findings:

- *Households cook with a mix of fuels.*
- *69% of households surveyed use charcoal for cooking.*
- *22% of the households surveyed which use biomass as their main fuel own at a least one New Lao Stove type stove.*
- *NLS users assess the reduction in their annual charcoal consumption as 7% (US$12.5) on average.*
- *Using the NLS results in an average saving of an hour and a half per week, i.e. 10 days per year, which can be allocated to income-generating activities.*
- *Using the NLS rather than the TLS seems to result in a slightly reduced risk of burns.*

In conclusion, the study shows that NLS dissemination has a significant socio-economic impact on household energy savings. Moreover, the latter are probably somewhat underestimated as a result of the possible rebound effect due to suppressed demand. The impact could nevertheless be enhanced and increased by carrying out regular awareness-raising campaigns, focusing on best practice for optimum use of the NLS. In monetary terms, the savings achieved show a return on investment within six months. GERES has used this argument to good effect in its promotional campaigns. The ergonomics of the NLS and the reduction in cooking times have been widely publicized and represent additional impacts in economic and social terms because the time saving frees women to carry out other activities. The study also shows that the NLS has been quite successful with the better off classes but is still not sufficiently well-known amongst the poorest social groups.

The suggested reasons have been the higher cost of the NLS, which may be a disincentive, and the fact that using the TLS is a long-established habit. In this regard, a satisfaction survey is presently being conducted amongst households by GERES in partnership with the University of Clermont Ferrand. Its final results, which will be available at the beginning of 2010, will probably include additional findings and proposals for improving NLS dissemination amongst poor communities.

Sanitary impacts of domestic cooking

Domestic cooking releases polluting particles

Inhaling smoke from traditional biomass cooking stoves is extremely detrimental to health. The gas and particulate emissions have short and long term effects on human health. In the last few years, considerable endeavours have been made to assess the health impact of using biomass cooking stoves in the South. On-the-spot measuring equipment has been specially designed and validated.

Carbon monoxide (CO) and fine dust particles are two particularly dangerous pollutants, both resulting from incomplete biomass combustion.

Carbon monoxide

In the blood, it reacts with haemoglobin in the place of oxygen. When present in excessively large quantities, carbon monoxide causes progressive asphyxia and death. Headaches and nausea are the first symptoms. Removing victims from exposure can gradually reduce carbon monoxide concentrations in the blood.

The gas is still responsible for thousands of deaths in industrialized countries every winter, as a result of poorly maintained combustion heating equipment combined with inadequate ventilation of premises. The standard carbon monoxide (CO) concentration that should not be exceeded in a room is estimated to be around 100 ppm[8].

Fine particles

Fine particles (less than 10 microns), on the other hand, do not have an immediately identifiable effect on health. Unlike larger particles (such as pollen), they are not trapped by the nose and throat but become deeply encrusted in the lung air cells. Over a long period, they can cause respiratory problems (very quickly in young children), cardiovascular distress and cancer.

Wide-ranging studies in several cities have shown a direct link between exposure to fine dust particles and the health of the communities concerned.

The World Health Organisation (WHO) recommends not exceeding daily average exposure of 0.1 to 0.15 mg/m^3.

Some lessons have been learned

Stoves with a chimney (installed to a professional standard) are of course advisable but, with good ventilation, concentrations of emissions from open fire stoves can be very considerably reduced (up to 95% with the door open). This is generally the case in hot countries, but becomes extremely problematic in areas which have a cold season.

Furthermore, the work of Kirk Smith[9] has shown the limits of this approach in densely populated areas, as the outside air gradually becomes charged with particulates as a result of cooking or other combined sources of pollution (such as transport and industry). Basic 3-stone cooking stoves nevertheless generate too much dust even in a well-ventilated room.

The case of the New Lao Stove in Cambodia

Measuring emissions with the PEMS

A reduction of 20-25% in charcoal use for the same job (useful energy in cooking a meal for a Cambodian family) has been confirmed in the field. This would therefore represent a reduction of approximately one quarter in the quantity of pollutants emitted during each cooking session. As explained above, the NLS should nevertheless only be used in well-ventilated premises.

The project team has recently equipped itself with a specific system, known as PEMS (Portable Emissions Measurement System), within its partner laboratory (ISC-MIME) in order to quantify these two pollutants more precisely.

Concentration of PM10 in mg/m^3	Increased mortality	Increased hospitalization due to heart problems	Increased hospitalization due to lung problems
10	0.5%	1%	2%
50	2.5%	5%	10%
65	4%	6.5%	13%
100	5%	10%	20%
150	7.5%	15%	30%

Table 5: The link between the dust particle concentration and health problems (Data from Health Effects Institute, 2000, BI/Clean Air Revival, Inc. 2001)

* PM10: fine dust particles below 10 microns

8 - Parts per million

9 - Kirk Smith: Professor at Berkeley University, California, internationally famous for his work on the health impact of domestic cooking stoves, which has led to various epidemiological studies on the subject and the development of specific measuring equipment.

Box 1- *Description of the PEMS*

This equipment is able to measure CO, CO_2 and fine dust particles in real time.

It has been designed to be portable, operating from a car battery, and is specially adapted for open fire cooking stoves.

It comprises an extractor hood linked to a blower extending into a tube in which sensors are positioned (to measure CO, CO_2, particulate rate, temperature and smoke/air flow). The smoke is discharged outside.

The data are transmitted and recorded on a laptop.

Initial results

A series of tests has been carried out to measure comparative emissions from the NLS and TLS when using traditional charcoal, green charcoal introduced by the project and wood.

As expected, there was no appreciable difference between the TLS and NLS with the same type of combustion. It was only the fuel saving that reduced the proportion of pollutants.

As stated above, cooking stoves of this type emit a lot less dust, 4 to 5 times less fine dust particles, when burning traditional charcoal rather than wood. Charcoal undoubtedly produces more carbon monoxide but in a lesser proportion (1.5 times more than wood). The other encouraging result is that producing better quality green charcoal not only limits deforestation but also helps to reduce indoor air pollution. The emission of fine dust particles can be cut in two in comparison with traditional charcoal, meaning 8 to 10 times less emissions than wood.

To conclude, combining dissemination of an economical charcoal cooking stove with the use of sustainably managed high-quality charcoal is a viable option in terms of health and environment in a country like Cambodia.

Utilisation du PEMS au Cambodge

Conclusion

The project to disseminate fuel-efficient cooking stoves was primarily aimed at economizing wood energy and consequently protecting forest resources. In looking back at the economic and social benefits of setting up the NLS supply chain, this study has shown that the project exceeded initial expectations. NLS dissemination also created jobs, boosted the skills of local craftsmen, enabled households to make financial savings, improved cooking conditions, reduced the time spent on that chore, etc. Moreover, the reductions in greenhouse gas emissions achieved by the project allowed it to access carbon finance (cf. Chapter 3). Its substantial economic and social impact is a rebuff to the many criticisms directed at the Clean Development Mechanism (CDM) according to which projects too rarely make any contribution to host countries' sustainable development. The notion of "social carbon" shows its true meaning here.

Nevertheless, several aspects still require more in-depth, systematic investigation.

