PROJECT IDENTIFICATION FORM (PIF)

PROJECT TYPE: Full-Size Project
THE GEF TRUST FUND

Submission Date: 14 August, 2009
Re-submission Date: 16 September, 2009

PART I: PROJECT IDENTIFICATION

GEFSEC PROJECT ID: **PROJECT DURATION:** 48 months
GEF AGENCY PROJECT ID: XX/CMB/09/XXX
COUNTRY: Cambodia
PROJECT TITLE: Climate change related technology transfer for Cambodia: Using agricultural residue biomass for sustainable energy solutions
GEF AGENCY: UNIDO
OTHER EXECUTING PARTNERS: National Cleaner Production office-Cambodia (NCPO-C) hosted by the Ministry of Industry, Mines & Energy (MIME))
GEF FOCAL AREA: Climate Change
GEF-4 STRATEGIC PROGRAM: CC-SP4
NAME OF PARENT PROGRAM/UMBRELLA PROJECT: TT-Pilot (GEF-4)

INDICATIVE CALENDAR	
Milestones	**Expected Dates**
Work Program (for FSP)	November 2009
CEO Endorsement/Approval	September 2011
Agency Approval	October 2011
Implementation Start	November 2011
Mid-term Review	November 2013
Implementation Completion	November 2015

A. PROJECT FRAMEWORK

Project Objective: To bring about sustained transfer of efficient, cost effective and environmentally friendly (low carbon) agro waste biomass-fuelled energy systems to replace fossil-fuel powered generators and boilers for power generation and thermal energy applications.

Project Components	Type*	Expected Outcomes	Expected Outputs	Indicative GEF Financing (US$)	%	Indicative Co-financing (US$)	%	Total (US$)
1 Technology transfer and implementa-tion of 2 pilot plants	TA INV	Transfer of clean and energy efficient low carbon technologies	1. Biomass-fuelled high efficiency power and heat generation technology in the 3-5 MW range is identified and assessed as suitable for Cambodia. 2. Two identified pilot plants are implemented a) high efficiency power generation from rice husks or other available fuel b) Electrical energy and steam generation from crude palm oil waste. 3. Personnel from the participating companies have been trained in operation, maintenance & trouble shooting.	200,000 850,000	57 20	150,000 3,400,000	43 80	350,000 4,250,000
2. Capacity building and development of tools for technology adaptation and transfer	TA	Supply of national service providers in technology evaluation and technology transfer	1. A cadre of at least 20 national experts from relevant support institutions (the Cleaner Production Centre, technical universities / university departments, EDC, EAC, MIME and independent	200,000	67	100,000	33	300,000

			engineers), are trained on evaluation and transfer of bioenergy technologies, including financial mechanisms 3. Capacity building of indigenous partners for adaptation of bioenergy technologies 4. Web-based guidance tool/manual, like EnTA/Comfar, developed for the transfer of bioenergy technologies 5. Technology data base and case study data base created for bioenergy technologies					
3. Strengthe-ning of institutional framework for technology transfer	TA	Stronger institutional framework in place to ensure long-term support for renewable energy (biomass) promotion	1. Capacity building of relevant Govt. departments to promote technology transfer. 2. Institutions are trained in TT financing using available mechanism like SCCF, LDCF, CDM and preparation of bankable TT project proposals 3. Capacity building of financial institutions to assess investment proposals in TT	150,000	65	85,000	35	235,000
4. Upscaling of biomass fuelled technologies in Cambodia	TA	A. Increased adoption of biomass based energy generation technologies by Cambodian businesses and private investors. The creation of a national market for biomass technologies	1. The results of the pilot projects are compiled and widely disseminated in the most appropriate manner. 2. Investors and decision-makers understand the potential for biomass energy sources. 3. Other stakeholders understand the role they can play to promote the uptake of this kind of technology	140,000	64	80,000	36	220,000
5. Policies, regulations and mechanisms	TA	Establishment of policies and regulatory frameworks to make the technology transfer economically sustainable	Implementation of the missing laws, regulations and policy instruments to (a) organize the systematic collection, intermediate storage and uninterrupted supply of biomass to the energy companies ; (b) facilitate long-term power purchase agreements (PPAs)	50,000	50	50,000	50	100,000
6. Project management				100,000	50	100,000	50	200,000
Total project costs				**1,690,000**	**30**	**3,965,000**	**70**	**5,655,000**

* INV = Investment; TA = Technical Assistance; STA = Scientific & Technical Analysis

B. INDICATIVE CO-FINANCING FOR THE PROJECT BY SOURCE and BY NAME (in parenthesis) if available, **($)**

Sources of Co-financing	Type of Co-financing	Amount
Project Government Contribution (MIME)	In-kind	150,000
GEF Agency (UNIDO)	In-kind Grant	100,000 200,000*
Bilateral Aid Agencies	--	0
Multilateral Agencies	--	0
Private Sector**	Cash	3,400,000
NGOs	--	0
National Cleaner production Office-Cambodia	In kind	115,000
Total co-financing		**3,965,000**

* Funding provided by the Swiss State Secretariat for Economic Affairs

** Private sector investors are 1) a crude palm oil unit currently using 2,500 tons/year of diesel for electricity alone in addition to its process heat requirements, and 2) a private electricity generator and supplier substituting diesel generator sets with biomass due to the attractive return on investment (ROI). A few foreign investors as JVs having experience in biomass based power plants are also interested due to the acute energy shortage and high price of electricity in Cambodia.

