EC - ASEAN Energy Facility

Project Reference No.: 103-2004

Feasibility Study of renewable Energy Options for Rural Electrification in Cambodia (REOREC)

Publication Reference: EuropeAid/119920/C/SV

Budget line BGUE-B2004-19.100200-C8-AIDCO

FINAL TECHNICAL REPORT

30 November 2006

This document has been produced with the financial assistance of the European Union through the EC-ASEAN Energy Facility (EAEF). The contents of this document are the sole responsibility of the Cambodian Research Centre for Development (CRCD) and its partners, and can under no circumstances be regarded as reflecting the position of the European Union.

CRCD

CRA-W Gembloux

RISØ

EPP Emerging Power Partners

EAEF Project Reference No.: 103-2004

Final Technical Report

Prepared by the Project Management Team:

…….
Dr. Tin PONLOK
Overall Project Coordinator

Date: 30 November 2006

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

LIST OF ACRONYMS AND DEFINITIONS

ACE	ASEAN Centre for Energy
ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
CDC	Council for the Development of Cambodia
CDM	Clean Development Mechanism
CIB	Cambodian Investment Board
CRA-W	Centre wallon de Recherches Agronomiques
CRCD	The Cambodian Research Centre for Development
CRDB	Cambodian Rehabilitation and Development Board
DNA	Designated National Authority
EAC	Electricity Authority of Cambodia
EAEF	EC-ASEAN Energy Facility
EC	European Commission
EDC	Electricité du Cambodge
EIA	Environmental impact assessment
EP	European Partners
EPP	Emerging Power Partners
FDI	Foreign direct investment
GEF	Global Environment Facility
GHG	Greenhouse Gas
IRR	Internal rate of return
MIME	Ministry of Industry, Mines and Energy
MOC	Ministry of Comerce
MOE	Ministry of Environment
NPV	Net present value
PDD	Project Design Document
RE-SSN	Renewable Energy Sub-Sector Network of ACE
RISO	RISØ National Laboratory
RE	Renewable energy
REEs	Rural Energy Enterprises
REF	Rural and Renewable Energy Fund
RE&T	Rural Electrification and Transmission Project
TFA	Technical-financial analysis
WB	World Bank

1. PROJECT DATA

Publication Reference	Publication Reference: EuropeAid/119920/C/SV
Contract title	External Actions of the European Community
Contracting Authority	ASEAN Centre for Energy, ACE
Beneficiary	The Cambodian Research Centre for Development
Project Partners	Centre wallon de Recherches agronomiques (CRA-W)
	Risø National Laboratory
	Emerging Power Partners Limited
Project Reference Number	103-2004
Overall Work Plan Period	01 March 2005 – 31 August 2006
Signing of ACE – CRCD Grant Contract	01 March 2005
Commencement Date	01 March 2005
Termination Date	31 August 2006
Amount of Grant	296,674 €

2. EXECUTIVE SUMMARY

The present report is the Final Technical Report of the *Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia (REOREC)*, covering the period from 02 March 2005 to 31 August 2006. The report integrates all activities that have been undertaken, according to the Grant Contract signed by the ASEAN Centre for Energy (ACE) and the Cambodian Research Centre for Development (CRCD) under the EC-ASEAN Energy Facility (EAEF).

The project is coordinated by the Cambodian Research Centre for Development (CRCD) as the beneficiary in partnership with Centre Wallon de Recherches agronomiques (CRA-W) of Belgium, Risø National Laboratory of Denmark and Emerging Power Partners Limited of Finland.

The project submitted an Interim Report which was received by the EAEF Project Management Unit on 23 May 2006 reflecting the progress of the activities of the project as of 1 March 2006. The structure of this Final Report has been modified in accordance with the recommendations provided by the EAEF Project Management Unit on their letter to CRCD dated 31 May 2006. A comparison of the achievement of objectives, resources used, results and outputs, impact, sustainability, multiplication effect is presented as a function of the Description of Operation in contract (Annex II, article 2.2). Moreover, this final report contains information on the detailed description of conditions in which the project was implemented; information on steps taken to identify the European Commission as the source of financing; and estimates of measurable impacts or their potentials: energy produced or saved, pollution avoided, business induced between EU and ASEAN and intra-ASEAN cooperation.

The principal objective of this project is to evaluate and develop the potential renewable energy options for the electrification of rural Cambodia. The project is divided into six tasks addressing the specific objectives of the project. The six tasks are as follows:

- Project Kick-off Meeting
- Renewable Energy Assessment and Cluster Identification
- Renewable Rural Electrification Policy, Institutional and Market Studies
- Feasibility Studies
- Project Announcement for Private Sector Participation
- Co-ordination, Management, and Reporting

The project produced activity reports highlighting the interaction with the identified stakeholders through the kick-off meeting, consultative meetings, regional dissemination and site visits; research reports, feasibility studies; and investment briefs distributed to potential developers and investors.

Activity Reports
The activity reports capture the coordination as well as interaction with the stakeholders. The following are the activity reports produced by the project:

- **Inception Report.** A two-day Kick-Off Meeting was held in Phnom Penh on 02-03 June 2005. Day 1 was the Project Management Internal Meeting and Day 2 was the Project Stakeholders' Meeting, where the Partners officially presented the project to participants from concerned government ministries/agencies, NGOs, and the private sector. An inception report was produced where the detailed work plan for the implementation of the project was presented. The report also presented the results of the discussions among the project partners as well as the detailed work programme and timeframe.

- **First Consultative Meeting.** The first consultative meeting on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia was held on 03 July 2006, at Teo Hotel, Battambang City, Cambodia. The meeting aimed to present the results of feasibility studies to representatives of the selected clusters, namely feasibility study of a 200 kW corncob-fired gasification system in Malai District, Banteay Meanchey Province, and feasibility study of a 100 kW rice husk-fired system and 1 MW rice husk-fired power generation plant in Battambang Province. The meeting also discussed potential electricity supply options for these clusters. Over 30

participants from concerned government agencies, local authority and private sector participated in the meeting.

- **Second Consultative Meeting.** The second consultative meeting on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia was organised on 05 July 2006 in Phnom Penh. The meeting aimed to present the results of the feasibility study of a methane-fired power generation plant in Kien Svay District, Kandal Province to concerned stakeholders. The meeting also discussed potential electricity supply options for the selected cluster, the likely structure and operations of the rural energy enterprise and the costs of various levels of service, as well as the requirements for local government participation, particularly for financing the local mini-grid portion.

- **Field Visit to a Methane-Fired Power Plant in the Philippines.** This field visit was organised following the completion of a number of feasibility studies on renewable energy options for rural electrification in Cambodia, one of which is methane capture from a piggery in Samrong Thom Village, Kien Svay District, Kandal Province. This field visit to the methane-fired power plant in the Philippines provided an excellent opportunity for the Cambodian participants, especially for the selected piggery owners, to get exposure to methane recovery practises using covered lagoon digesters. The participants have been familiarised with a technically proven methane capture technology from piggeries; they have gained first hand experience on the construction and operation of the system, which can be adapted for use in Cambodia. However, the investment cost of the system seems to be high for an average Cambodian piggery. Therefore, if the technology is to be selected for application in Cambodia, there is a need to explore a variety of funding sources to make proposed projects feasible.

- **Field Visit to Chia Meng Rice Husk Cogeneration and 100 KW Gasifier Pilot Project at Suranaree University of Technology, Thailand.** This field visit was organised following the completion of a number of feasibility studies on renewable energy options for rural electrification in Cambodia, including the Feasibility Study of a 1 MW Rice Husk-fired Power Generation Plant in Battambang province, the Feasibility Study of a 100 kW Rice Husk-fired System in Thma Koul District of Battambang Province and the Feasibility Study of a 200 kW Corn Cobs-fired Gasification System in Malai District of Banteay Meanchey Province. These field visits provided opportunities for the Cambodian participants, including selected rice miller and corn silo owner to get exposure to renewable energy technologies for electricity and heat generation. Participants have gained first hand experience on the construction and operation of the systems, which can be adapted for use in Cambodia.

- **Regional Dissemination Workshop on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia.** This workshop aimed to present the outputs of the activities of the project to the relevant stakeholders including the members of the RE-SSN, project developers, investors, bankers, equipment suppliers and other stakeholders. The specific objectives of the workshop were: to increase awareness on the renewable energy resources and their potential for rural electrification in Cambodia; to understand the barriers and opportunities for using renewable energy for rural electrification in Cambodia; to understand the roles of concerned stakeholders in implementing renewable energy projects for rural electrification in Cambodia; and to discuss strategy for promoting renewable energy for rural electrification in Cambodia.

Research Reports
The main research reports are as follows:

- **Renewable Energy Assessment and Cluster Identification Report.** This report presents the results of Task 2 which consists of a set of Renewable Energy Resource Maps for Cambodia, plus data on the three selected village clusters. This task has built upon the results of the various renewable energy resource assessments performed previously in Cambodia, added new primary resource data and other relevant factors. These maps were then used to identify three potential clusters for further study.

- **Report on Markets, Policies and Institutions.** This report presents the results of Task 3. The report included an evaluation of the market potential of renewable energy in rural electricity markets in Cambodia; analyses and recommendations on the proposed policy interventions

promoting renewable energy for rural electrification in Cambodia; and reviews and proposes a renewable rural electrification institutional framework for Cambodia.

- **Report on Pricing Options for RE-based Electricity Generation.** This study examines pricing options for renewable energy-based electricity generation, both on-grid and off-grid, for rural electrification in Cambodia.