As regards NLS users, a nationwide study based on statistical analysis models needs to be conducted by an independent research laboratory. This will also help to predict the future of NLS dissemination. Discussions have started between GERES and the Evaluation Department of AFD to consider the feasibility of a project evaluation over a minimum 18-month period. This evaluation would provide an opportunity to introduce innovative experiments such as, for example, setting up a microcredit system for purchasing the stove, which would run for 18 months in just a few areas, so as to measure the impact of the arrangement on dissemination amongst the poorest social classes. In addition, it would look again at fuel savings and seek to quantify to a greater extent the suppressed demand phenomenon that was offered as an explanation for the difference in savings measured by the household study and the controlled cooking tests.

Research into the links between air quality, stove, fuel used and kitchen layout must be continued. This work would also benefit from the input of external bodies to develop sound experimental protocols drawing on international standards whilst remaining compatible with field conditions.

Finally, changes in economic results and numbers of NLS and TLS producers and employees need to be monitored in the long run to get more subtle, complete interpretations of the economic impacts demonstrated by this study. This work could be done by ICOPRODAC, whose remit includes informing members about the state of the sector and extending membership to distributors.

In conclusion, the study highlights some areas of concern which the project needs to tackle quickly:

- the tendency towards NLS market saturation noted by producers. This is an important signal for ICOPRODAC and GERES, as it continues to train NLS producers. The NLS market needs to be better understood and investigated in order to avoid this saturation. Stoves more suited to rural conditions should also be offered;
- the matter of suppressed demand mentioned above;
- the proportionately lower rate of NLS dissemination amongst the groups with the highest charcoal consumption in relation to the better off classes, most of whom use LPG.

Carbon finance: a new funding stream for fuel efficient stove projects 3

Samuel Bryan is the author of this chapter. He is the Technical Director of GERES Carbon Finance projects. Following an MSc in Environmental Technology, he joined the Climate Change Unit in 2006 and began working on the New Lao Stove project in Cambodia. As Technical Director, his work focuses on ensuring GERES projects progress through the carbon project cycle and obtain certification, as well as providing assistance to the CDM analysts who are responsible for the preparation of the projects. His role is also to assist regional partners' access carbon finance and to train development stakeholders on accessing carbon finance.

Carbon offsetting is a funding mechanism which exists to mitigate Greenhouse Gases (GHG) and enhance sustainable development. At present it is worth over 26 billion dollars per year[1]. Part of the funding is generated through mitigation projects implemented in developing countries (Clean Development Mechanism, for example). This level of investment could make a huge difference to the vulnerable population of these countries, who will be the most affected by the impacts of climate change. However, a paradox lies at the heart of efforts to enhance sustainable development through offsetting in that the there is little opportunity to generate emission reductions in the least developed countries or poorest areas of emerging countries where the use of fossil fuels is limited[2].

1 - World Bank (2009)
2 - Evans (2006)

The main fuel of the poor is biomass, such as wood, charcoal or agricultural waste. Biomass may appear to be a renewable energy source since it comes from plants and plants are a renewable resource because they only need light and water—of which there is an unlimited supply—to grow. However, if wood is gathered from natural sources such as a forest and burned at a rate faster than the source is replanted, the carbon cycle[3] is broken. Excess carbon dioxide (CO_2) goes out into the atmosphere. This makes it "non-renewable biomass" and a contributor to greenhouse gas emission, just as fossil fuels are, and therefore also to climate change. Management of the biomass used by households is therefore a major issue to be addressed in the effort to fight climate change.

Improve cooking stove projects, which reduce the combustion of non-renewable biomass fuels, have been championed for their potential to reduce CO_2 emissions and to channel carbon funding directly to poor communities. Indeed, the GERES NLS project, started in 1996 and still in operation, has been funded through carbon finance since 2006.

This chapter is divided into three parts. The first deals with the institutional and financial framework of CDM and the voluntary market, the second with the specific requirement for stove projects accessing carbon finance and the last deals with the impacts that carbon finance has on stove projects.

3 - The decomposition of plant material under natural conditions, or due to anthropogenic burning, results in equivalent carbon dioxide (CO_2) emissions. Theoretically, this is re-absorbed by growing plants/trees through the process of photosynthesis. This is referred to as the carbon cycle.

Institutional background of carbon markets

Flexible mechanisms initiated by the Kyoto protocol

The Kyoto Protocol

In 1992, at the Earth Summit in Rio de Janeiro, over 150 countries signed the United Nations Framework Convention on Climate Change (UNFCCC) and industrialised nations (so called "Annex 1 countries") agreed to take on voluntary caps of manmade GHGs. By 1997, the Kyoto protocol had been adopted with stronger, legally binding, emission reductions. Industrialised countries are committed to returning GHG emissions to an average of 5.2% below 1990 levels. The protocol targets a basket of six gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF_6). The emissions are to be achieved during the first commitment period from 2008-2012.

One of the innovative aspects of the Kyoto protocol was the introduction of flexible mechanisms. To assist Annex 1 countries in cost effectively meeting their emission reduction targets, the Kyoto protocol introduced three market-based mechanisms.

- Emission trading: 38 industrialised countries are assigned permits which can be traded between themselves
- Joint Implementation (JI): allows countries to claim credits for emission reductions that arise from investment in other Annex 1 countries, mainly economies in transition from Central and Eastern Europe.
- Clean Development Mechanism (CDM): allows Annex 1 countries to implement mitigation projects in developing countries. The former can claim credits for emission reductions. In addition, the projects must contribute to sustainable development in the host country.

Compliance and Voluntary Market: the trading of Greenhouse Gases

The Kyoto Protocol's flexible mechanism gave rise to a global marketplace for carbon. The carbon market is founded on the premise that, as gases circulate freely in the atmosphere, a reduction in Greenhouse Gases (GHG) is the same wherever it occurs.

According to Kyoto's emission trading system, a country can convert the unused share of its emission rights into "negotiable emissions permits" and sell them to countries that have exceeded their emission levels. This exchange can also take place between businesses that have reduction objectives within the same country.

GHG reduction derived from CDMs implemented in Southern countries, so called "carbon offsets", is also a possible exchange currency on these markets.

Compliance markets have thus developed in a number of countries that signed the Kyoto Protocol.

Whilst the Kyoto Protocol was being set up, a growing number of businesses, individuals, and public stakeholders made voluntary commitments to offset their GHG. Consequently, the voluntary markets were established. The offsets are not used to meet compliance obligations but individuals and entities buy carbon credits for ethical reasons or to enhance their corporate image. Offsetting projects for the voluntary market which are implemented in Southern countries usually follow the CDM rules closely (*see "the rules of the Clean Development Mechanism" here after*); however, they are more flexible than its counterpart. Transaction costs are lower and it is often possible to obtain funding for projects that would otherwise be unviable under the rules of the CDM. The voluntary market is often a window for project developers to test methodologies or start non-eligible projects for the CDM (agriculture and land use, "avoided deforestation").

At first the voluntary market was unregulated. However, the dubious quality of some of the emission reductions led to the development of market standards. Box 1 describes the two main market standards in the voluntary market.

Box 1- ***Voluntary Market Standards***

Voluntary market standards have proliferated in recent years. The two main standards are differentiated by their respective niches

The Gold Standard (VGS) *is the market's premium standard. Only energy efficiency and renewable energy projects are eligible and there is a strong emphasis on development benefits. The GS aims to enhance the quality of carbon offsets and increase their co-benefits by improving and expanding on the CDM processes. These factors mean Gold Standard credits attract a higher price in the market. The gold standard applies for both CDM and projects from the voluntary market.*

The Voluntary Carbon Standard (VCS) *aims to be a universal, base-quality standard with reduced administrative burden and costs. The VCS requires that project verification is undertaken by a Designated Operational Entity (DOE) which is accredited to verify CDM projects. There is more flexibility within the VCS in terms of project types and the administrative burden of compliance.*

(WWF, 2008)

The rules of the Clean Development Mechanism

The final rules for implementation of a CDM arrangement were adopted in 2001 at the 7th Conference of the Parties to the UN Framework Convention on Climate Change held in Marrakech, Morocco. The CDM has the twin objectives of assisting host countries achieve their sustainable development goals, while giving industrialised countries some flexibility in how they meet their emission reduction targets.