C. INDICATIVE FINANCING PLAN SUMMARY FOR THE PROJECT ($)

	Previous Project Preparation Amount*	Project	Total	Agency Fee
GEF financing		1,690,000	1,690,000	169,000
Co-financing		3,965,000	3,965,000	
Total		**5,655,000**	**5,655,000**	**169,000**

* Amounts being requested for the PPG are to be found in the PPG Request.

PART II: PROJECT JUSTIFICATION

A. THE ISSUE, HOW THE PROJECT SEEKS TO ADDRESS IT, AND THE EXPECTED GLOBAL ENVIRONMENTAL BENEFITS TO BE DELIVERED:

The Issue: In recent years, Cambodia has enjoyed robust economic growth, averaging at 9.4% over the last decade, 10.6% over the 5 year period 2003-2007, and with a record high of 13.3% in 2005.Growth slowed to 6.8% in 2008 and is projected to drop further to 4.8% in 2009 (Cambodian Economic Performance and Outlook-2009, Dr Hang Choun Naron), reflecting the global economic slowdown. Nevertheless, the prospects for continued growth are good. Such growth is critical if Cambodia is to achieve its target for poverty reduction. However, slow progress in technology development to use alternative local sources of energy (needed because of the limited traditional energy resources in Cambodia) could well limit the country's future economic growth, and more specifically its future industrial growth as well as the growth in its exports in what are becoming increasingly competitive regional and global markets. Therefore, there is an urgent need for the country to identify and develop the options available to it to satisfy the country's energy requirements using locally available resources. However, this must be done while at the same time pursuing environmental and social sustainability. A strategy that combines energy efficiency with low carbon alternative technologies offers the most comprehensive solution for Cambodia to achieve these twin goals of energy security and sustainable energy solutions. With respect to energy efficiency, Cambodia has been implementing a Cleaner Production programme for 5 years, and as part of this programme, comprehensive demonstration projects have been successfully undertaken on cleaner production, energy conservation, and fuel substitution for industrial applications. UNIDO will be further promoting this aspect – a GEF PIF on the Industrial Energy efficiency topic was approved recently. More effort is now required with respect to sustainable energy solutions.

Currently, energy demand in the country, both electrical and thermal (in industries), is mostly met through imported fossil fuel. Information and data in available documents/studies on GHG emissions from the energy sector and industrial activities are for the most part incomplete, unreliable and – being old – no longer very relevant (for instance, both the National Communication and the Technology Needs Assessment are based on a GHG inventory prepared back in 1994).

More recent, but still partial, data come from a study conducted by UNIDO and MIME on fossil fuel fired utility and power boiler/generators in the context of the potential application of BAT/BEP for POPs reduction. According to this study, 513 entities in Cambodia are using fossil fuels to generate 203 MW, or 1458 million kWh/year, of energy. 450 are reported to have less than 500 kVA, 27 between 500 to 1000 kVA, and 36 with more than 1000 kVA. It is estimated that the energy generation sector alone consumes a little under 500,000 tons/year of fuel (diesel oil and fuel oil) and is responsible for emitting approximately 1.46 million tons/year of CO_{2eq} GHG. In addition, the rice milling sector consumes about 120,000 tons of diesel oil for milling operations (and does not use the approximately 2 million tonnes of rice husk it generates as its energy source) and emits approximately 360,000 tons/year of CO_{2eq} GHG. Unknown amounts of fossil fuel consumption and GHG emissions take place from captive energy generation in the brick-making sector, in the palm oil processing sector, and other significant industrial sectors.

In the Cambodian context, a strong contender for locally available sources for sustainable energy solutions is biomass. Cambodia has significant biomass energy resources, either as standing biomass, including plantation forests such as rubber and fast growing tropical trees like Glyricidia and Acacia species, or as agricultural residues like rice husk, rice straw, corn cobs, palm oil extraction waste, cashew nut shells etc.. According to a study done in 2004 by MIME with Japan’s Institute for Global Environmental strategies (IGES) and the Cambodian Research Centre for Development (CRCD) (*De Lopez, T.T. 2004, Assessing Cambodia's potential for Bio-Energy, CRDC, Phnom Penh*), biomass – excluding biomass available from natural forest and waste timber from wood processing sector as well as rubber tree harvested at the end of their productive life. It has an estimated potential generation of nearly 19,000 GWhr per year from waste biomass alone (agricultural residues, domestic and animal waste), which can be used both for electrical energy generation, or it can be converted into other fuels such as producer gas, biogas or a range of liquid fuels (the actual amount available for these options could be lower, since some of the waste is probably already being used for other purposes).