Feasibility Studies

Four feasibility studies were conducted to address the use of available biomass resources for rural electrification. The project focused (and created a niche) on the use of biomass as the main renewable energy source for rural electrification as it was determined that many international and local agencies already investigated other forms of renewable energy such as PV systems, micro and mini-hydro, and wind. Each feasibility study report contains an evaluation of the existing sources of energy; a review of the available commercially proven technologies; technology selection, system configuration and energy balance; assessment of environmental and social impacts; financial analysis; conclusions and recommendations. The four feasibility studies are as follows:

- **Feasibility Study of a 100 kW Rice Husk-Fired System in Thma Koul District.** The objective of this feasibility study is to determine the viability of installing a rice husk gasifier to supply the required electricity for the local mini-grid in Thma Koul. This study considers the implementation of a rice husk gasifier coupled to an engine generator set to generate up to a maximum of 120 kWe of power. The electricity produced will be used to supply the requirements of the mini-grid.

- **Feasibility Study of a 200 kW Corn Cob-Fired Gasification System in Malai District, Banteay Meanchey Province.** The objective of this feasibility study is to determine the viability of installing a corn cob gasifier to supply the required electricity and heating for the corn drying facility in Malai. This study considers the implementation of a corn cob gasifier coupled to an engine generator set to generate up to a maximum of 200 kWe of power. The electricity and heat produced will be used to supply the requirements of the corn drying facility. Excess power (if any) will be used to supply electricity to the mini-grid through a rural electricity enterprise.

- **Feasibility Study of a 1 MW Rice Husk-Fired Power Generation Plant in Battambang.** The objective of this feasibility study is to determine the viability of installing a rice husk power plant to supply 1 MW of electricity to the provincial grid in Battambang. Rice husk will be sourced within the Battambang City area.

- **Feasibility Study of a Methane-Fired Power Generation Plant in Kien Svay District, Kandal Province.** The objective of this feasibility study is to determine the viability of installing a Covered In-Ground Anaerobic Reactor system (CIGAR) to capture methane generated from wastewater, and then use it as a fuel for a gas engine-driven generator to supply the required electricity of the farm. This study considers the two power generation scheme of 100 kWe and 200 kWe installed capacity. The 100 kWe system will be able to meet the requirements of the piggery. The 200 kWe system will both be able to meet the requirements of the piggery and at the same time meet the requirements of the communities around the vicinity of the piggery through a mini-grid.

Roadshow Materials

An investment brief for the four feasibility studies conducted were prepared and distributed to potential developers and investors. The investment brief provided information regarding the current electricity sector of Cambodia including the electricity supply profile, electricity demand and consumption profile, rural electrification development, policy instruments, investment laws, and summaries of the feasibility studies highlighting the technical solution, environmental mitigation measures, financial feasibility results as well as sensitivity analyses.

All research reports and feasibility studies were provided in English and were translated into Khmer. All project outputs are published and are downloadable from the website of CRCD (www.camdev.org). In all consultative meetings, workshops and presentations, the logos of EU and ASEAN are shown in the backdrops as well as clear indication that the project is co-funded by the European Commission through the EC-ASEAN Energy Facility. In all invitations, programmes, press releases and presentation concerning the project, it was systematically stated that the project was co-funded by the EC through the EAEF. All research reports and feasibility studies clearly identify the European Commission as a co-funder for the project. The disclaimer below was included on the cover of each report:

"*This document has been produced with the financial assistance of the European Union through the EC-ASEAN Energy Facility (EAEF). The contents of this document are the sole responsibility of the Cambodian Research Centre for Development (CRCD) and its partners, and can under no circumstances be regarded as reflecting the position of the European Union.*"

The Final Financial Report is presented in a separate volume.

3. PROJECT OBJECTIVES AND DELIVERABLES

3.1 Background

Over 80% of the Cambodian population live in rural areas. The Royal Government of Cambodia's objective, through its Rural Electrification and Transmission Project (RE&T), in co-operation with International Institutions, is that by the year 2030, over 70% of this rural population will have access to *grid-quality electricity*. These are ambitious goals which can be achieved only through the continued support of the international community.

In Cambodia, the extent of environmental problems varies both in the nature and extent of development, population density, availability of natural resources and geographical location. Cambodia is highly dependent on energy imports. With no known currently exploitable fossil fuel resources, Cambodia should seek alternative sources to support its development efforts. However, there are many barriers and constraints to the adoption of renewable energy projects in the country. These include limited and unreliable technical, operational and market data at all levels leading to poorly established financial mechanisms, weak research and development capacity, and limited awareness of the commercial possibilities of such technologies. More specifically, the lack of detailed geographic resource data makes project feasibility assessment and preparation difficult. The major stakeholders also lack information about technology characteristics,, economic and financial costs and benefits, energy savings potential, operating experience, maintenance requirements, sources of finance, and installation services. The lack of information may increase perceived uncertainties and constrain decision-making. Proven, cost-effective rural energy technologies may still be perceived risky if there is little experience with them in a new application or region. For example, the lack of visible installations and the lack of familiarity and experience with RE technologies can lead to perceptions of greater technical risk than for conventional energy sources. These perceptions may increase required rates of return, result in less capital available, or place more stringent requirements on technology selection and resource assessment.

3.2 Project Objectives

The principal objective of this project is to evaluate and develop the potential renewable energy options for the electrification of rural Cambodia.

Specifically,

- To assess and map the available renewable energy resources (biomass, wind, solar, mini-hydro and micro-hydro) and evaluate its potential as options for rural electrification in Cambodia;
- To identify the major clusters of villages where a renewable energy facility could be established as a function of the available renewable energy in the locality;
- To estimate the market potential of renewable energy in rural electricity markets, propose policy interventions and institutional framework to promote renewable energy for rural electrification and provide incentives to private project developers in line with the ongoing formulation of Cambodia's national rural electrification plan and national renewable energy master plan;
- To conduct feasibility studies in the selected clusters considering the technical, economic and financial, social and environmental impacts of the renewable energy projects and to demonstrate successful implementation of renewable energy for rural electrification.
- To propose pricing options for RE-based electricity generation, both on-grid and off-grid, for rural electrification.
- To generate a pipeline of renewable energy projects which could be facilitated for private financing by local, ASEAN and European investors.

A key goal for the proposed project is to identify opportunities for the private sector, in collaboration with the Government, to establish private sector-led profitable rural energy enterprises and to develop these into bankable projects. Because the private sector will *not* invest merely on the basis of the market packages developed in this project, it is essential that the market packages provide a transparent and compelling case for interested private sector entities to conduct their own feasibility studies as a prelude to investment. The work conducted for this project can substantially reduce the risks and costs of pre-investment preparation by potential investors and increase the likely return on investment.

3.3 Summary of Achievements in Comparison with the Expected Results

The outputs of the project for the whole duration from the signing of the Grant Contract on 02 March 2005 up to 31 August 2006 are summarised in the Table below. The summary of achievements incorporates the original Overall Objectives and Specific Objectives as presented in the logical framework submitted to EAEF. In general, it can be concluded that the achievements of the project under the major tasks exceed the set targets and objectives.

The achievements for each Task are discussed in the following Chapters of this Report. The output and related Annexes are also indicated for each specific task.

Table 1. Summary of actual achievements vs. expected results

Overall objectives	Objectively verifiable indicators of achievement	Achievements	Reference in the Final Technical Report
The principal objective of this project is to evaluate and develop renewable energy options for the electrification of rural Cambodia.	Increased awareness on the feasibility of renewable energy options for rural electrification in Cambodia.	A number of local and foreign delegates participated in the consultative meetings, workshops and stakeholder discussions.	List of participants (Annex 1, 10-14)
	Government support in developing RE projects for rural electrification in Cambodia.	Created synergy with the various programmes by the MIME, World Bank, ADB, JICA etc.	Annex 3
	Increased interest from the private sector to invest and implement RE projects in Cambodia.	Developers and investors were identified. The identified developers also visited similar projects in neighbouring countries that they intend to implement.	Annex 4-7, 9-14
	RE projects are implemented for rural electrification in Cambodia	The developers identified indicated that they will pursue the development of the projects identified.	Annex 4-7, 11-14
Specific objectives	**Objectively verifiable indicators of achievement**	**Achievements**	**Reference in the Final Technical Report**
To assess and map the available renewable energy resources (biomass, wind, solar, mini-hydro and micro-hydro) and evaluate its potential as options for rural electrification of Cambodia.	Renewable energy resources map of Cambodia is established.	A series of 10 maps (population density, roads and protected areas, power grid plans, biomass – land use and selected sources of agricultural residues, biomass – energy crops – soil fertility, biomass energy crops – dry periods, micro hydro – topography and rivers, micro hydro – rainfall, wind energy, solar energy) for the renewable energy resources in Cambodia was produced.	Annex 2 part 2; Annex 6 of Annex 2
To identify the major clusters of villages where a renewable energy facility could be established.	Clusters of villages are identified based on the selection criteria and the available RE resources in the area.	3 sites were identified and clusters were selected and prioritised	Annex 2 part 3

To estimate the market potential of renewable energy in rural electricity markets, propose policy interventions and institutional framework to promote renewable energy for rural electrification and provide incentives to private project developers in line with the ongoing formulation of Cambodia's national rural electrification plan and national renewable energy master plan.	Market potential for RE in rural electricity estimated, existing policy tools are reviewed and policy interventions and institutional framework are established.	The report on markets, policies and institutions included an evaluation of the market potential of renewable energy in rural electricity markets in Cambodia; analyses and recommendation on the proposed policy interventions promoting renewable energy for rural electrification in Cambodia; and review and proposal for a renewable rural electrification institutional framework for Cambodia.	Annex 3
To conduct feasibility studies in the selected clusters considering the technical, economic and financial, social and environmental impacts of the renewable energy projects and to propose pricing options for RE-based electricity generation, both on-grid and off-grid, for rural electrification.	Feasibility studies are completed and pricing options for RE-based electricity generation proposed	4 feasibility studies were completed (2 rice husk, 1 corn cobs, 1 methane capture). Proposed pricing options for renewable energy-based electricity generation, both on-grid and off-grid, for rural electrification included in the study on pricing options for RE-based generation.	Annex 4-7 Annex 8
To generate a pipeline of renewable energy projects which could be facilitated for private financing by local, ASEAN and European investors.	A pipeline of RE projects is identified and presented to potential investors	Investment briefs of all projects were produced. The projects were presented to the developers and investors through the consultative meetings and regional workshops.	Annex 9-12

3.4 Long-term and short-term impacts

The ultimate goal of this project is to see the development of renewable energy projects for rural electrification by private investors in Cambodia. It is also expected that strong support not only from the government but more importantly from the end consumers and local communities will be obtained.