Numerous CDM guidelines and procedures have been used extensively in the voluntary market. To generate credits in either market, project activities must follow the stages of a project cycle and be in compliance with an approved methodology. The CDM project cycle is explained below and is the starting point for any project developer aiming to implement an offsetting project.

Governing authorities

Like a legal system, the CDM is founded on a body of rules which developed over time. Its rules are set by the UNFCCC and it is to be "supervised" by the CDM Executive Board[4]. The EB has set up the basic structure of the CDM. Firstly, private organisations have been accredited as Designated Operational Entities (DOEs). The role of these organisations is to validate proposed CDM activities and verify emission reductions. Secondly, the EB has established various panels and working groups to oversee the technical work of the executive board. It is through interaction with these institutions that projects progress through the project cycle. Figure 1 below illustrates the project cycle and the role of the participating institutions.

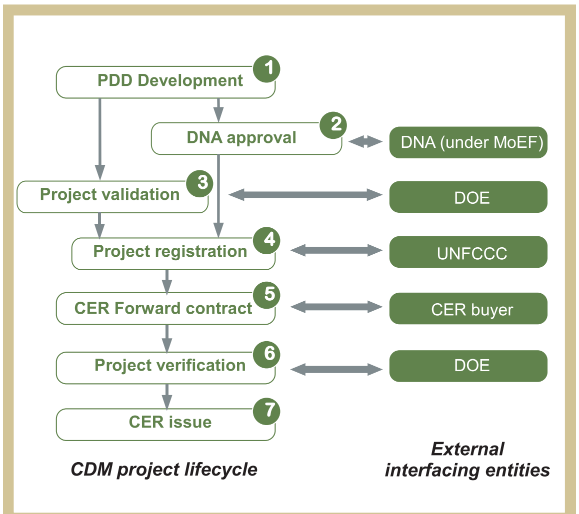

Figure 1: the CDM project cycle (UNFCCC, 2009)

4- Michalowa. A, (2007),

Project cycle

The CDM project cycle is long and complicated. It can take up to 2 years from the design phase to the issuance of the credit. It involves all the stakeholders previously introduced.

Design Phase
Projects must comply with methodologies that have been approved by the EB. The information detailing how the project meets the requirements of the methodologies is compiled in a Project Design Document (PDD). The PDD is a standard template created by the EB. The PDD has to be approved by two institutions. Firstly the Designated National Authority (DNA) and then a DOE. The DNAs are set up by the host country that has ratified the Protocol. Their role is to determine the sustainable development criteria of the country and confirm a project meets those criteria. The PDD is then submitted to a DOE for validation.

Validation
The project implementer chooses an accredited DOE and hires its services for validation of the project. DOEs check the claims made in the PDD and evaluate the project in terms of its compliance with the approved methodology. If the DOE thinks a project conforms to the relevant rules, it will release a validation report which is the basis of a request for registration to the EB.

Registration of the project
Once submitted to the EB, a project is registered automatically within 8 weeks from receipt of the registration request (4 weeks for small-scale projects), unless at least three EB members launch a request for review.

Monitoring
Project developers collect information to prove emission reductions have occurred. Methodologies describe the information needed in a monitoring plan and project developers produce annual monitoring reports to present evidence of emission reductions

Verification
At the verification stage, a DOE checks the monitoring reports and evaluates the emission reductions. It checks whether the project is in compliance with the methodology and the monitoring plan in the PDD.

If the DOE approves the monitoring report, credits can be issued. DOEs conduct a field visit and issue a draft report. The draft report may contain a number of requests for action which the project developer must take before the final certification report can be issued.

Issuance
Once the certification report is released, an issuance request is submitted to the EB and credits are issued to the project.

Methodologies and project size

Methodologies describe the various measures needed to calculate and monitor emission reductions. Whilst the voluntary and regulatory markets are separate, the voluntary market standards often require the use of an approved CDM methodology to be eligible. The largest sources of methodologies are those approved by the EB of the CDM. The existence of standardised methodologies for certain project types allows both the approved project auditors or Designated Operational Entities (DOEs) and the EB to assess the quality of a particular project type. Methodologies contain the basic instructions of a project design in terms of baseline emissions, project boundary, leakage and monitoring.

The baseline (scenario and emissions) for a CDM project activity is the scenario that reasonably represents GHG emissions that would occur in the absence of the proposed project activity. A CDM project activity must reduce emission below those that would have occurred in the absence of the project. The difference between the baseline emission and the project emissions are the emission reduction. *(See figure 2)*.

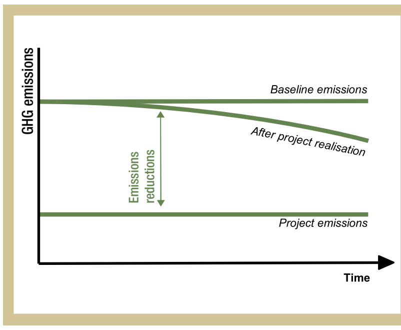

Figure 2: Valuation of emission reduction on a CDM project (source IGES, 2009)

Complying with methodologies and moving through the project cycle is an expensive process. The transaction costs depend on the size and complexity of the project but can be between US$15,000 – 100,000. Early in the process of constructing the CDM market it was realised that small-scale projects, which are more likely to have development benefits, would find it harder to absorb these costs[5].

Therefore the CDM distinguishes between large-scale and small-scale projects. Small-scale projects have simplified methodologies and procedures to reduce the transaction costs.

Selecting the appropriate carbon market

Project developers must assess the relative advantages of the markets to select the most appropriate for their project. The chapter below highlights some of the pros and cons of the voluntary and CDM markets.

The CDM credits, Certified Emissions Reductions (CERs), attract higher prices than their equivalents in the voluntary markets (VERs). Initially the unregulated carbon market led to a dubious quality of emission reductions. This prompted the development of market standards such as the VCS or Gold Standard. The voluntary market standards borrow a lot from the CDM and have provided quality assurance to buyers. The increase in the quality of voluntary offset credits has led to higher prices for voluntary credits. The range is between US$2 and US$25 but the average price is around US$4.10[6]. This is far below the average CER price of US$16[7]. Another reason to access CERs is that demand is more assured in the compliance market. The voluntary market is driven by ethical consumerism but in a tumultuous financial climate it is hard to forecast demand. This has driven a race to quality where generating CERs is increasingly seen as a hedge against market uncertainty.

The procedures of the CDM have numerous bottlenecks, not least the EB which many see as overwhelmed by the scale of its workload[8]. Due to the voluntary markets' greater flexibility and reduced bureaucracy, projects can deliver credits quicker. In the CDM, projects have a lead-in time of around 1.9 years from the point of validation to issuance[9].