The importance for Cambodia to promote the use of locally available renewable sources of energy has been recognized in the Technology Needs Assessment (in which the onsite production of electricity using biomass residues as fuel is mentioned, along with an increased use of Combined Heat and Power Systems), and the initial National Communication (which encourages enhancing the use of renewable energy), as well as in national policy documents (see section B below for more details), although there is little detail in these documents as to what types of renewable energy technologies should be given priority. Specifically with respect to biomass, current projects are focusing primarily on promoting biomass based technologies for the rural electrification and some studies on captive power generation by industries.

Since industry is one of the main drivers of the country’s economic growth, but also is a major energy user, it is also appropriate to focus on promoting the on-site application of biomass based energy sources in industry. One possible application is for on-site captive energy generation and usage by processing industries such as crude palm oil (CPO) processing units, rice mills, and cashew nut processing units. Another possible application is in small areas like industrial estates or districts where the individual industrial facilities (and in the case of districts other entities) are each operating small diesel-powered generating units; in cases like these, a centralised power generation system can be considered, associated to an estate or district-level power distribution network feeding the consumers in the estate/district. Given the scale of operations being considered in Cambodia, both applications would require medium-to-large biomass-based systems (3-5 MW). Not only would both applications lead to reductions of greenhouse gases (as well possibly as dioxins), but also the energy so generated could be cheaper (more than 50% reduction in energy-related operating costs are possible, although this needs to balanced by possible higher capital costs), and the reliability and flexibility of the energy supply could increase (although it will be critical here to deal with possible seasonal fluctuations in fuel supply – this is taken up later). Both factors could make the enterprises more competitive.

Currently, there are few if any such units in this capacity range in operation in industries in Cambodia, and consequently little if any knowledge about their operation. The transfer of such technologies from outside the country would be required.

The proposed response: At the heart, therefore, of this project concept is the proposal to promote the sustained transfer to Cambodia of 3-5 MW biomass-fuelled power and steam generation technologies from one or more countries where these technologies are already proven. In all cases, the biomass fuel will be agricultural wastes or other organic residues.

One of the more important constraints on the transfer of technology is the fact that the relevant actors lack the necessary information and skills as well as the fact that there is little communication between them. The project will help to overcome this particular barrier by demonstrating through pilot projects that biomass-based technologies transferred from another country can be relevant in the Cambodian context. Specifically, the project will implement two pilot projects with appropriate biomass-based technologies.

However, in any technology transfer project, it is important to ensure that the transfer will not be a one-off exercise but will be replicated elsewhere in the recipient country. In the particular case of Cambodia, over the last 15 years the country has hosted many projects involving the implementation of foreign technologies. However, it is difficult to find examples that have achieved successful long term technology transfer. Experiences from sustainable energy projects in Cambodia suggests that foreign donor organisations insist on employing their own nationals and hardware and rarely provide know-how or even testing or performance data to their Cambodian counterparts (MOE,CRCD & IGES-2004). The project will address the issue of sustained replicability by using an integrated approach that will combine the technical support in the implementation, commissioning and performance evaluation of the pilot demonstrations, with interventions at the institutional and policy levels and in the market place so as to assure the development of a technology transfer mechanism that is appropriate for a country like Cambodia.

The design of the project will therefore be based on UNFCC's technology transfer framework, which defines the need for five key elements for successful technology transfer: (1) technology need and technology assessment; (2) technology information; (3) enabling policy level environment; (4) capacity building; (5) mechanism to facilitate institutional and financial support to technology cooperation, development and transfer.

A. <u>The potential technology to be transferred</u>: The project will consider the following two technology options:

- Replacement of the small generators in an industrial estate/provincial town using fossil fuel with biomass based high efficiency electricity generators of 3-5 MW (depending on requirements). Based on consultative meetings held in the recent past with potential recipients, a good fuel for this technology would be the abundant amounts of rice husk generated in provincial town having rice mills, although a final decision about the fuel to be used will be taken during the project preparation phase based on actual biomass availability and other relevant criteria.
- Replacement of diesel oil with available biomass in existing industrial captive power generation systems. Based on consultative meetings held in the recent past with potential recipients, the crude palm oil (CPO) processing industry seems a good candidate, although a final decision on the sector will be taken during the project preparation phase. Since this would be for both their electrical and their thermal energy requirements, a technology based on combined heat and power cycle (CHPC) would be chosen. The pilot will be designed so that if there is excess power, it can be supplied to nearby residential areas.

On the basis of criteria developed during the project preparation phase, potential medium-to-large biomass based energy technologies will be identified and assessed for their strengths and weaknesses.