As evident from the response of the local developers, there is much interest in developing the proposed projects where CRCD and its partners have conducted feasibility studies. The presence of multilateral organisations during the dissemination activities has also resulted in potential financing for such projects.

The capability of CRCD to promote rural development through electrification in Cambodia has been further strengthened. The consultative and engagement approach has provided opportunities to build capacity among the stakeholders. The thorough market, policies and institutional study has resulted in mitigation measures to remove barriers and clarified the role of existing institutions in developing RE projects. In effect, the different institutional bodies will be able to interact more efficiently and effectively.

The government of Cambodia has indicated a positive response on the proposed policy recommendations, which will hopefully lead to actions where the uptake of renewable energy investment in Cambodia is further stimulated. Through positive engagement with the different stakeholders, procedures and programmes in developing renewable energy projects are currently being reviewed to facilitate private sector participation and investment.

3.5 Sustainability

The consultative approach has resulted in a broader, transparent and complete transfer of know-how and ensured that the different stakeholders, who have different interests and concerns, have been able to provide input in a proactive manner.
The methodology has relied on the complementary expertise of the project participants, their experience in

preparing detailed feasibility studies for rural energy enterprise development and in successfully implementing energy projects under the ASEAN-EU partnership.

The project has been able to reach a variety of stakeholders from the grassroots up to policymakers. Through the renewable energy maps produced, developers of renewable energy projects will have easy access to information that was not available before the project started. Moreover, the maps provide a good starting point for potential developers to locate their prospective renewable energy projects addressing rural electrification.

The research studies provide a platform for the government to review and streamline the current procedures and programmes in developing renewable energy projects. Moreover, these studies also provide developers, investors and financing institutions a comprehensive picture of the current policy environment for renewable energy development. The engagement of various organisations have resulted in various aid and grant programmes which could provide a greater depth in understanding the resources, technical, policy and financial context of renewable energy development in Cambodia.

The feasibility studies conducted provide a wealth of information on potential renewable energy projects that could be implemented in Cambodia. Moreover, the studies may be used as guides or templates for replicating similar projects. With the currently high price of diesel as well as high level of interest on the part of local developers and multilateral organisations, private sector investment and development in renewable energy projects through rural energy enterprises in Cambodia is expected to occur. Coupled with this development would be the development of new markets for European renewable energy technology suppliers, service providers and project developers.

As the projects involve renewable energy, it is envisaged that the national/local environment will be improved by promoting the curbing of uncontrolled emissions and pollutants from field burning of biomass and use of fossil fuels.
The technical and management capacities of target groups and partners have improved based on their experience in participating in the project, particularly in the areas of resource assessment, technical feasibility study, financial feasibility study and assessment of the environmental and social impacts.

3.6 Multiplication effect

The uptake and level of interest by the host local communities and developers will be the main measure for the success of the project. The number of projects implemented and/or assisted will constitute the best way to monitor the success of the project.

Replication and extension of the project outcomes will be dependent on the actions of the government, private sector, NGOs and end-users. The removal of barriers for development and implementation of renewable energy technology through this project will contribute to the establishment of the infrastructure needed for the deployment of such technologies.

The project has incorporated technical solutions, identification of potential sources of financing, pipeline of renewable energy projects and renewable resources assessment. From the feedback obtained from the participants of the activities of the project, a well-balanced public-private partnership mechanism would be created which will encourage the private sector to build rural renewable enterprises that will meet the specific requirements of the local markets.
The successful implementation of the project will pave the way for private investors to feel secure considering the unfavourable investment situation in Cambodia. Assuming that the local developers where the feasibility studies were conducted proceed with the development of these projects, other owners of rice mills, piggeries and corn drying facilities will likely follow. Based from the experience of the beneficiary and partners, the presence of operating facilities in Cambodia will definitely help in replication, and act as demonstration sites.

The pipeline of projects generated shows to the investors, government and the local communities that financially and technically viable energy service projects that are affordable are a viable alternative. It is envisaged that the linkages created by the project will help attract government and private sector investments to support the development of community services. This project could also be replicated in other ASEAN countries where electrification rates may still be low.

3.7 Visibility

The project has conducted numerous activities in which all the major stakeholders involved in the renewable energy sector in Cambodia as well as the ASEAN renewable energy network have participated. These activities have included the project kick-off meeting, consultative meetings and regional dissemination workshops. In all these meetings, the logo of the European Commission was properly displayed and the organisers explicitly stated in all invitations and during the event itself that the project is co-funded by the European Commission through the EC-ASEAN Energy Facility. Moreover, the EAEF PMU as well as the EC Delegation representatives were invited and given the opportunity to make contributions.

In all reports produced by the project, the European Commission has been mentioned to be the co-funder of the project. Moreover, a disclaimer (as shown below) was presented on the cover of each report:

> "*This document has been produced with the financial assistance of the European Union through the EC-ASEAN Energy Facility (EAEF). The contents of this document are the sole responsibility of the Cambodian Research Centre for Development (CRCD) and its partners, and can under no circumstances be regarded as reflecting the position of the European Union."*

Furthermore, all reports produced by the project are published on the website of CRCD (www.camdev.org).

3.8 Major Deviations and Mitigation

Some aspects of the project deviated from the original proposal. However, CRCD and its partners provided mitigation measures to avoid major changes in the implementation of the project. Some of these deviations are as follows:

- It took the team longer time to conduct Task 2 due to the present road conditions in Cambodia. Moreover, flights to other provinces were discontinued which led to the team to conduct all data gathering by road travel. The presence of land mines in certain areas of the country prevented the team to move at a faster pace and this also resulted in some areas of the countries being inaccessible for the survey.
- The project eventually focused on the biomass resources in Cambodia based from the discussions with the major international organisations also involved in renewable energy in the country. It was concluded by the project team that there had been a dearth of information on biomass resources availability as well as projects utilising biomass as most of the other organisations focused on mini-hydro, solar and other renewable resources.
- The resignation of Dr. Pacudan from Risø resulted in the delay in completion of Task 3. Eventually, CRCD had to finalise the report and was able to submit it at the same time as the Interim Report.
- The changes above resulted in the re-allocation of manpower resources from CRCD to handle Tasks 2 and 3.
- Site visits were to be conducted only in Thailand. However, a site visit to a methane capture plant in the Philippines was deemed necessary as the prospective developers of the project at Kien Svay opted for the technology which is regionally available only in the Philippines. Although a similar facility was being implemented by the CP Group in Cambodia, it remained closed to public visits.

3.9 Methodology

The methodology used to achieve the Project Objectives is shown in Figure 1. There has been no significant changes in the methodology for the project implementation.

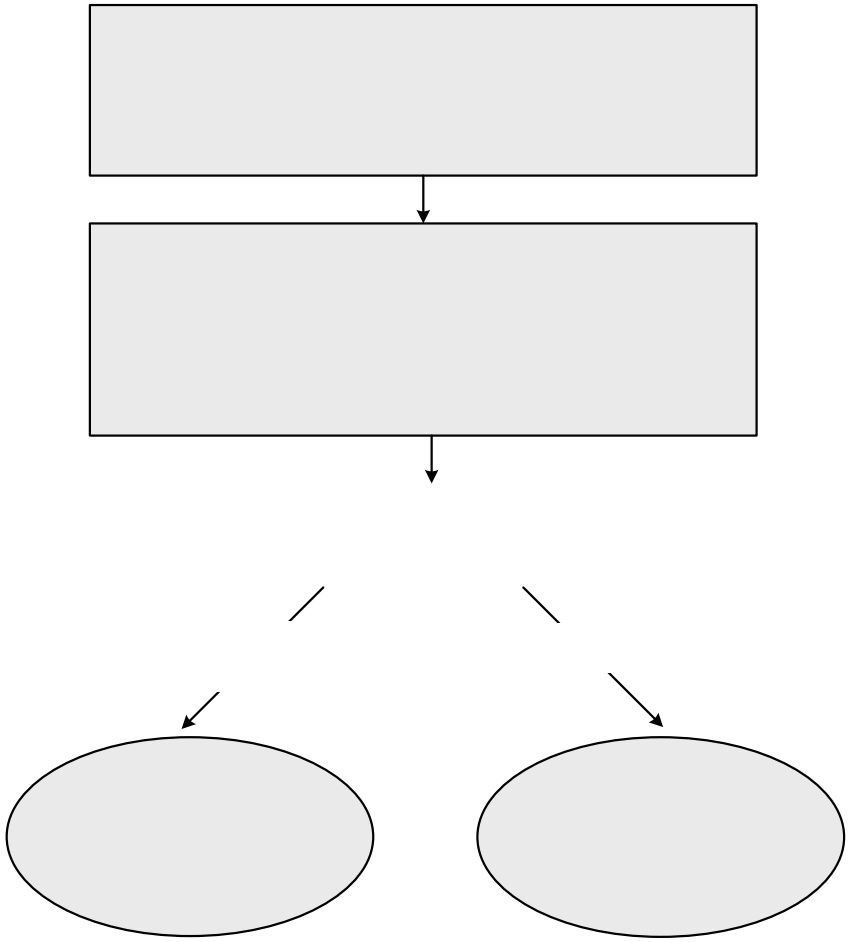

Figure 1: Methodology for the implementation of EAEF Project No. 102-2004

4. TASK 1: PROJECT KICK-OFF MEETING

Objective:

The objective of the *Project Kick-Off Meeting* is to establish a common understanding of the project's conditions, methodologies, objectives, expected outputs, needed inputs, activities, implementation plan and distribution of work and responsibilities among the partners.