The voluntary market can also allow projects to be more innovative and smaller. Around 36% of offset credits in the voluntary market were sourced from projects involving less than 100,000 tCO_2e[10]. Cooking stove projects are an example of how the flexibility of the voluntary market can be beneficial. Voluntary markets do not prevent projects avoiding deforestation from claiming for emission reductions. Furthermore, it was not until 2008 that the CDM approved two stove methodologies[11]. The main barrier to approval has been the status of biomass in the Kyoto Protocol. To understand this, the distinction between renewable and non-renewable biomass must be explained.

Accessing carbon finance for fuel-efficient stove projects

Non-renewable biomass

Biomass is generally considered to be a renewable fuel. When it is burnt any CO_2 released is assumed to be reabsorbed through re-growth of biomass. If biomass is not re-grown, then the emissions from biomass can be considered to be a non-renewable fuel. Therefore, cooking stove projects can only generate emission reductions where it can be shown that the biomass used is non-renewable.

However, crediting displacement of the combustion of non-renewable biomass is by extension crediting avoided deforestation projects and this is explicitly prohibited under the Kyoto Protocol *(see box 2)*.

5 - World Bank, 2003
6 - Hamilton et al. (2007)
7 - World Bank, (2009)
8 - IETA, (2009)
9 - Olsen, K, (2009)
10 - Hamilton et al. (2007)
11 - The methodologies are AMS-I.E for renewable projects and AMS II.G for energy efficiency projects.

Box 2 –*"Avoided deforestation" projects excluded from CDM:*

Between 2000 and 2005 deforestation took place at an accelerated pace. It is currently responsible for 17.5% of greenhouse gas (GHG) emissions and has become a key point in current international negotiations on climate change mitigation. While "avoided deforestation" emerged at the October 2006 Summit on the World Agenda, it was proposed to include it in the post-2012 negotiations and that pilot projects and methodology testing be implemented as quickly as possible.

Some opponents argued that forest conservation was a risky strategy for combating greenhouse gases because it did not address the demand for timber or land. Deforestation is driven by demand for timber and land and avoidance in one area does not diminish the overall demand.

These concerns led to the exclusion of projects that generated emissions from avoided deforestation and by extension led to the exclusion of biomass cooking stove projects from the CDM. (Lawrence, 2007).

* Global Forest Resources Assessment FAO, 2005

To avoid this, CDM projects must use a fossil fuel baseline. The assumption is that, unless there is an improvement in efficiencies of biomass stoves, users will seek to switch to fossil fuels in the future.

Whilst this is somewhat counter-intuitive, it is seen as the only way to resolve the contradictory position of non-renewable biomass[12]. However, because the fossil fuel alternatives to biomass, LPG and Kerosene, are much cleaner, it significantly reduces the amount of emission reductions such projects can claim. This is illustrated by figure 3 below. Using a non-renewable12 biomass baseline the area a,b,c can be claimed. However, the use of a fossil fuel baseline reduces this area to a1,b1,c.

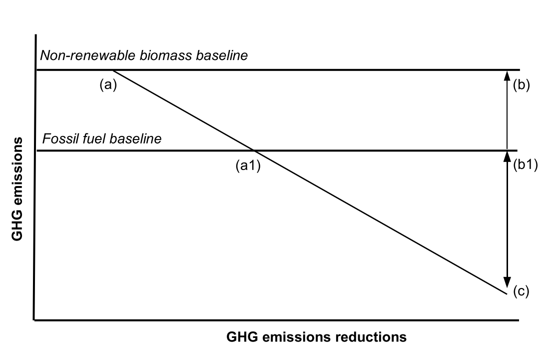

Figure 3: Emission reductions from projects using fossil fuel and NRB baseline (Bryan, 2006)

GERES a pioneer in accessing carbon finance

In 2006 Carbon Finance was a relatively new funding stream, with very few precedents for stove projects. However, as the limitations of the CDM pipeline became more apparent, interest grew on how more development-centric projects could be encouraged. As a result the World Bank made a small grant available to establish a carbon facility in Cambodia for the purpose of accessing carbon finance for NLS cooking stove projects. This enabled GERES to conduct studies and build capacity to develop robust calculations on the baseline and emission reductions from the NLS project.

In 2007 the Designated Operational Entity, Det Norske Veritas (DNV), visited the project in Cambodia to approve the emission reductions claimed for the period 2003-2006. DNV verified that the project had avoided the emission of 182,402 t /CO_2. There have been two subsequent verifications generating 126,022 t/CO_2 and 192,349 t/CO_2 credits under the Voluntary Carbon Standard in 2008 and 2009 respectively.

As one of the first and certainly the largest fuel efficient stove projects to be validated and verified by a United Nation approved auditor, the GERES NLS is a useful case study to illustrate the generic issues facing stove projects that seek carbon finance *(see figure 4)*.

12 - Schneider, (2007)

GERES	NLS Project Phase 1		NLS Project Phase II	NLS Project Phase III • Cambodian Climate Facility • NLS Project wins Ashden Award	1st Verification • First ERPA for stove credits	2nd Verification	3rd Verification
Time	**1997**	**2001**	**2002**	**2006**	**2007**	**2008**	**2009**
Carbon Market	Kyoto Protocol	Marrakesh Accords		Launch of the Voluntary Carbon Standard (VCS) Community of Practice approves cooking stove methodology		CDM approves cooking stove methodologies II.E ad II.G	

Figure 4: Compared timeline between the Carbon Market and GERES NLS project

Generic risks and uncertainties associated with stove projects

Emission reductions are calculated by multiplying the number of fuel efficient stoves in use by the quantity of biomass saved by each fuel efficient stove. Ascertaining this is complex because there are many hundreds of units dispersed over a large geographical area and the usage of each stove cannot be metered. These uncertainties mean that the risk of inaccurately reporting the emission reductions is high. DOEs decide to assess projects by how well these risks are mitigated, which is why stove projects must focus on identifying and mitigating reporting risks. The risks associated with the cooking stove supply chain are illustrated in the figure below. They occur at three levels:

- Production risk
- Distribution risks
- Utilisation risks

Conservativeness is the main rule to follow to address uncertainties. As the absolute value of the emission reductions can never be known, the values used are low range so that, whilst the absolute value of the emission reductions cannot be known, you can say that the stoves are saving at least x amount. Where ranges are not applicable, conservative assumptions are used. For example, all stoves are assumed to be sold to households. In reality many stoves are used by businesses such as restaurants whose consumption is far higher. The result of conservativeness related to verification is that the effective amount of emissions avoided by the project could be far higher than those verified and approved by the DOE.

On the producer side

Production and sales of NLS: towards efficient recording

The producers are the starting point of ICS dissemination. NLS production is the key information helping to calculate the number of stove in use.

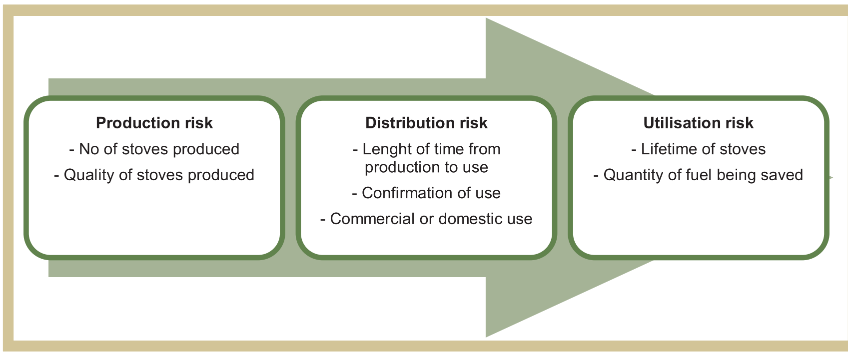

Figure 5: Reporting Risks in the NLS supply chain (GERES 2009)

To collect monitoring data GERES will ask the producers to record:

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

The methods used to record stove production depend on the mode of dissemination, the number of producers, the technology available and the capacity to record.