Considering the size of systems being proposed, initial evaluations suggest that technologies based on fluidized bed seem to be one of the better candidates, although this will be considered in more detail during the project preparation phase. Looking more specifically at the different types of fluidized bed systems available, circulating fluidized bed combustion (CFBC) boilers have generally proven to be very economic for industrial applications requiring more than 50-100 t/hr of steam. Fluidized bed combustion takes place at about 840-950°C. Since this temperature is much below the ash fusion temperature, the melting of ash and associated problems are avoided. The ability to use various fuel sources and types provides the user with the flexibility to take advantage of changing costs and fuel availability; this factor is especially useful where agro residue biomass is used, since its availability fluctuates depending on many factors. The special boiler design, that separates the combustion section from the heat transfer section using an adiabatic combustion system (furnace, cyclone), external bed material heat exchanger, large radiation passes and tail-end type boiler, is the only suitable solution to meet all the required standards concerning steam parameters and plant emissions. More specifically, the features of CFBC that provide the most benefits to clients are:

1. High combustion efficiency of CFBC boilers: over 95% with overall efficiency 84% (+/- 2%)
2. Flexibility in biomass fuel usage based on availability and pricing
3. Ability to burn low grade, high moisture content (up to 55%) fuel as well as fines
4. Low environmental impact (the low combustion temperature eliminates NO_x formation, and the fuel type minimizes SO_2 formation)
5. Low corrosion and erosion problems
6. Easier ash removal - no clinker formation
7. Simple to operate and quick to start up
8. Rapid response to load fluctuations
9. No slagging in the furnace - No soot blowing and low maintenance requirements

Biomass based power generation is well established, and during last decade significant improvements in technologies have taken place in the Asian region, particularly in India, China, Malaysia, and Thailand. More detailed discussion of CFBC technologies is given in the Annex, along with a table of some potential suppliers of this technology.

The potential recipients will be assisted in vendor selection, particularly with respect to the technical evaluation of proposed technologies. One of the criteria that will be used to assist them will be that there exists an effective transfer potential from the business perspective. So vendor review will include a detailed review of the potential business links between the developers/vendors of the most promising technologies on the one hand, and the technology recipients on the other. A key to such business links is a willingness on the part of the technology supplier to develop local partners. On the one hand, this creates a network of after-sales services, which is critical for the sustainability of technology, and on the other hand, it can minimize costs and aid uptake and dissemination by encouraging local suppliers to manufacture as much as possible of the technology locally (the costs of technology import i.e. hardware is generally expensive).

Given the particular challenges faced by developing countries, the criteria mentioned above will strongly favour south-south transfer of technology. Biomass based power generation is well established, and during last decade significant improvements in technologies have taken place in the Asian region, particularly in India, China, Malaysia, and Thailand. As a result, south-south transfer of technology will probably be economically more attractive, will make available more appropriate technology, and will make after-sale maintenance easier (past experience with technology transfer from developed countries has been mixed mainly due to after-sale service /maintenance costs). In this connection, several companies have already shown an interest in supplying this kind of technology in Cambodia, through joint ventures or otherwise. For instance, informal discussions for a joint venture between Annapurna Exports Ltd., based in Muzaffarnagar (UP), India, and Electricité de Cambodge (EDC) are ongoing. Annapurna is a leading Indian company in biomass energy-based generation, having already established seven such plants in India. Another example is the Palm Oil Energy Research Institute of Malaysia, which is in discussions with the Mong Ritthy Group, a leading industrial group in Cambodia, on the transfer of cogeneration technology using palm oil residues/waste as the energy source. This institute is a leading developer and supplier of technologies based on palm oil plantations.

The transfer of technology funded through this project will be subject to UNIDO's financial rules and regulations governing the procurement of such goods, and will include international bidding.

B. Other considerations: In addition to identifying suitable and proven technologies at acceptable costs, the following aspects will need to be considered in detail during project preparation:

a) *Biomass fuel collection and logistics*: to assure guaranteed supply of specific quality and quantity a supply chain will be established, preferably with techno-legal agreements between supplier and user. Given the seasonal fluctuation in the availability of agricultural residues, this will be especially important to ensure a continued supply of biomass to the system.

b) *Infrastructure requirement*: External infrastructure such as connecting roads, proximity to biomass markets, water availability, water discharge facility, ash disposal or usage (road construction, cement manufacturing, soil conditioner etc.) availability of a local electricity grid and internal infrastructure, mainly land suitable for the project with clear title and that is not an environmental hot-spot.

c) *Supporting technologies:* Additional supporting technologies need to be available like a water treatment plant for boiler feed water, fuel preparation, handling and safe storage (biomass based fuel is prone to fire, propensity of biomass to decay/decompose and therefore requires special storage areas), air and water pollution control devices, ash handling system (e.g., rice husk has approximately 20% ash), fuel drying system if required, and cooling towers for water recycling. In addition provisions for used lubricating oil handling will be considered.

d) *Human Resource requirement:* Availability of trained manpower both at the supervisory and operational level is critical for efficient operation, maintenance and trouble shooting of plant operation. Provision of required training of plant personnel by technology supplier will be made in addition to capacity building by NCPO-C and its network of international expert partners (see below for more details).

C. <u>Techno-economic assessments</u>: Out of these assessments, the most suitable, proven and techno-economically viable projects for biomass based energy generation will be selected, elaborated, and implemented by the investors with support from the project. This will include undertaking a detailed financial engineering of the selected options, with assistance from the project, to support company decision-making and the securing of financing for implementation. Part of the funds for implementation will come from the enterprises themselves, part will come from GEF funds, and part will be raised through the preparation of proposals to be submitted to banks or other financing institutions (see next point). The specific types of investments envisaged will be described in more detail during the project proposal preparation.