The *project's conditions* include the contractual framework and the project context, the project's general management and support, the partners / participants expertises and experiences, and other supporting / supplementing / associated / related ongoing or planned projects and activities.

The *methodologies* include the methods to be applied, the ways to provide the assumed input data, the organisations to be involved and the organisation of activities.
The *objectives* form the guidance for the contents and the format of the results of the task or project and must ensure that the results actually support the overall objective of the project.

The format and the contents must be specified for the expected *outputs*, reflecting the defined and agreed objectives.

The *inputs* include both the inputs and platforms assumed to be provided for the task (but outside the specific task) and the resource input to be provided by the participants as part of the work.

The *implementation plan* includes a time schedule and the interaction with other tasks and external activities. The distribution of *work* and *responsibilities* must be clearly specified and agreed upon.

Activities:

A two-day Kick-Off Meeting was held in Phnom Penh on 02-03 June 2005. Day one was the Project Management Internal Meeting and Day 2 was the Project Stakeholders' Meeting, where the Partners officially presented the project to participants from concerned government ministries/agencies, NGOs, and the private sector. An inception report was produced where the detailed work plan for the implementation of the project was presented. The report also presented the results of the discussions among the project partners as well as the detailed work programme and timeframe.

The core activity of the Kick-Off Meeting was the initial *discussion* among all project partners with consensus discussions of the issues. The outcomes of the Project Kick-Off Task were:

- A common understanding between the project partners of the project context;
- A common understanding of the contractual obligations, including interpretation, clarification and further specification;
- A common understanding of the project activities in terms of objectives, expected outputs, expected inputs, implementation plan, responsibilities and work;
- An *Inception Report* for the project, documenting the outcome of the Kick-Off Task and acting as the reference document for the project implementation. If necessary and based on consensus, the Inception Report will be revised during the project.

Output: Inception report.

Annex 1: Inception Report.

5. TASK 2: RENEWABLE ENERGY ASSESSMENT AND CLUSTER IDENTIFICATION

Objectives:

- To assess and map the available renewable energy resources (biomass, wind, solar, mini-hydro and micro-hydro) and evaluate its potential as potential sources for rural electrification of Cambodia.
- To identify the major clusters of villages where a renewable energy facility could be established.

Activities:

5.1 Task 2.1: Local Renewable Energy Resources

Cambodia has an abundant supply of renewable energy resources, however barriers exist that prevent significant utilisation of these resources. Several donor-funded initiatives have been conducted to assess the renewable energy in Cambodia. However, most of these focussed on a few particular technologies and were either too broad to enable specific project identification, or else focused on only a limited geographic area. Most of the previous renewable energy assessments have not considered the other basic factors required for a potential rural electrification project, such as:

- Proximity to suitable power loads,
- Existing and planned power infrastructure, or
- Environmentally sensitive areas.

The key objectives for producing these renewable energy resource maps were as follows:

- To produce a series of maps that depict the following renewable energy resources in Cambodia: biomass (agricultural residues and potential energy crops), micro hydro, solar and wind energy.

- To consolidate the output of any relevant previous studies regarding renewable energy assessments in Cambodia.
- To generate primary resource data where appropriate to fill any significant gaps in the existing studies.
- To combine the renewable energy resource data with other relevant rural electrification data (e.g.: village locations, power infrastructure, exclusion zones etc) to make more useful maps.
- To publish the maps in a format that will be relevant and accessible to all interested stakeholders in Cambodia's rural electrification.

The target group of interested stakeholders for which these maps should be useful includes: project developers, investors, existing rural electricity operators, suppliers of technology and project services, policy makers, government regulators and local communities.

The maps are not intended to provide data at sufficient accuracy or resolution for the detailed site-specific needs of some of these stakeholders. However these maps should provide sufficient information to satisfy the stakeholders' initial requirements and provide a good basis to investigate more detailed data.

CRCD conducted a desk study of existing renewable energy resource assessments for Cambodia and the Region based on published and unpublished literature on available renewable energy resources such as biomass, micro-hydro, wind and solar.

Once all existing data was assembled from the desk study, it was clear that very little data existed for potential biomass energy. The term biomass covers a huge range of energy sources, not all of which are relevant to rural electrification in Cambodia. For the purposes of this survey, just two types of biomass resources were identified for further study: Agricultural Residues, and Potential Energy Crops.

The task of identifying, surveying and mapping all potential sources of agricultural residues in Cambodia is beyond the scope of this project. So, in order to maximise the relevance and effectiveness of REOREC field work, the following types of agricultural residue sources were chosen, based on total crop production and availability of residues in Cambodia:

- **Rice processing** – after milling, the rice husk can be use in a biomass gasifier to generate 'producer gas' that can run an engine and generator, or else the husk can be combusted in a steam boiler to drive a turbine and generator (usually on a larger scale);
- **Maize ('red corn')** – once kernels are removed for drying the corn cobs can be used in a small biomass gasifier or a steam boiler, as described above;
- **Cassava ('tapioca')** – once the viable starch has been removed for drying the waste effluent sludge can be passed through a large biodigester (a covered lagoon or tank under controlled conditions) in which it will decompose to generate methane that can be used to drive generator sets;
- **Piggeries** – the waste effluent from the pigs can be passed through a large biodigester, as described above, and the methane gas used to drive generator sets.

Information on each of these four agricultural processing activities in Cambodia is very limited. Even basic data such as the location and contact details for large processing sites proved difficult and in some cases impossible to obtain despite a range of communications with all apparent industry stakeholders including government and private sector. This lack of data has also been reported in a number of the sources used for the desk study, and is understandable given the limited resources and priorities of government departments, and the lack of incentives for private companies to publicise detailed information about their activities.

A dedicated survey team was sent to each region to collect basic site data. As far as possible the surveys were designed to be technology-neutral. In other words the survey results should help determine the availability, quantity and quality of biomass, without assuming a particular energy conversion technology. This is especially important in the area of biomass energy where many technologies and processes are in various stages of commercialisation.

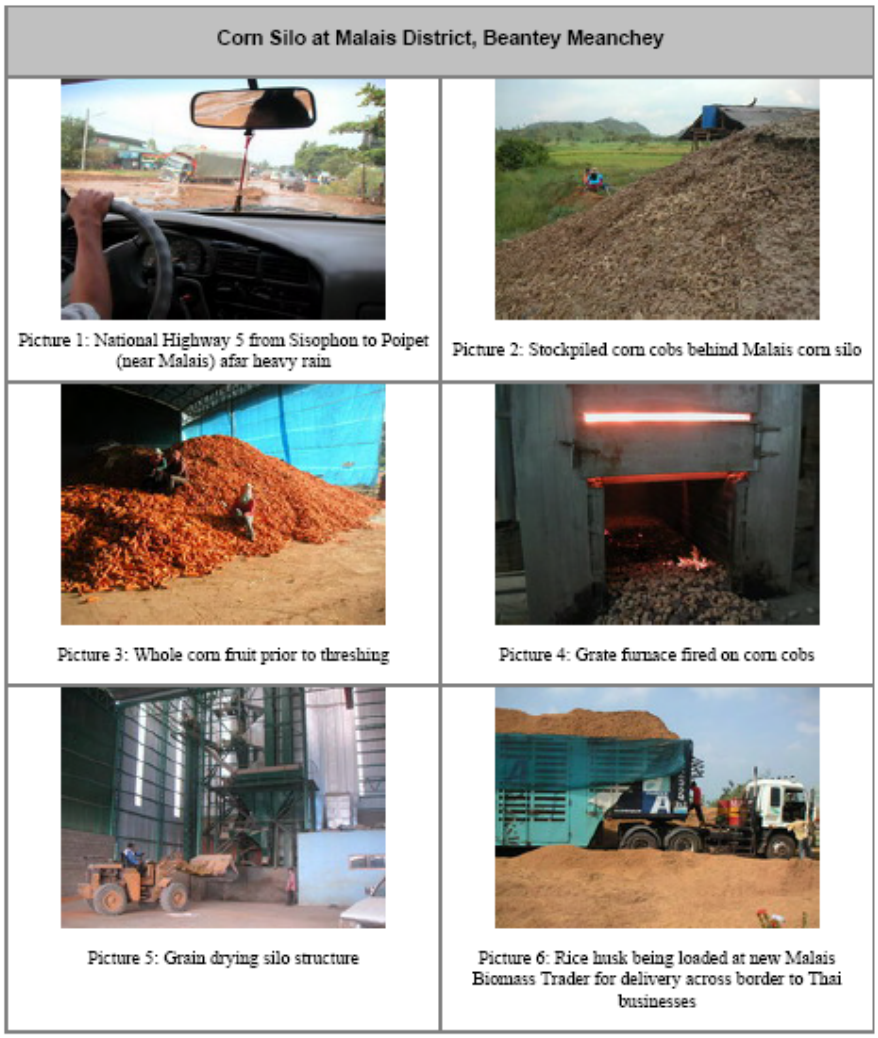

Figure 2. Pictures taken during data collection

A set of maps have been produced that combine the results of previous resource assessments, with the results of the biomass field surveys described above, plus a series of other geographical data relevant for the identification of viable rural electrification sites. There are 10 maps in the full set with each map presenting a particular renewable energy resource type or rural electrification issue. The components and sources of data for each map have been described in detail, and the complete set of maps have been produced. Electronic versions of the maps are available for free download from the CRCD website – **www.camdev.org**.