In the GERES project, NLS are commercially distributed. Traditional stove producers are trained to produce NLS and the stoves reach the end user through the same market channels as traditional stoves *(see chapter 1 "Cookstove in South Countries and lessons learned from the GERES project in Cambodia")*.

In 2009, there are 30 NLS stove producers operating in Cambodia *(see figure 6 below)*. Each producer is provided with a log book where they record stove production data. GERES employs a monitoring team of 5 people to visit the producers and collect the production data from them.

Though the collection data seem simple, there are numerous challenges to be overcome:

Firstly, the dispersal of production centres means some are not easily accessible, such as during the rainy season, and data must be collected through phone interviews.

Secondly, it requires capacity to manage large amounts of data. For example, during the first verification of the GERES project in 2007, the data collection system was deemed inadequate by the verifier because the original records were not systematically archived and there were a large number of data entry errors. In order to secure the verification, GERES had to collect all hard copies of the log books of the producers and re-enter the stove production data to eliminate errors. A central archive was set up and data entry procedures changed to reduce the potential for errors.

Finally, the producers are not used to keeping paper records, such as receipts, of stove sales. This causes problems because there is no incentive to keep accurate stove production records. At the same time, the verifier (DOE) requires that quality assurance measures are taken for the production data. GERES initially did it through comparing stove production sales with sales from market stalls. However, because the stoves follow commercial distribution channels, it is impossible to track all sales and furthermore reliability of the sales recorded by markets stalls was considered unreliable. In the short term GERES overcomes this by reducing the time between visits to collect data and using quality control labels. More recently developed stove projects elsewhere have met this challenge through offering guarantees of stove parts in exchange for users registering their details[13].

13 - For example, see Climate Care/J P Morgan Cooking stove project in Uganda.

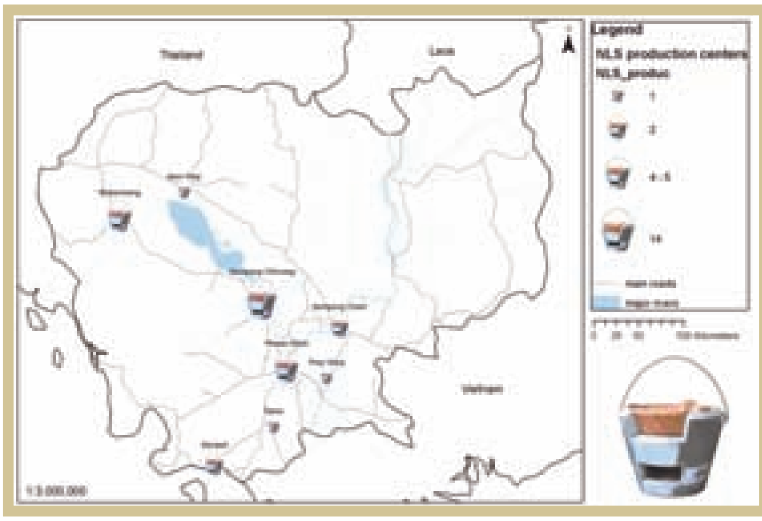

Figure 6: Mapping of the NLS producers in Cambodia (GERES, 2009)

Quality and performance of stoves produced: quality control measures

The quantity of stoves in use is also a function of the quality of the stoves being produced. Stoves must be constructed to a standard so that performance and lifetime is reasonably consistent. A large variability in stove performance affects the accuracy of fuel savings and therefore emission reductions.

This risk is mitigated by quality control measures which ensure that all stoves will have similar performance. The challenges of quality control vary with the mode of production. For example centralised and mechanised stove production produces more uniform products whereas decentralised artisanal production has greater variability.

In the GERES project, the NLS stoves are produced by using local artisans with varying skills. To provide quality assurance, samples of NLS are collected every three months from each producer to check their quality. Water Boiling Tests (WBTs) are used to determine that their performance is within pre-defined thresholds (see below). The samples are also measured to ensure they conform to standardised stove dimensions.

Finally, a system of labelling has been initiated for quality assurance of NLS *(see chapter 1)*. 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. If a batch of stoves has been identified as not conforming to the standard dimensions or performance threshold, the GERES monitoring team works with the producers to diagnose the reason and rectify it.

On the distributor side

Production is not necessarily an indication or at least not information accurate enough to assess the number of stoves being used. Stoves have to travel to the user before emission reductions can start to accrue. The scale of this risk varies with project design, e.g. institutional stoves which are constructed on the site of use can be assumed to be used from the date of production. However, stoves which are produced and sold via retailers and middlemen have to proceed through a supply chain.

Studies were developed by the NLS monitoring team to estimate the Point of Sales Time (POST). The studies utilise the unique number on the Quality Control labels which are affixed to the stoves. The quality control team knows the date certain batch numbers of labels were given to producers. The team can then conduct a survey of stoves in shops and estimate the length of time since the labels were initially given to the producers.

At the stove user level

Uncertainties and variability in the fuel savings

The final element in emission reduction calculations is the amount of fuel saved by each stove. There is a large risk of uncertainty, due to the variability that occurs at household level. The quantity of fuel is a function of a complex interaction between numerous non-uniform variables such as:

- the number of people using the stove
- the skill of the user
- the availability and type of fuel (fuelwood or charcoal) and food.

Calculating fuel savings involves calculating the amount of fuel that would be consumed without the fuel efficient stove, the baseline scenario, and the fuel saved by use of the improved cooking stove. There are two commonly accepted ways of collecting data on fuel savings. Project developers can use Kitchen Performance tests which test a small sample size very accurately. Alternatively they can conduct a user survey which has a much larger sample size but could be less accurate.

Kitchen Performance Tests study a sample of households as they cook a typical menu. One week participants cook with a traditional stove and, following a period of adjustment, they cook for a week with a fuel efficient stove. The quantity of fuel used for each stove is measured, giving accurate field-level data on fuel consumption and fuel savings. However, the method has the disadvantage of being time-consuming and intrusive. To incentivise participation, users have to be provided with food and fuel which will automatically change the consumption patterns. It is also hard to test for seasonal variation in fuel and properly replicate the mix of fuels being used.

The other option is to develop a survey to evaluate variables like fuel consumption and fuel mix. Enumerators are provided with scales and ask respondents to estimate the amount of fuel they use daily. The survey is implemented in a representative area where NLS have been disseminated. Whilst this method can capture the different fuel mixes as the respondents have a good evaluation of the type of fuel (gas, charcoal, wood, kerosene) they buy or use, there are doubts about the accuracy of the estimations of daily consumption. Furthermore, if the project covers a large area, it will impact on the costs of the survey for the project.

The GERES NLS choice: a combination of two approaches

In the GERES project, both of the approaches are used. Emission reductions are calculated using a baseline scenario of the amount of fuel used by each household without a fuel efficient stove. The baseline data is obtained by a "National User Survey" which involves a statistically representative sample of traditional stove users. These surveys are repeated every two years. The sample is stratified to incorporate geographic variation at the national level. It established the average quantity and mix of fuels used by families using traditional cooking stoves. Figure 7 below is an example of the result of the survey in 2006.