D. <u>Preparation of bankable proposals</u>: For the technology-vendor selected, "bankable proposals" will be prepared, including full costing for all aspects like environmental costs and liabilities, social sustainability and risk mitigation, for potential financers of the technology. This will also cover relevant transaction and contractual aspects - identification and fulfilment of the relevant contractual aspects between the various stakeholders such as the technology supplier, the technology recipient, financers, and the government (the latter will be particularly important in ensuring a viable business proposition between technology supplier and recipients). The National Cleaner Production Office of Cambodia (NCPO-C) will play an important role here in overcoming any hurdles related to IPR in particular.

E. <u>Technology installation and operation</u>: On the basis of the proposal, the selected technology will be procured, installed, commissioned and run. The capacities of the technology recipients will be built to ensure that they can effectively operate and maintain the technology system and respective components.

F. <u>Capacity Building</u>: While the pilot projects are proceeding, national expertise will be built in technology transfer/ adaptation services. In line with the size of the energy sector in Cambodia, at least 20 such national experts will receive the necessary training and capacity building. To ensure that these persons can continue to offer these services after project completion they will be included by the NCPO-C into a formal network of TT service providers. The NCPO-C will be able to use them as experts in its own future project and alert them to other potential TT projects. For their part, they can use the NCPO-C as a mechanism for continuing to upgrade their technology transfer related skills over time.

From the start of the project, knowledge and technical capacity for the process of technology assessment and transfer will be built up, to familiarize the relevant actors with technology assessment and its related environmental, social, financial and policy implications. The personnel from the enterprises involved in the pilot projects will of course be targeted, but so will MIME, the Council for Development of Cambodia (CDC), the Ministry of Environment(MOE), Électricité de Cambodge (EDC) , the Electricity Authority of Cambodia(EAC), the Institute du Technology Cambodge (ITC), and local banks. Part of this capacity building will relate to an understanding of intellectual property right (IPR), patent and trade secret regimes. In particular, with respect to IPR's, it will be explored if the WTO TRIPS agreement might give some flexibility for renewable energy technology transfer to enjoy a waiver similar to that of public health related technology transfer. Use of financial engineering tools will also be covered.

To assist in the general process of skills building and upgrading, the project will make available a web-based guidance tool/manual for technology transfer for renewable energy from biomass/agricultural residues. This will include a decision-making tool to assist enterprises select the most appropriate technologies for their needs. Trainings depending on requirement will be tailor made for different stakeholders and will be conducted by the NCPO-C with international experts having relevant expertise.

G. Dissemination: Once stable operating conditions are achieved, the results of the pilot projects will be widely disseminated in the most appropriate manner. The targets for this dissemination will be potential users of the technology, but also those in the private sector for whom supporting, servicing and maintaining the technology could be a business (this could include manufacturers of certain parts of the technology), banks and other potential sources of financing, local government officials from other provinces and districts who through policy activities could encourage the uptake of the technology in their districts/provinces. The focus will be on encouraging further business partnerships to transfer and install the technology elsewhere in Cambodia.

H. Removal of Financing Barriers: In parallel, the project will address the issue of how to overcome the major barrier of availability of finance to implement technology transfer. Existing mechanisms like the Special Climate Change Fund (SCCF), the Least Developed Country Fund (LCDF), and the Clean Development Mechanism (CDM) will be examined for their relevance. However, the project might conclude that it will be necessary to develop new financial products.

I. Policy Development: The project will assist RGOC to strengthen, or if necessary develop, policies and regulations that can support development of mechanism and financial incentives for scaling up of the development and transfer of technology. One such area of policy that will be targeted, together with the Electrical Energy Authority of Cambodia, the national utility Électricité de Cambodge (EDC), and MIME, is the development of the rules allowing private generators of electricity using renewable resources to feed their generation into their local grid at a fair price (this would make the investments more economically viable). Another key policy area where the project will focus is power purchase agreements (PPAs). Investors will be assisted in negotiating long term (preferably 10-year) PPAs with Electricity Distribution Agency of Cambodia (EDC).

Global Environmental Benefits: Implementation of energy generation technologies using available surplus biomass as agricultural residue will lead to global environmental benefits delivered in the form of reduced GHG emissions, both in the form of CO_2 emissions from the avoided burning of fossil fuels (diesel and fuel oil) as well as in the form of avoided methane generation from the possible anoxic biodegradation of unused agro residue waste.

Depending on the type of technology selected, there is also the possibility of avoiding the formation of unintended POPs (viz. dioxins and furans) that are formed during the combustion of fossil fuels in the generators and boilers currently used.

The emissions of other atmospheric pollutants (nitrogen oxides, carbon monoxide, volatile organic compounds and sulphur dioxide) may well also be reduced, depending on the type of technology selected, providing local benefits.

It should be noted that reducing import of fossil fuels through a greater use of locally available sources of renewable energy has other notable local benefits. It will enhance energy security and provide local economic benefits through entrepreneurship development and job creation.

B. THE CONSISTENCY OF THE PROJECT WITH NATIONAL/REGIONAL PRIORITIES/PLANS:

The project is fully consistent with Cambodia’s national priorities and plans.