The set of maps produced as part of this task will provide a valuable tool for stakeholders in the development of rural energy in Cambodia. The maps combine a large number of existing data sets into a relevant and accessible format. This resource should be made available widely, for free access, to ensure that the value of the work accrues to Cambodia's energy future. To this end the authors have placed the maps on the CRCD website, as described above, with appropriate references to original data owners and the EAEF's project support. The authors encourage others to disseminate the maps to interested stakeholders. The complete digital files comprising the GIS database that was used to prepare the maps is held by CRCD and could potentially be distributed once appropriate permissions are obtained from data owners.

Another significant outcome from this task was the identification and initial quantification of significant supplies of biomass resources that have not, to the authors' knowledge, been reported in detail elsewhere. The most significant are the five corn processing sites generating large volumes of waste corn cob, in addition to the cobs that are already used as heat source for grain drying.

In addition, the identification and description of a new private biomass trader, found operating on the border with Thailand, has implications for the feasibility of any biomass project in Cambodia This will also have significant implications for other rural Cambodian industries, such as rice millers, brick kilns timber mills, rubber plantations, and for all the rural communities in which they operate. In some cases the impact may be positive, such as a rice miller receiving high prices for selling rice husk to Thailand that was previously dumped. Examples of industries that may potentially suffer are the brick kilns that rely on cheap biomass, mainly rice husk.

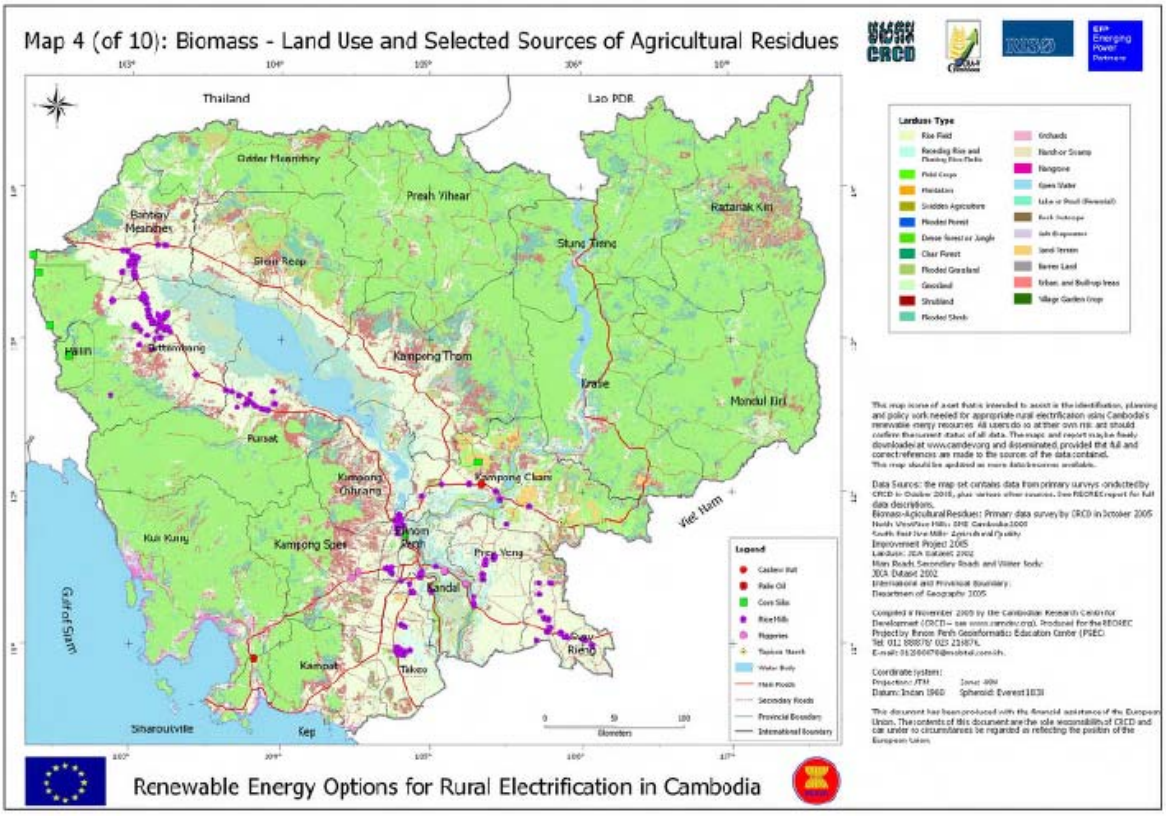

Figure 3, Sample renewable resources map for Cambodia

The authors believe that there is a need for a separate study into the implications for Cambodia's rural industries of the changes in the market for biomass from agricultural residues in Cambodia that are being driven in particular by the increasing demand in Thailand for use in electricity and various industrial heating applications.

The results of the renewable energy resources assessment for Cambodia are included in the report entitled **"Annex 2: Renewable Energy Assessment and Cluster Identification Report".**

5.2 Task 2.2: Cluster Review and Prioritisation

The first step in the process of identifying suitable clusters for potential rural electrification projects was to establish appropriate criteria as the basis of the selection. Initially these criteria consisted only of the standard technical and financial issues as described in the project proposal. However the team decided that some other important issues should be considered in order to maximise the value of the REOREC findings. For example: the potential impact of the project type for Cambodia's current situation, and the additionality of the selected projects with respect to other development projects being conducted in country by other organisations.

The following basic selection criteria were used to prioritise candidate village clusters with the highest

potential for a feasible rural electrification project based on renewable energy sources that are appropriate for further analysis under the REOREC project.

Table 2. Selection criteria for village clusters

Criteria	Comments
Agreement of Electricity Authority of Cambodia (EAC)	At this pre-feasibility stage it is not possible to obtain formal EAC approval, or to obtain an operating license. So this criteria refers to consulting EAC and confirming no objection to the establishment of a rural energy service enterprise in the village or cluster of villages targeted for RE electrification.
Provincial and local government leaders	The local government leaders has expressed interest to support the project.
Distance from backbone grid	Village excluded from official electrification plan in the short term. In the case of clusters inside the 40-km buffer zones around every provincial town, EDC and EAC were consulted on their specific plans for grid extension to the clusters. In addition both EAC and EDC confirmed that even if the grid did extend to these areas in the future, the grid operator would consider all possibilities of buying from a local embedded generator if it were viable.
Size and contiguity of villages and potential load demand	Priority municipalities should have a sufficient load density, relative to the potential supply, for sufficient operating efficiency.
Market structure within villages	Villages with public facilities (e.g.: markets, hospitals, water treatment) that can provide good daytime base load.
Income/willingness of consumers to pay	Communities with incomes above poverty level and willing to pay a premium for efficient and reliable service.
Presence of other rural development programs	Priority is given to communities which are recipients of development programs by other sectors.
Local energy sources	Potential for solar, wind, biomass residues and hydro resources. However greatest weighting to be placed on areas with biomass resources due to good potential for replicability, and limited existing experience in Cambodia.
Accessibility	Relatively accessible to facilitate timely implementation.
Security of personnel and equipment	Areas should be socially and politically stable.
Regional diversity	Market packages should not be concentrated in just one or two regions for socio-political reasons.
Consistency with the government's power development plan	The clusters should not already be the subject of other rural electrification projects where there is likelihood of development in the near future.
Local commercial markets unspoiled by grant-in-aid energy supply projects	Should not be in areas where there are grant-in-aid projects which cannot be re-structured to support electrification of market packages. There should be potential for private sector collaboration with and building upon grant-in-aid and concession-financed RE projects.

Once the above selection criteria were established, the team decided to focus the investigations on potential projects based on the use of biomass resources, and in particular agricultural residues. This decision was taken because these types of projects could be replicated widely throughout the country, and also because there is very little experience or data on the commercial viability of these types of projects in Cambodia.

The above selection criteria were applied to all the potential sources of agricultural residues identified in the initial field surveys (see previous section). The following sites were prioritised as the most promising and suitable for further investigation under REOREC:

- **Corn Drying Silo in Malai District, Beantey Meanchey Province** - with a cluster of 4 villages with almost 600 households, and including an REE business that recently ceased operation due to the rising prices of diesel fuel. There is potential for a small gasifier using waste corn cobs and providing excess power to local villages.
- **REE and Rice Mill (co-located) in Thma Koul District, Battambang Province** - with a cluster of 12 villages with just under 4,000 households. The site partner operates both a rice mill and an electricity supply business on the same site. The REE currently supplies only about 800 households due to limited capacity and high fuel prices. Potential exists for a number of scenarios based on gasification or combustion of rice husk for captive power plus supplying the community to expand the existing REE mini-grid to supply over 1,000 customers.
- **Piggery in Kien Svay District, Kandal Province** - surrounded by almost 1,000 households with no electricity service. There exists good potential to capture the biogas from waste of 10,000 pigs for supplying daytime captive load and exporting excess, especially at night, to surrounding villages.