These figures have been validated by the verifier and used by GERES for the calculation of the emission reduction

The National User Survey is combined with Household Cooking Tests (HCTs), which are a variation on the Kitchen Performance Test. The HCTs are used to establish the % fuel saved by using fuel efficient stoves. These tests are repeated for all fuel types used and in different seasons.

Stove Type	kg/ month	kg/ day	Tonnes/ month
Traditional Stove Charcoal	32.12	1.06	0.03212
Traditional Stove Wood	37.56	1.24	0.03756

Figure 7: Average fuel consumption in traditional stoves (GERES, 2006)

To conduct the test, 20 sample households are identified based on the number of stoves distributed in that particular area. A test lasts two weeks, one week cooking with the traditional stove and one week cooking with the fuel efficient stove. 140 daily tests with one stove model and 140 daily tests with the other model are conducted. Before performing the test, a typical schedule of meals and water used is established for both traditional and fuel efficient stoves.

Since the verification of the NLS project, it has become common practice to identify clusters of stove users. These clusters incorporate variance in stove use, for example between households and restaurants. Furthermore, the latest generation of stove projects is investigating how technology can be used to obtain accurate results. For example, heat sensors can be used to record the quantity of fuel used. They have recently become commercially viable. These would provide accurate data on fuel consumption[14].

Lifetime of stoves

This is the last factor to impact on emission reduction.
Fuel efficient stoves can only reduce emissions while they are used, therefore the lifetime of the stoves must be known. Estimates of stove lifetime have concerned DOEs during the GERES project verifications. Initially, the project used survey data to estimate the ages of stoves. However, it is difficult to sample randomly for NLS stove users who have replaced their stove and are able to gauge the age of the stove accurately. The result is a conservative estimate of a 2.5 year lifetime for stoves. To improve the accuracy of this data, a system of stamping the stoves with the month and year of production has been initiated. This will enable more accurate records of average stove lifetime to be made.

An approach being adopted by newer stove projects is to guarantee parts so that reliable data on the lifetime of stoves can be collected.

14 - Hedon (2009)

Human Resources and marketing operations

A team to complete the requirements of the project cycle and mitigate the risks of the project

In order to generate carbon finance, project developers need to have access to a specific set of human resources.

- Research Capabilities are needed to generate baseline and survey data. The national household survey requires a research co-ordinator with a further team of enumerators periodically employed to collect data. The size of the team depends on the project area and the amount of data to collect. Often these can be recruited through local academic institutions.
- Further research skills are needed to carry out the Kitchen Performance Tests and Water Boiling Tests to ascertain stove performance. This is close to protocols developed in Universities and requires similar experience.
- Carbon Analysts must have the capacity to write the project documents in accordance with the required methodology, identify the key project risks and work to mitigate them. This will require someone with knowledge of the CDM project cycle and international climate change regimes. Carbon analysts must ensure the implementation of the monitoring plan and collect the data necessary to compile a monitoring report. They are the main contact point for DOEs and must deal with any requests from them.
- A monitoring team is needed to collect the data required by the monitoring plan. They must have sufficient data management skills to ensure the process is transparent enough to be verified by a DOE. In the case of the NLS project, a team of five people collects data on stove production and a further three people are employed to provide quality assurance for the stoves produced.
- Marketing skills are needed to sell credits once they have been issued. Selling credits and striking the right deal requires an entirely different set of skills from those needed to generate credit.

The key document governing the relationship and obligations of buyers and sellers is known as an Emission Reductions Purchasing Agreement (ERPA) (see box 3). A successful ERPA will balance the risks and rewards assumed by the sellers.

Box 3 - *Emission Reductions Purchasing Agreements (ERPAs)*

There are three main types of ERPA.

Spot Agreements
This occurs when credits have been issued and are ready for delivery. As there is a very low risk of non-delivery credits can be sold for a higher price. However, the seller takes a risk in that the selling price and quantities of sales are not known in advance. Many project developers need capital upfront to cover the costs of setting up the project.

Future Delivery
Most ERPAs take the form of agreements over future delivery. Credits have not been issued but are expected to be issued at a predetermined point in the future. Future delivery agreements carry more risks for the buyer and therefore credits are sold at a lower price. Many organisations seek pre-finance from buyers which is repaid through the delivery of credits. In this case the price paid per credit is low because the risks to the buyer are high. The sellers also might take on liability if they fail to deliver credits.

Options
Options can either be

• Call option
Buyer has the right but no obligation to buy credits at a certain point in the future for a fixed price ("strike price")

• Put Option
Seller has a right to sell credits at a certain price
In either case sellers need to negotiate favourable outcomes to avoid selling to low.

Negotiation of the sales of credits

Based on the experiences of GERES, there are a number of key factors in negotiating sales of credits. Project operators are even less well prepared for this.

Market Intelligence
Credits are sold on the carbon market and the terms for the sale of credits will be determined by the state of the market. Sellers must be aware of the market trends to ensure commensurate rewards for their projects.

Understanding project risk
ERPAs are negotiated based on the perceptions of risk. Sellers need to understand what the risks associated with their project type are and mitigate these risks. In this way they can strengthen their negotiating position and guard against non-delivery risks.

Understanding contracts
There is a considerable cultural gap between the development and finance worlds. Undertaking contracts for delivery requires expertise to understand what is being agreed in the ERPA.

Outsourcing human resources

In many cases, project developers have been forced to outsource some or all of these human resources. Initiatives to help development organisations build these capacities, such as capacity-building workshops, have often failed because assistance is required throughout the project cycle. Recent initiatives, such as the UNEP CASCADE programme, have selected pilot projects and mentored them throughout the pipeline[15]. The problem remains replicability once the programme has finished. Another approach has been taken through the NEXUS initiative. NEXUS is an alliance of project developers, which aims to fill the skills gap through setting up help desks to provide technical assistance to its members. The members then form a pool of expertise which can aid other members. *(See Box 4 below).*

15 - See http://www.cascade-africa.org/Accueil_en/tabid/56/language/en-US/Default.aspx

Ownership of the credit

Ownership of carbon credits from cooking stove projects has always been a contentious issue, which can nevertheless be resolved. The project developer is initiating the project, taking it through the pipeline and taking the attendant risks and therefore has some claim on ownership of the credits. However, at the same time, as the stove users are generating the emission reductions, it could be legitimate for them also to have a claim on ownership. At the heart of the issue is the transference of benefits from the carbon finance to the user.

Transference of benefits

Stove users must directly benefit from carbon finance in order to be compensated for the emission reductions that they have generated. The problems begin when trying to prove that the benefit given to stove users is commensurate with their loss of ownership of the credit.
Some projects directly subsidise the costs of fuel efficient stoves through carbon finance. In this way the users are directly receiving a benefit from carbon finance through the reduced costs of the stoves. However, the history of stove programmes demonstrates that such direct subsidies create market distortions, and prevent the establishment of sustainable supply chains.

Other projects therefore pass benefits to users indirectly. For example, in the case of the NLS project, carbon finance is used to fund externalities that cannot be passed on to the consumer. This includes the costs of marketing, research and development, training producers, quality control and assurance as well as standardisation. If the costs of these activities were passed directly to the end user, the stove would no longer have a competitive advantage over the traditional stoves. In this case the users are indirectly receiving a benefit from carbon finance. However, the issue then becomes how far project developers can be trusted to self-regulate the transference of benefits and what proportion of the returns can be legitimately claimed by the project developer and what proportion must be transferred to the stove users. To date there are three approaches to dealing with the issue of ownership. Each approach comes with its own advantages and disadvantages.