Cambodia submitted its Technology Needs Assessment (under the Climate Change Enabling Activity (CCEAP) project) in 2003, and its Initial National Communication in 2002, within the context of its obligations under the UNFCCC. Both documents emphasise the use of renewable energy as fuel to produce electricity.

In the same year, the Royal Government of Cambodia promulgated a policy and plan on energy conservation and efficient use of renewable energy sources. In 2001, Prime Minister Samdech Hun Sen also recommended and solicited support of the private sector to promote renewable energy technologies to complement the Government's policies and objectives. The Renewable Electricity Action Plan (REAP), first published in 2003 and including a proposed 10 year programme of activities, was aimed at encouraging the generation of electricity from renewable energy sources. One of the sections in REAP covers the potential opportunities for private investment in the electricity sector. REAP envisions an active partnership between the public and private sectors to create a favourable environment for investment opportunities in renewable electricity sources. REAP proposed 10 year programme focussed mainly on Solar House systems (SHS) and micro hydro sources to meet Cambodia's rural electrification objective.

C. THE CONSISTENCY OF THE PROJECT WITH GEF STRATEGIES AND STRATEGIC PROGRAMS:

The project is fully consistent with Strategic Program (SP-4) "Biomass as source for Renewable Energy", in the Climate Change Focal Area.

The project is also fully consistent with GEF's strategic programme on technology transfer. The project will aim to bring about the transfer and diffusion across the energy sector of low carbon technology using biomass as fuel.

D. THE TYPE OF FINANCING SUPPORT PROVIDED WITH THE GEF RESOURCES:

The activities outlined above are best catalyzed by the use of a grant from GEF. It is the best tool to assist the government in creating the necessary policy framework that will stimulate the creation of a national market for technology transfer and adaptation to suit local condition, which is the key to ensuring sustainability and uptake on a national scale. It is also the best mechanism for demonstrating to the key stakeholders (the private sector, the financial sector, different levels of government) the financial and environmental benefits of biomass related technology in the face of initial reluctance and scepticism. Such demonstration – together with a more supportive policy framework – can catalyze the necessary myriad of investments that need to be made by clients to replicate and upscale the use of the technology.

E. COORDINATION WITH OTHER RELATED INITIATIVES:

Several initiatives involving elements of biomass based energy generation have been undertaken in the country in the past, and the Cambodian government has been working actively with regard to the development of its infrastructure for harnessing biomass.

Rural Electrification: A major focus has been on rural electrification using available biomass. A major initiative has been undertaken mainly involving the installation of small biomass based gasifiers (10-20 KWhr capacity) at the local level. The Cambodia Research Centre for Development (CRCD) has worked extensively with international organizations and has identified a few larger biomass-based gasifier projects for rural electrification. Financial, social and environmental feasibility studies have been conducted and since the results were encouraging work on projects has started.

Captive Generation: There has also been a push on promoting biomass based systems for captive generation. One 400KWhr power plant was installed in February 2009 for captive power generation by a corporate group using fast growing Acacia wood as fuel, and two rice husk fired power plants are planned for Battambang province, which is the largest producer of rice in Cambodia and has therefore the maximum number of rice milling facilities. Some potential biomass fired co-generation projects are also in the pipeline for cashew nut processing factories but they are still in the early stages of techno-economic viability assessment and are smaller in size than what is being proposed here.

Recently, the International Finance Corporation (IFC) has financed a study on the potential of energy generation using rice husk biomass as fuel. The study has been awarded to the Economic Institute of Cambodia (EIC) and focuses mainly on the gasifier route for small sized plants (less than 1 MWhr) mainly for captive power generation for provincial towns and possibility of selling surplus power to EDC. Three small biomass fired generation projects are being planned and coordinated by SMEs and an NGO. Two wood fired gasifiers are also planned in Battambang province using the fast growing Glyricidia species. Under the COGEN3 programme funded by the European Commission pre-investment studies for a 1.5 MWhr rice husk based power plant was studied.

The New Energy and Industrial Technology division Organisation (NEDO) commissioned a biogas-fired electricity generation project and solar PV station in 2004 in Sihanoukville which is non-operational. The installation was done partly for captive power consumption of an animal breeding farm, an oil palm plantation and oil extraction company, with the surplus going to the workers' and other residential colonies.

The proposed project will also build on the prior experience, particularly on policies and mechanisms that MIME has gathered during the several programmes mentioned in Section B It will also build on UNIDO's experience in executing the country's cleaner production programme, which has focused on assisting enterprises to increase their materials efficiency as well as their energy efficiency. Thermal energy (steam) using biomass has been successfully demonstrated by CP programme, and its implementation by a number of enterprises has resulted in significant reductions of greenhouse gases due to replacement of fossil fuel. These reductions have ranged from 80-98% and have been implemented in all important industrial sectors in Cambodia, showing significant economic and environmental benefits.

To the extent that all these projects have built relevant biomass based energy generation experience and capacity, they will be used in this proposed project.