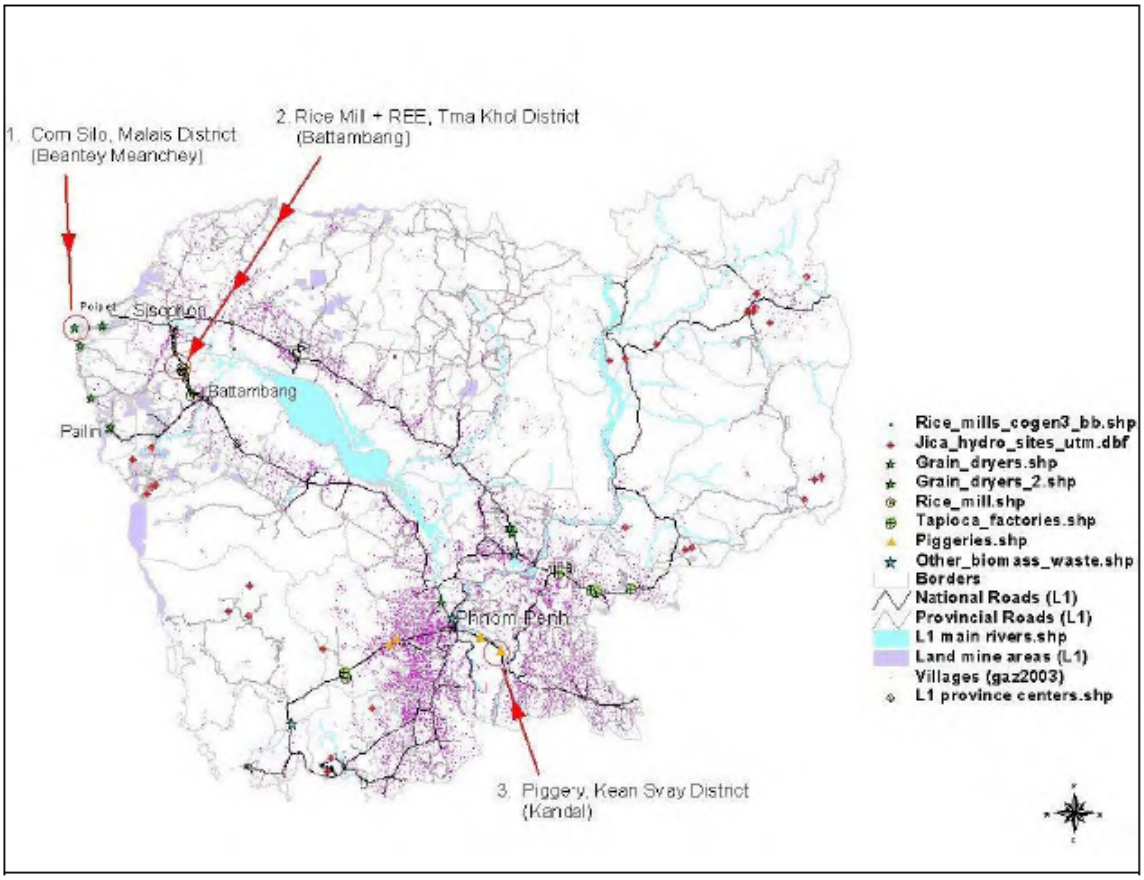

Figure 4. Location of the prioritised areas

The results of the cluster review and prioritisation are included in the report entitled **"Annex 2: Renewable Energy Assessment and Cluster Identification Report".**

5.3 Task 2.3: Collection of Local Cost Data, Field Visits and Community Consultations

Discussions were held with the owners of each of the three sites to explain the objectives and activities of the REOREC project, and a simple Site Partner Agreement was executed between CRCD and the site owners. This memorandum of understanding was seen as an essential step in order to establish the commitment and trust of the site owners. Detailed site surveys were designed for each of the three sites, with the objectives of obtaining information regarding the available biomass resources within the vicinity, on-site heat demand, on-site power demand, possible external heat and power loads and future plans of the facility owner. A summary of the survey results is provided but commercially sensitive data has not been published in compliance with the terms of the MOU with the site owners.

The results of the collection of local cost data, field visits and community consultations for the selected clusters are included in the report entitled **"Annex 2: Renewable Energy Assessment and Cluster Identification Report".**

Output: Renewable energy resources map of Cambodia, Clusters or market packages for Feasibility Study.

Annex 2: Renewable Energy Assessment and Cluster Identification Report.

This report presents the results of Task 2 which consists of a set of Renewable Energy Resource Maps for Cambodia, plus data on the three selected village clusters. This task has built upon the results of the various renewable energy resource assessments performed previously in Cambodia, added new primary

resource data and other relevant factors. These maps were then used to identify three potential clusters for further study.

6. TASK 3: RENEWABLE RURAL ELECTRIFICATION POLICY, INSTITUTIONAL AND MARKET STUDIES

Objectives:

This project component seeks to address the policy, institutional and market barriers to private sector development and implementation of renewable energy for rural electrification in Cambodia. The objective of this was to estimate the market potential of renewable energy in rural electricity markets, propose policy interventions and an institutional framework to promote renewable energy for rural electrification and provide incentives to private project developers.

Activities:

6.1 Task 3.1: Renewable Rural Electrification Market Study

The main objective of this study is to estimate the market potential of renewable energy in rural electricity markets. This task has reviewed the rural electrification development strategies and targets of the government, and has summarised the medium term rural electricity demand based on the country's power development plan. Market segments in the rural areas have also been identified and characterised. The market potential for renewable energy in the rural electricity market has been estimated based on the available renewable energy resources in the country (identified and quantified geographically in the resource assessment task).

The result of the study is shown in Chapter 2: Renewable Rural Electricity Market of the report entitled "Task 3: Markets, Policies and Institutions". The study presents the rural electrification development in Cambodia as well as the rural electricity supply market and renewable energy technologies applicable for rural electrification.

Cambodia has no national grid and the country's electricity supply consists of 24 isolated grids centred in major cities, provincial and small towns, with the exception of the electricity supply system of Kampong Speu which has been connected to the Phnom Penh system through a 115 kV single circuit transmission line since 2002. Electricity service providers in small towns and communes near the borders of Thailand and Vietnam also source some of their power from electricity suppliers from their countries. The three main electricity suppliers in Cambodia are: i) Electricité du Cambodge (EDC); ii) licensed electricity providers; and iii) rural electricity enterprises.

As almost 90% of the total households in the country do not have access to modern electricity services, the Government of Cambodia has made rural electrification one of its key energy sector priorities. Only 253,152 out of almost 2.3 million households are currently being served by Electricité du Cambodge (EDC), licensed suppliers and non-licensed electricity providers. Energy end-use in the residential sector in general is for cooking, lighting, electrical appliances and air conditioning. In Cambodia, cooking and lighting represents the main energy end-uses, and electricity accounts only for a small percentage in the overall household energy demand. There exists therefore a huge latent demand for modern electricity services in the country. Under the Power Sector Policy, the government sets the following long term targets:

- increase the access rate to reliable and good quality electricity services to 70% of rural households by year 2030, and
- 90% of villages will be electrified by year 2030, a village is considered electrified when most community facilities and more than 50% of households have electricity.

6.2 Task 3.2: Renewable Rural Electrification Policy Study

The objective of this study is to propose policy interventions to promote renewable energy for rural electrification and provide incentives to private project developers. The study has reviewed existing policies and measures on renewable rural electrification in Cambodia, analysed the possible application of EU and other developed and developing countries best practice policies, instruments and regulatory frameworks, and proposed alternative policy and regulatory options for the country.

The result of the study is shown in Chapter 3: Renewable Rural Electrification Policy of the report entitled "Task 3: Markets, Policies and Institutions". This study presents the opportunities and barriers to renewable energies for rural electrification and renewable rural electrification policies and instruments. Renewable energy for rural electrification policy options for Cambodia are also presented.

The rural electricity supply in Cambodia currently suffers from some serious issues, summarized as follows:

- Only 11% of rural households are electrified by grids, and about 50% of rural households depend on batteries for lighting.
- Electricity tariffs in rural areas are extremely high, $0.30 to $0.91 per kWh, due to high fuel prices and the prevalence of small scale systems with low load factors and poor fuel efficiency.
- Rural households are inequitably facing higher electricity costs than urban dwellers who are offered subsidized tariffs (up to 12 times less than the cost faced by rural users to charge batteries) despite generally having higher incomes.
- Rural electricity services generally suffer from low reliability and poor power quality.

The huge gap between the current situation in rural Cambodia and the Government's targets presents significant opportunities for the development of renewable energy resources as part of the solution for rural electrification.

Rural Energy Enterprises (REEs) face many of the same issues as Electricité du Cambodge (EDC) with respect to operating small diesel power systems. They also face the additional challenges common to small businesses, including limited access to finance, small economies of scale across the business, limited bargaining power for fuel or equipment and limited access to technical advice and assistance. Surveys of REEs have also highlighted the issues of limited technical knowledge about power generation and distribution or business management, the cost of complying with tightening regulatory requirements, the high rate of chronic bad debtors (mainly government customers), and the high rates of unofficial fees extracted by various levels of government.

The following are the market barriers for implementing renewable energy for rural electrification:

Limited information and low levels of awareness
- Rural electrification options
- Existing renewable energy technologies

Lack of trained personnel
- Limited available technical skills (engineering, law, business development, economics, foreign languages)
- Inadequate training, research and education facilities

Commercial viability
- Small and fragmented markets, limited number of national industries and potential customers

Inadapted financial institutions
- National financial sector only undertakes basic consumer savings and loans operations
- High interest rates, no grace period, short duration loans
- Stringent collateral requirements for loans
- Loans available only for traditional technologies and activities

Unfavourable Investment Climate
- "Weak rule of law, bureaucratic costs and corruption" (World Bank 2004)
- Private sector faces high unofficial trade facilitation costs and barriers to establishment and operations

Central planning favours establishment of national grid over decentralised systems
- Construction of national grid with support from multilateral lending agencies
- Imports of competitively priced electricity from neighbouring countries

- Licensing uncertainties for smaller independent power producers.