Approval of the host country

In this instance, the host country or an institution within the host country approves the use of carbon finance for a specific purpose. It is assumed that the host country institution is responsible for safeguarding the equitable use of carbon finance. By implicitly recognising that the proposed utilisation of the carbon finance contributes to the development goals of the country, they confer legitimacy on the use of carbon finance without the consent of each user. In this case the host country can impose conditions of use on the carbon finance. This is the case in the GERES NLS project where the Ministry of Mines and the Environment (MIME) explicitly recognised GERES' right to utilise the carbon revenue from the project provided that 95% is reinvested into Cambodia.

Implied Consent

A number of projects have implemented a claim that consent is given by users where carbon finance is directly passed to consumers through a received benefit. By accepting a direct benefit, users are tacitly consenting to recognising the project proponent's right to ownership of the credits. For example, where projects offer guarantees of stove parts for the lifetime of the stove, users are asked to sign a guarantee which implies giving up ownership of the credits.

Informed Consent

Direct consent would take the form of a signed contract between the stove user and the project developer. However, the validity of such a contract would always be questionable because it could be argued that the consent is not informed. To obtain properly informed consent, users would have to be aware of carbon finance and the implications of the signed contract. This would arguably not be the case in many instances. Secondly, it would only really apply in cases where the producer is directly selling to the user. Securing informed consent through commercialised distribution would be highly problematic.

Impact of carbon finance on development projects

Historically, the majority of improved cooking stove programmes have been initiated using donor funding[16]. Under a donor funding model, project developers are paid to establish a project and to carry out activities. On the other hand, carbon finance is becoming an increasingly prominent funding alternative. Under carbon finance, project developers are paid for the outputs, emission reduction credits, of a particular project; they have an objective to produce results. This change in emphasis has two implications. Firstly projects are incentivised to produce as many emission reductions as possible and secondly projects must avoid underperformance.

Scaling up

The ability of projects to generate their own income has a number of advantages over donor funding.

Longer time horizons

A benefit of carbon finance is that projects can last between ten and twenty-one years, whereas donor funding typically lasts between three to five years. The length of the funding horizon has implications for project design, because a project developer has to plan within the allotted funding period. Using carbon finance, project developers can plan longer term initiatives and develop more sustainable projects which would not otherwise be possible with shorter time horizons. The longer time span also has benefits for the implementing organisation in that staff can be offered greater job security and provided with professional development opportunities.

16 - Barnes (1993)

A continual growth

In contrast to donor systems where the quantity of finance is known from the start of the project, the amount of funding is determined by the quantity of emission reductions that are achieved. In terms of stove projects, carbon finance favours commercialised production with the ability to grow continually and yield higher levels of emission reductions and more revenue. Again this can be contrasted with the donor approach where long-term growth cannot be guaranteed beyond the funding period. Carbon finance can be said to encourage project designs to be larger because the ability to scale up will increase revenue. The tendency towards scale is reinforced by the high transaction costs. In order to enter the market, projects have to pay for the various steps in the project cycle. Therefore projects have to be able to generate sufficient credits to pay these costs. Considering that most household stoves reduce emissions somewhere between 0.5-1 t CO_2 per year, only stove projects that can realistically expect to disseminate tens of thousands of stoves would be realistic for carbon finance.

The lack of pre-financing and potential solutions

The need to achieve scale is often at odds with the resources of project implementers. Payment for credits occurs once a project has completed the approval process. Project developers have to access large quantities of upfront capital to initiate the project and pay the transaction costs. In order to develop a stove project, there must be finance available prior to the sale of credits. This can take several forms.

Firstly projects could find pre-financing, where a buyer agrees to buy credits before they are produced ("forward credit"). However, the disadvantage is that because the risks are so high for the buyer, the price paid to the project developer is very low.

The second option is that projects find financial backing from the private sector.

However, these projects tend to adopt a one size fits all approach and the danger of this approach is that it ignores the lessons of stove programme history.

Successful stove programmes are reliant on stoves being adopted by distribution chains and users. Adoption is a function of a complicated set of interrelated variables and stoves must be adaptable to the nuances of the localised context.

A third option is a combination of donor finance and carbon finance. The best way to gauge adoption and tailor a stove project to the needs of users is through a successful pilot project. Donor funding is necessary to establish successful pilot projects, over a short period, followed by carbon finance to help projects achieve scale. In this regard the GERES NLS project is a good example of how the two sources of funding can be used to complement each other. Whilst in the case of the NLS project this funding symbiosis was the result of a coincidental set of circumstances, GERES is establishing a funding mechanism called NEXUS to help other development stakeholders follow this model.

Box 4- ***NEXUS***

Nexus is an alliance of project developers committed to using carbon finance to alleviate poverty and foster sustainable development. It was created in 2007 and has 8 members. Through NEXUS, project developers can benefit from technical assistance throughout the carbon project lifecycle at discounted prices, thus reducing drastically transaction costs and maximising selling prices. Nexus also provides its members with funding solutions tailored to their needs. Members can access a grant, called the innovation fund, to help them establish or refine a pilot project. Once they have established a design capable of achieving the necessary scale, they can access a loan, the NEXUS fund, which can help cover the transaction costs of accessing the market. The loans are repaid upon receipt of carbon proceeds.

Avoiding underperformance

Carbon finance projects have to be regularly verified in order to receive credits. Under verification a project might underperform, producing fewer credits than expected, or fail verification altogether. This results in a reduction or loss of carbon revenue and therefore funding for the project. This is then a powerful driver to maintain the standards of the project and guard against underperforming. Monitoring activities are performed to gather evidence of the emission reductions generated by the project. This evidence is summarised in a monitoring report which is evaluated by an independent auditor known as a DOE. The DOEs are internationally reputed certification bodies and they face considerable reputational risk if they are discovered to be inaccurately verifying emission reductions. They are required to view the evidence presented to them with 'professional scepticism'. The maintenance of high standards of proof has a number of positive benefits.

Firstly, it ensures accurate record-keeping and introduces efficiency and professionalism in a sector which has been criticised for its inefficiency. Whilst many donor funders include monitoring requirements, there is often no real pressure behind the activity because the funds have already been utilised. However, under carbon financing, monitoring activities are integral to the release of funding and are scrutinised for inaccuracy.

Secondly, consumers benefit by the maintenance of standards. Whilst Phase One and Phase II of the NLS project introduced the concept of standardised production and quality assurance, without funding this would not have been maintained. It is a reasonable assumption that over time the quality of production would deteriorate. However, as quality assurance is paramount to emission reduction calculations, the quality of stove production has been maintained.

Conclusion

The GERES NLS case study illustrated some of the generic issues facing stove projects.

Firstly, it exposes some of the pros and cons of the different market approaches. The CDM credits attract higher prices and demand is more assured. However, there are long lead-in times and the rules on avoided deforestation have the effect of reducing the quantity of emissions. On the other hand, although the credibility of the voluntary market has improved, the impacts of the global economic situation may affect demand and the prices of the credits are generally lower.

Secondly, it illustrates the human resources and project management capacities that are needed.

Finally, the GERES experience points to the potential benefits of combining donor finance and carbon finance to scale up stove dissemination. To benefit from the opportunities of carbon finance, stove projects must be able to achieve large-scale dissemination. However, such widespread adoption must be adapted for the context of use and this often requires a pilot phase. Donor funding can be used to develop and refine suitable technologies.