F. THE VALUE-ADDED OF GEF INVOLVEMENT IN THE PROJECT:

Although a broad policy framework is in place, as described in Section A there is still insufficient institutional and technical capacity in and resources for technology transfer. This has meant that there is inadequate support for identifying the appropriate technologies suitable to Cambodian climate. In the relative absence, therefore, of the five elements described in UNFCCC's technology transfer framework (see section A), significant opportunities to tap into the country's potential of abundantly available biomass to install biomass-based high efficiency power generation (both thermal and electrical) will go unrealized. The use of agricultural residue biomass as an energy source and the creation of a market for energy generation technology transfer will be further delayed. Limited knowledge of relevant international experiences and proven technologies, weak coordination of interventions, poor communication/ collaboration between public and private sectors will persist and negatively impact policies/programs development and implementation in terms of significantly lower energy, environmental and economic benefits achieved.

The proposed project will provide the incremental policy, technical and financial inputs required to support and effectively leverage national efforts in GHG emission reductions. At the policy and institutional levels, the project will strengthen local expertise, knowledge and capacity in effective and sustainable clean energy technology transfer, adaptation where required, and implementation assistance, and will assist in rationalizing interventions and focusing resources.

G. THE RISKS THAT MIGHT PREVENT THE PROJECT OBJECTIVE FROM BEING ACHIEVED, AND THE RISK MEASURES THAT WILL BE TAKEN:

Political risk: low government commitment to support transfer of cleaner/environmentally sound technologies and the project. ***Potential impact:*** High. ***Probability:*** Low. The project objectives and activities are perfectly in line with national policies and objectives for ensuring energy supply to everyone at an affordable cost and creating a market for efficient energy generation technologies.

Technical risk: There is no technical risk associated with the project, as the proposed technology transfer using biomass as fuel is well proven in many countries globally and particularly in Asia. No significant risk is envisaged with respect to the delivery of capacity building for the technology transfer mechanism in Cambodia. UNIDO has already successfully completed projects of this nature in many countries. However, policy level interventions conducive to promote and develop technology transfer need to be addressed carefully. ***Risk management:*** Regular communication, close coordination, and delegation of responsibility, involvement of all stakeholders will ensure continuous active involvement of policy/institutional counterparts.

<u>Market risk</u>: Current market demand for renewable energy generation technologies is poor, mainly due to high initial investments compared to diesel generators and the non-availability of hardware and software locally. ***Potential impact:*** High. ***Risk Management:*** The project builds on creating and expanding market relationships between users in Cambodia of the technology and external suppliers of that technology. Customers, both companies needing captive generation as well as energy companies, trained through the project will request more frequently and place a higher value on investments from their technology vendors/suppliers. The project preparation phase will play a major role in minimizing/ eliminating this risk. A tailored communication/ information strategy combined with an active dialogue and involvement of potential clients both during project preparation and project implementation should ensure the desired client response to the project.

<u>Financial risk</u>: Financial/credit constraints, high capital costs and an inhospitable investment environment prevent Cambodian industries from investing in high investment technology transfer. The existing financial mechanisms are inadequate and could affect technology transfer on the required scale. ***Potential impact:*** Medium-high on the project's outputs, possibly greater on the project's outcomes. ***Probability:*** Medium. ***Risk Management:*** Selection of suitable suppliers, preferably from the region will allow the technology transfer costs to be minimized with positive impacts on project outputs. The ability to use available financial mechanisms under the UNFCCC like the SCCF, LCDF and to some extent CDM for financing the technology transfer <u>will be explored.</u> Financial risk can also be mitigated by ensuring that least-capital cost is not the sole appraisal criterion in enterprises' energy-related investment decisions.

<u>Implementation risk</u>: ***Potential impact:*** Medium. ***Probability:*** Low. UNIDO has significant experience in identifying, transferring, adapting and implementing technology, and it has a good knowledge of the key variables that determine the success and the failure of project implementation. ***Risk Management:*** UNIDO will mitigate this through the development of detailed activities plans in close cooperation with in-country project partners, stakeholders and developers. A thorough stakeholder consultation process will be conducted in the context of finalizing the scope of the project during the project preparation phase. An agreed and transparent modus operandi will be designed before the start of project implementation.

<u>Sustainability risk</u>: failure to achieve project outcomes and objective after successful delivery of outputs. ***Potential impact:*** High ***Probability:*** Medium. By making investors, suppliers and technology transfer experts fully aware of the economic potential for biomass based power generation, and equipping them with the capacity and tools to realize and reap the benefits of such potential, the project will generate a self-reinforcing market pull for technology transfer. In addition, the policy-making outputs of the project will create the conditions to produce and sustain a policy-driven push for non conventional energy generation technologies. The creation of such a balanced and flexible policy-push and market-pull environment through the delivery of the project outputs is expected to ensure the attainment of the project outcomes and their sustainability.

H. The expected cost-effectiveness of the project:

Initial calculations for both options being proposed here indicate very attractive economics in both cases. Due to the availability of surplus biomass, there is a significant difference in price between the locally available biomass fuel and imported fossil fuels. The payback period is therefore short provided finance is available at reasonable rate (CDM could improve the financial viability of such technology transfers). CO_2 emission reductions from such technologies are also very attractive. It is estimated that the two pilot projects alone will be instrumental in reducing 35,000 tons CO_{2eq} emissions for savings of 12,000 TOEs/ year of fossil fuel.