Increasing access to electricity services in rural areas is one of the main priorities of the energy sector development in Cambodia. This is one of the prime objectives in the national energy sector development policy of the country. The provision of electricity services is pursued by the Government as an instrument to meet national development objectives such as poverty reduction, standard of living improvement and foster economic development in rural areas. The rural renewable electricity policy sets out six policy statements with specific objectives and guidelines for the development of infrastructure that provides renewable electricity services in rural areas. These statements relate to the provision of electricity services in rural areas, encouragement of private sector participation, provision of legal and regulatory frameworks, development of a rational tariff policy, promotion of renewable energies, and establishment of appropriate institutions.

To achieve both long and medium term rural electrification policy objectives and physical targets, the Government is pursuing a strategy that combines grid extension, development of isolated grid systems, and installation of individual household systems. This strategy calls for a balanced development in the provision of electricity services in rural areas using technologies that provide the highest net benefit. The strategy also takes into account renewable energy technologies such as hydro (mini and micro) and solar PV systems as well as cross border supply of electricity in the provision of energy services in rural areas.

The *proposed* rural electrification strategy based on renewable energies aims to initiate the process of maximizing the use of indigenous natural resources in providing least-cost options in the power sector and to create equitable access to electricity services and associated opportunities for increased social welfare, education, health and economic improvement through income generating activities. The strategy's specific objectives include expansion of electricity services, promotion of private sector participation, creation of legal and regulatory frameworks, development of appropriate tariff policies, promotion of small scale technologies, and creation of economic opportunities. The *proposed* strategy also calls for the development of decentralized rural electrification alternatives using small hydropower for mini-grids, solar PV systems, village level hydro systems and other systems using indigenous renewable energy resources.

The main instrument to support market deployment of renewable energies for rural electrification in Cambodia at present is the grant from the Rural and Renewable Energy Fund (REF) established as one of the components of the Rural Electrification and Transmission Project funded by the World Bank and Asian Development Bank. Renewable energy technologies covered by the subsidy are mini and micro hydropower and solar home systems. The grant could cover up to a maximum of 25% of the total project investment costs. The subsidy grants are financed by funds from the International Development Assistance (IDA) and the Global Environment Facility (GEF). In addition to the subsidy grant, renewable energy project developers could also avail both the fiscal and non-fiscal incentives offered to foreign investors under the 2003 Amendment of the Investment Law.

6.3 Task 3.3: Renewable Rural Electrification Institutional Framework Study

The main objective of the study is to ensure that there is an institutional support for RE in rural electrification and private investments. The commercial, legal frameworks and regulatory environment concerning renewable energy project development and implementation has been assessed and evaluated. Moreover, the study has reviewed the overall energy, power sector and rural electrification institutional frameworks, identified potential gaps and recommended measures to address these differences.

The result of the study is shown in Chapter 4: Renewable Rural Electrification Institutional Framework of the report entitled "Task 3: Markets, Policies and Institutions". This study presents the electricity sector institutional frameworks as well as stakeholder activities.

The basic law governing the power industry in Cambodia is the Electricity Law promulgated by a royal decree in February 2, 2001. The Law establishes the governance structure and framework for electric power supply and services throughout the country. It covers all activities related to the supply, the provision of services and use of electricity and other associated activities of the power sector. The main purpose is to establish various principles in the functioning of the electricity supply industry.

For rural electrification and promotion of renewable energies to improve electricity access in rural and remote areas, MIME is responsible for the development of policies, strategies and in the design of policy instruments while EAC focuses on the economic regulation of those entities operating in rural areas.

Among the various functions specified in the Electricity Law, issuance of licenses, tariff-setting and performance regulation are the main regulatory roles being carried out by the EAC. EAC issues eight types of licenses: generation, transmission, distribution, consolidated, dispatch, bulk sale, retail, and subcontract licenses. To financially support EAC's operations, the Electricity Law allows EAC to charge fees on licenses. EAC also reviews electricity tariffs. Currently, the Electricity Law allows full cost recovery principle in setting tariffs for distribution utilities since power service providers are self-financed and do not receive any form of subsidies from the government. Some form of cross-subsidies were introduced between poor and non-poor residential customers, and between domestic and non-domestic customers.

The legal and regulatory frameworks for the protection of the environment are contained in the Law on Environmental Protection and Natural Resources Management issued in 1996 and other environmental protection sub-decrees. Environmental regulation in Cambodia is bestowed on the Ministry of Environment (MOE). Cambodia has developed a *sustainable development matrix* to be used as a tool for assessing Clean Development Mechanism projects under the Kyoto Protocol. This matrix of 25 indicators is based on Cambodia's existing laws, regulations, policies, statements, and commitments to international conventions. The matrix focuses on four aspects of sustainable development: economic, social, environmental, and technology transfer.

All CDM projects are assessed by rating each indicator on a scale ranging from positive to negative rating. A positive rating indicates best practice for a particular criterion, while a negative rating signifies that the project has serious impacts. A neutral rating indicates that the project has no significant positive or negative impact. Projects must achieve a positive or neutral rating for each of the 25 indicators of the matrix. The absence of negative impacts is considered to be the minimum threshold with which project proponents must comply. In addition, Cambodia's DNA explicitly specifies that the *monitoring and verification plan* not be limited to GHG emissions reduction; it must also cover all commitments of the project outlined in the PDD pertaining to the sustainable development matrix.

The institutional and legal frameworks for investments in Cambodia are specified in the Law on Investment (promulgated in 1994 and amended in 2003). The Council for the Development of Cambodia (CDC) is the agency responsible for the development and management of foreign direct investment (FDI). CDC is composed of two executive boards: the Cambodian Rehabilitation and Development Board (CRDB), and the Cambodian Investment Board (CIB). CRDB manages the international assistance and public investment while CIB coordinates private investments. Local investors may register directly with the Ministry of Commerce (MOC) and are not required to apply for a license with the CDC.

Some of the stakeholders' activities discussed in the study are the following: power licenses, procedures for obtaining power licenses, power purchase agreements, environmental permits, accessing the Rural Electrification Fund, accessing investment incentives and CDM approval procedures.

Output: Report on the Market Potential of Renewable Energy in Rural Electricity Markets in Cambodia, Proposed Policy Interventions Promoting RE for Rural Electrification in Cambodia, Renewable Rural Electrification Institutional Framework for Cambodia

Annex 3. Task 3 Report on Markets, Policies and Institutions.

7. TASK 4: FEASIBILITY STUDIES

Objective:

- To conduct feasibility studies in the selected clusters considering the technical, economic and financial, social and environmental impacts of the renewable energy projects.

7.1 Task 4.1: Technical Project Design

Four feasibility studies have conducted for this project. These are:

- **Feasibility Study of a 100 kW Rice Husk-Fired System in Thma Koul District, Battambang, Province.** The objective of this feasibility study is to determine the viability of installing a rice husk gasifier to supply the required electricity for the local mini-grid in Thma Koul. This study considers the implementation of a rice husk gasifier coupled to an engine generator set to generate up to a

maximum of 120 kWe of power. The electricity produced will be used to supply the requirements of the mini-grid.

- **Feasibility Study of a 200 kW Corn Cob-Fired Gasification System in Malai District, Banteay Meanchey Province.** The objective of this feasibility study is to determine the viability of installing a corn cob gasifier to supply the required electricity and heating for the corn drying facility in Malai. This study considers the implementation of a corn cob gasifier coupled to an engine generator set to generate up to a maximum of 200 kWe of power. The electricity and heat produced will be used to supply the requirements of the corn drying facility. Excess power (if any) will be used to supply electricity to the mini-grid through a rural electricity enterprise.

- **Feasibility Study of a 1 MW Rice Husk-Fired Power Generation Plant in Battambang.** The objective of this feasibility study is to determine the viability of installing a rice husk power plant to supply 1 MW of electricity to the provincial grid in Battambang. Rice husk is intended to be purchased within the Battambang area.

- **Feasibility Study of a Methane-Fired Power Generation Plant at Kien Svay District, Kandal Province.** The objective of this feasibility study is to determine the viability of installing a Covered In-Ground Anaerobic Reactor (CIGAR) system to capture methane generated from wastewater, and then use it as a fuel for a gas engine-driven generator to supply the required electricity of the farm. This study considers the two power generation scheme of 100 kWe and 200 kWe installed capacity. The 100 kWe system will be able supply the requirements of the piggery. The 200 kWe system will both be able to supply the requirements of the piggery and at the same time supply the requirements of the communities around the vicinity of the piggery through a mini-grid.

Energy demand profiles and peak power requirements: The data obtained from the local site visits have been used to identify the various residential, community, commercial, and government customer energy and peak power demands.

Pre-engineering designs of power supply options: Options for power generation have been examined considering the availability of specific renewable energy resources. Pre-engineering designs include equipment configurations and specifications, reflecting the daily energy load curves. Equipment and system performance have been modelled using manufacturer and system supplier data, and using renewable energy resource data as appropriate.

For the 4 sites, the technologies have been selected and the energy balance calculations performed. The report for the technical project design for each site has been consolidated into 4 specific Feasibility Study reports.