By encouraging long-term planning and scale, carbon finance could improve the adoption of improved cooking stoves. This need is all the more pressing considering the failure of the current CDM project pipeline to channel resources to pro-poor technologies in LDCs. However, what is clear is that in many cases the requirements are highly specialised and project developers need assistance to bring their projects to the market. Initiatives such as NEXUS can help project developers cover the skills gap by providing technical and financial assistance throughout the project cycle.

Acronyms

AFD
Agence française de Développement

CDM
Clean Development Mechanism

CER
Certified Emissions Reductions

CFSP
Cambodia Fuelwood Saving Project

CLIP
Combustion Latérale Inversée Performante

CO_2
Carbon dioxide

COP
Council of Parties

DOE
Designated Operational Entity

DNA
Designated National Authority

DNV
Det Norske Veritas

EB
Executive Board

ERPA
Emissions Reductions Purchasing Agreement

FAO
Food and Agriculture Organisation

GHG
Greenhouse Gases

GERES
Groupe Energies Renouvelables Environnement et Solidarités

HCT
Household Cooking Test

ICOPRODAC
Improved Cookstove Producers and Distributors Association of Cambodia

ICS
Improved Cook Stove

JI
Joint Implementation

KPT
Kitchen Performance Test

LDC
Least Developed Country

LPG
Liquefied Petroleum Gas

MIME
Ministry of Industry, Mine and Energy

MOP
Meeting of Parties

NIS
National Institute of Statistics

NKS
Neang Kongrey Stove

NLS
New Lao Stove

PDD
Project Design Document

PDPPM
Planning Department of Phnom Penh Municipality

PSU
Policy and Study Unit (GERES Cambodia)

R&D
Research and Development

RWEDP
Regional Wood Energy Development Program in Asia

T-LUD
Top Lid UpDraft

TLS
Traditional Lao Stove

UNFCCC
United Nations Framework Convention on Climate Change

VER
Voluntary Emission Reduction

WHO
World Health Organisation

References

Baskoro, S.Y. Iwan. (2006). ENERGIA News: Woman Energy Entrepreneur in Cambodian. Vol. 9nr2.2006. Phnom Penh.

Bryan, S (2006), The Clean Development Mechanism and Improved Cooking Technologies: Evaluating methodologies to incorporate non-renewable biomass, MSc thesis, Imperial College, London

Carbon Collaborative (2009)
http://carboncollaborative.net

Climate Care (2009) Improved Cooking with Ugastove
http://www.jpmorganclimatecare.com/media/documents/pdf/090324%20PDD%20UGASTOVES%20reg.pdf

DARE, (2009) Efficient Wood Stoves in Nigeria
http://www.atmosfair.de

Evans. J (2006), Submission on Regional Distribution of CDM Project Activities, Submissions from J. Evans to Executive board on behalf of World Bank. [online]
http://carbonfinance.org/docs/CDM_Regional_Balance_EB_call_for_input.pdf

GERES Cambodia. (2007). National Wood Energy Policy Implementation in Cambodia 2002-2007. Phnom Penh.

GERES Cambodia. (2008). Monitoring Activities for Second Verification of GERES-Cambodia's New Lao Stove Project. Phnom Penh.

GERES Cambodia. (2009). Stove production rate data in 2007, 2008 and 2009. Unpublished data. Phnom Penh

Hamilton et al (2007), State of the Voluntary Carbon Market
http://ecosystemmarketplace.com/documents/acrobat/StateoftheVoluntaryCarbonMarket18July_Final.pdf

HEDON (2005), Carbon SIG message non Non-reneawable biomass and Household Energy
http://www.hedon.info/docs/COP12-MOP2-HEDONstatement.pdf

IIED, (2006) Expanding the development benefits from carcbon offsets,
http://www.iied.org/pubs/pdfs/11056IIED.pdf

IGES (2009), The CDM in Charts
http://www.iges.or.jp/en/cdm/report01.html

Laurance. W (2007) A New Initiative to Use Carbon Trading for Tropical Forest Conservation, Biotropica 39 (1), 20–24

Michalowa, 2007, Understanding CDM methodologies
http://www.perspectives.cc/home/groups/7/Publications/CDM_Guidebook_Perspectives_DEFRA_122007.pdf

Minh Cuong, L. Q. (2006). Efficient Cookstove to Mitigate Global Warming and Contribute
Poverty Alleviation in Cambodian. Phnom Penh.

Mitsubishi UFJ Securities (2007), Emission Reduction Purchase Agreements: A seller's perspective
http://cdmdna.emb.gov.ph/cdm/secured/uploads/CDM1803195073306017_Emission_Reduction_Purchase_Agreement__ERPA__FINAL.pdf

National Institute of Statistic. (2008). Statistical Year Book 2007. Ministry of Planning. Phnom Penh.

National Institute of Statistic. (2005). Statistical Year Book 2005. Ministry of Planning. Phnom Penh.

Olsen, K, (2009), Overview of the Supply of Credits,
http://www.cdmgoldstandard.org/fileadmin/editors/files/1_communication/presentations-GS-events/2009_Mar_GSAcademy/Policy-trends_Olsen_UNEP-Risoe.pdf

Planning Department of Phnom Penh Municipality. (2004). Profile of Phnom Penh City.
Phnom Penh.

Schnieder, (2007), Crediting the displacement of non-renewable biomass
http://www.oeko.de/oekodoc/327/DP-2007-004.pdf

WWF, 2008 Making sense of the voluntary carbon market
http://assets.panda.org/downloads/vcm_report_final.pdf

UNFCCC (2005), Report of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
http://unfccc.int/resource/docs/2005/cmp1/eng/08a01.pdf

UNFCCC (2009) Project cycle of the Clean Development Mechanism
http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/howard.pdf

World Bank, (2009), State and trends of the carbon market
http://wbcarbonfinance.org/docs/State___Trends_of_the_Carbon_Market_2009-FINAL_26_May09.pdf

Almost half of humanity uses biomass on a daily basis for its domestic needs, whether in the form of animal matter, agricultural residues, green waste, wood or wood derivatives. It is used for essential needs like cooking, heating, etc.

The experience of GERES in Cambodia, which began more than 10 years ago in 1996, has resulted in nationwide dissemination of an efficient, low-cost domestic cooking stove, known as the New Lao Stove (NLS). Nowadays, around 25,000 NLSs are sold every month. A particular feature of this programme, which saves on so-called non-renewable biomass, is its access to carbon finance. It has also helped to strengthen and structure a cooking stove supply chain and validate standardized cooking equipment.

In the following document, we therefore look back on the experience with the aim of:

- **Sharing innovative methodological tools in the field of biomass energy that have been validated;**
- **Making a quantitative and/or qualitative evaluation of the socio-economic and health impacts of disseminating efficient cooking stoves in Cambodia;**
- **Reviewing the programme's links with international mechanisms to combat climate change;**

It is meant for all stakeholders involved with Energy-Development-Climate issues: policymakers in the South and North, international bodies (donors, UN agencies, etc.), international solidarity organizations, training and/or research institutes, resource centres, networks and, finally, carbon market operators.

Approche texte & image Imprimé sur papier recyclé 100 % par Chaumeil PACA

Groupe Energies Renouvelables, Environnement et Solidarités

2, cours Foch - 13400 Aubagne - France
Tél. : +33 4 42 18 55 88 - Fax : +33 4 42 03 01 56 - www.geres.eu - contact@geres.eu
Association Loi 1901, à but non lucratif