These initial estimates will be refined during the project preparation phase.

I. UNIDO'S COMPARATIVE ADVANTAGE:

The project fits squarely into the GEF Strategic Program Strategic Program 4: Biomass for Energy generation. GEF Council document GEF/C.31/rev.1 gives UNIDO comparative advantage for this Strategic Program under the intervention type Capacity building/Technical assistance. In general, UNIDO has a long history of involvement in technology transfer projects.

PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT AND UNIDO

A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT ON BEHALF OF THE GOVERNMENT:

Lonh Heal Technical Director General Ministry of Environment	Date: *(Month, day, year)*

B. GEF AGENCY CERTIFICATION

This request has been prepared in accordance with GEF policies and procedures and meets the GEF criteria for project identification and preparation.

Agency Coordinator, Agency name	Signature	Date *(Month, day, year)*	Project Contact Person	Telephone	Email Address
Dmitri Piskounov Managing Director Programme Development and Technical Cooperation Division UNIDO			Heinz Leuenberger	+43-1-26026-5611	H.Leuenberger@unido.org

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Dmitri Piskounov Managing Director UNIDO GEF Focal Point	[signature]	08/14/2009	Heinz Leuenberger	+43-1-26026-5611	H.Leuenberger@unido.org

ANNEX
Biomass fired circulating fluidized bed combustion technologies

The conventional conversion efficiency of biomass technologies is estimated by assuming an average conversion efficiency of 40% for thermal applications and 15% for electricity generation (UNDP, 2000), compared to >30% net efficiency in large coal based power plants. However, currently available biomass based technologies using high efficiency thermal and mechanical energy conversion are reported to be more than 65% for combined heat and power cycle (CHPC) and more than 35% for electrical energy generation using a standard heat rate (SHR) of <3000Kcal/KWhr of energy. These technologies not only contribute more than 50% reduction in specific operating costs but also significant reduction in emissions by:

- replacing fossil fuel with carbon neutral fuel
- High efficiency conversion rate both thermal and mechanical energy
- Avoiding methane generation due to degradation of unused biomass and contributing significant GWP gases.

One of the more promising types of biomass based technologies uses combustion in fluidized beds. Of the several types of fluidized bed combustion technologies (FBCs), circulating fluidized bed combustion technologies (CFBCs) have several advantages over other types of FBCs, namely:

- CFBC boilers are generally proven to be more economic than air fluidized bed combustion (AFBC) boilers for industrial application requiring more than 50-100 t/hr of steam. The combustion takes place at about 840-950°C. Since this temperature is much below the ash fusion temperature, melting of ash and associated problems are avoided.
- CFBCs have a greater ability to utilize various fuel sources and types, which provides users with the flexibility to take advantage of changing cost and availability of fuel. This is especially critical where agro residue biomass is being used, where availability fluctuates depending on many factors.
- The special design of CFBC boilers, where the combustion section is separated from the heat transfer section using an adiabatic combustion system (furnace, cyclone), external bed material heat exchanger, large radiation passes and tail-end type boiler, is the only suitable solution to meet all the required standards concerning steam parameters and plant emissions.

Design of the CFBC boiler components – especially of the fuel handling equipment – is very unique, to account for the significantly varying bulk densities, net calorific values and moisture contents of the fuel. The possibility of optimizing the fuel mixture allows the plant to operate in an economically sustainable way over the entire lifetime. The system also offers the possibility to change the fuel after years of operation – with minor modifications in the most cases.

The use of waste material as cheap fuel is an important factor for an economically viable operation. The process integrated emission control technology of CFBC boilers substitutes further flue gas cleaning installations in most applications and reduces investment and operation costs.

Table of Potential Suppliers of Biomass Fired CFBC Boilers

Supplier	Country	Address
Thermax Limited	India	Basant Lok,New Delhi - 110 057
Babcock & Wilcox	USA	20 S. Van Buren Avenue Barberton, OH, USA 442030351
Wartsila Biomass Power	Finland	Wartsila Corporation John Stenbergin Ranta 2 FI-00530 Helsinki / P.O. Box 196 FI-00531, Finland
Mega Retro Thermal Equipments	India	Hyderabad, Andhra Pradesh - 500 034, India

An important component of energy generation is the steam turbine. The table below lists potential suppliers of such technology, which would also be required.

Table of Potential Steam Turbine Suppliers

Supplier	Country	Address
Triveni Engineering & Industry Ltd	India	Bangalore, Karnataka India 560058
Turbo Engineers	India	Kolkata, WB, India 700039
Solar Thermal & Biomass Power Plant	USA	Milwaukee, Wisconsin USA 53212
HPG Limited	Canada	Oakville, Ont Canada L6L 2X8
CITIC Heavy Machinery Co. Ltd.	China	Luoyang City Henan China 471039
Mitsubishi Heavy Industries, Ltd	Japan	Marunouchi, Chiyoda-ku 100 Tokyo, Japan