7.2 Task 4.2: Analysis of Cost of Service Delivery, Connection Rates and Financial Feasibility

The principal objective of this task is to conduct an integrated technical/financial analysis of alternative approaches to delivery of rural energy services on a sustainable basis. The Technical-Financial Analysis (TFA) model developed by the EC-ASEAN COGEN Programme Phase III has been used in evaluating the feasibility of the projects. The main objective of the financial analysis is to evaluate the profitability of the proposed project based on its expected incomes and expenditures. The results of the financial analyses for the four projects are as follows:

- **Feasibility Study of a 100 kW Rice Husk-Fired System in Thma Koul District, Battambang Province**

The power plant yields positive pre- and post-tax NPV (at 20% discount rate) with a pre-tax project IRR of 38.72% (post-tax equity IRR of 34.04%). The pay-back period is 3.91 years. These values are considered very attractive for projects of this magnitude as the electricity sales price from rural electricity enterprises operating their own mini-grids are much more expensive compared with EDC.

Table 3. Results of the financial analysis

	Result
Biomass Gasifier System (USD/kW)	1,800
Total Project Costs (USD) excluding financing	286,061
Annual Operating Costs (USD)	21,283
Annual Income (USD)	104,100
Pre-tax Project IRR (%)	33.22
NPV – Cash Flow Before Interest and Tax (USD)	194,037
Post-tax Project IRR (%)	24.74
NPV – Net Cash Flow Before Debt Service (USD)	72,847
Nominal Post-tax Equity IRR (%)	28.24
Pay-back Period – Project (years)	4.52

The financial analysis using the assumptions and data mentioned shows that the NPV (at 20% discount rate) is positive, with a project pre-tax IRR of 33.22% (equity post-tax IRR of 28.24%). The payback period is 4.52 years. Using the lifeline rate of 0.12 USD/kWh while maintaining all parameters yielded a pre-tax project IRR of 10.93% which will make the project not financially viable.

- **Feasibility Study of A 200 kW Corn Cobs-Fired Gasification System in Malai District, Banteay Meanchey Province.**

The power plant yields positive pre- and post-tax NPV (at 18% discount rate) with a pre-tax project IRR of 17.27% (post-tax equity IRR of 13.09%). The pay-back period is 8.74 years. These values are considered not attractive for projects of this magnitude as the plant utilisation rate is low and electricity sales through a rural electricity enterprises operating their own mini-grids have not been considered to augment the revenues for the project.

Table 4. Results of the financial analysis

	Result
Biomass Gasifier System (USD/kW)	1800
Total Project Costs (USD) excluding financing	451,416
Annual Operating Costs (USD)	14,780
Annual Income (USD)	46,656
Pre-tax Project IRR (%)	17.27
NPV – Cash Flow Before Interest and Tax (USD)	-21,976
Post-tax Project IRR (%)	13.09
NPV – Net Cash Flow Before Debt Service (USD)	-150,489
Nominal Post-tax Equity IRR (%)	13.65
Pay-back Period – Project (years)	8.74

The financial analysis using the assumptions and data mentioned shows that the NPV (at 18% discount rate) is negative, with a project pre-tax IRR of 17.27% (equity post-tax IRR of 13.65%). The pay-back period is 8.74 years. The project could be financially viable if the developer could source the equipment in Asia which is substantially less expensive. Moreover, the project could also be viable if the diesel price increases further beyond 0.84 USD/l or the plant utilisation increases by more than 13 hours per day.

The results of sensitivity analyses indicate that certain parameters influence significantly the profitability of

the project. Some of these, such as the EPC costs, are within the owner's control and therefore should be carefully managed to maintain a viable project.

- **Feasibility Study of a 1 MW Rice Husk-Fired Power Generation Plant in Battambang.**

The power plant yields positive pre- and post-tax NPV (at 18% discount rate) with a pre-tax project IRR of 25.39% (post-tax equity IRR of 21.04%). The pay-back period is 6.10 years.

Table 5. Results of the financial analysis

	Result
Boiler, TG and Accessories Costs (USD/kW)	1,400
Total Project Costs ('000 USD) excluding financing	2,952
Annual Operating Costs ('000 USD)	347
Annual Income ('000 USD)	956
Pre-tax Project IRR (%)	25.39
NPV – Cash Flow Before Interest and Tax ('000 USD)	1,380
Post-tax Project IRR (%)	18.95
NPV – Net Cash Flow Before Interest and Debt Service ('000 USD)	189
Nominal Post-tax Equity IRR (%)	21.04
Pay-back Period – Project (years)	6.10

The financial analysis using the assumptions and data mentioned shows that the NPV (at 18% discount rate) is positive, with a project pre-tax IRR of 25.39% (equity post-tax IRR of 21.04%). The pay-back period is 6.10 years. No CER and ash sales were considered at this stage in the analysis. However, these revenue streams should be considered and further explored as these will further boost the profitability of the project. As envisaged in this prefeasibility study, the project is already financially attractive.

The results of sensitivity analyses indicate that certain parameters influence significantly the profitability of the project. Some of these, such as the EPC costs, are within the owner's control and therefore should be carefully managed to maintain a viable project.

- **Feasibility Study of a Methane-Fired Power Generation Plant in Kien Svay District, Kandal Province.**

The analysis shows that both options are attractive projects considering the magnitude as well as level of plant utilisation rate. The electricity sales through a rural electricity enterprise operating its own mini-grids would significantly improve the profitability of the project.

Table 6. Results of the financial analysis

Project Performance	**Option 1 100 kW**	**Option 2 200 kW**
Nominal Pre-Tax Project IRR	31.45%	51.14%
NPV - Cash Flow Before Debt Service (Interest + Principal) and Tax (in USD)	225,234	949,512
Nominal Post-Tax Project IRR	26.63%	42.32%
NPV - Net Cash Flow Before Debt Service (Interest + Principal) (in USD)	153,565	704,784
Nominal Equity IRR (Post-Tax)	26.63%	42.32%
Pay-back Period (yrs)	4.00	2.40

The financial analysis using the assumptions and data mentioned shows that the two options have positive NPV (at 15% discount rate), with a project pre-tax IRR of 31.45% (payback of 4.00 years) for Option 1 and 51.14% (payback of 2.40 years) for Option 2. As envisaged in this feasibility study, the project is already financially attractive with Option 2 as a more profitable option.
The results of the sensitivity analyses indicate that certain parameters influence significantly the profitability of the project. Some of these, such as the investment cost and electricity selling price, are within the developer's control and therefore should be carefully managed to achieve a viable project.

7.3 Task 4.3: Assessment of Potential Environmental and Social Impacts

The use of renewable energy technologies brings with it some environmental and social consequences, although the environmental impacts associated with use of renewable energy technologies are often small compared with those from fossil fuel-based power generation. Among renewable energy technologies, with the exception of hydropower, the burning of biomass may potentially have the most serious environmental impacts. Biomass combustion may result in air pollution, including emissions of carbon monoxide, nitrogen oxides, sulfur dioxide and particulates. In the case of biomass gasification, the resulting producer gas requires scrubbing or cleaning which in turn results in contaminated waste water discharge. Potential adverse social impacts may include noise from generation activities, displacement of community battery charging, competition with local or traditional uses of biomass, and work accidents associated with the maintenance and operation of equipment.

A review of the legal framework governing Environmental Impact Assessment (EIA) and pollution control was conducted, to ensure the compliance of the proposed renewable energy projects with existing regulations. Relevant laws and sub-decrees include: the Law on Environmental Protection and Natural Resources Management (1997), the Sub-Decree on Solid Waste Management (1999), the Sub-Decree on Water Pollution Control (1999), the Sub-Decree on Environmental Impact Assessment Process (1999), and the Sub-Decree on Air Pollution Control and Noise Disturbance (2000). The annexes of each of these sub-decrees provide specific standards for effluent discharge and pollution loads for different environmental parameters. These standards have determined the design and technical characteristics of the proposed projects. Because of the small size of the proposed projects, a full assessment of social and environmental impacts is not required by law. However, the projects will still be required to conform with national pollution standards, many of which follow internationally accepted safety and precautionary principles.

Environmental and social data gathering has been conducted for the four sites. Results indicate that adverse social impacts would be limited, in particular if local people retain access to biomass residues for household fuel uses. Data gathered have provided the basis for determining the environmental and social baseline. In addition, the data constitute an essential input for the technical design of the projects, thus ensuring that the most environmentally friendly technologies are used and environmental and social impacts are mitigated. The assessment of the potential environmental and social impacts of the proposed projects have been included in the specific Feasibility Studies.

The environmental due diligence of the projects reveals that negative environmental and social impacts are expected to be limited. The implementation of the project would make a significant contribution to local sustainable development by providing a low-cost and clean alternative source of electricity to the present diesel generation baseline.

7.4 Task 4.4: Pricing Options for Renewable Rural Electrification

A number of feasibility studies have been carried out to identify and evaluate actual renewable energy projects. These include both on-grid and off grid projects which raises different questions regarding the possible end-user tariffs or buy back tariffs. These issues are discussed in relation to overall energy pricing policies in this report.

The report is divided into five sections. Section 1 presents an introduction to the issues involved in pricing options. Section 2 discusses the pricing policies and its implications for renewable energy in rural areas in terms of fairness and equity concerns, development objectives, regulation and approval of tariffs, specific elements of tariff structure in relation to renewable energy projects, off-grid and on-grid generation. Section 3 analyses the existing tariff structure in the EDC supply areas as well as comparison with the international tariffs. A tariff structure for Cambodia and the incentives for investment in renewable energy in rural areas is also presented. Section 4 presents an analysis of revenue simulations using the 4 feasibility studies conducted in the project. Finally, Section 5 suggests other fiscal and financial measures to promote rural renewal energy and its implications in the projects where feasibility studies were conducted.

7.5 Task 4.5: Preparation of Investment Briefs

An investment brief has been prepared and presented to potential investors, project developers and financing institutions. The brief provides a comprehensive, yet transparent, presentation material for the projects chosen showing the technical, financial, social and environmental impacts as well as the business risks and uncertainties, and the incentives available to support investors and operators.

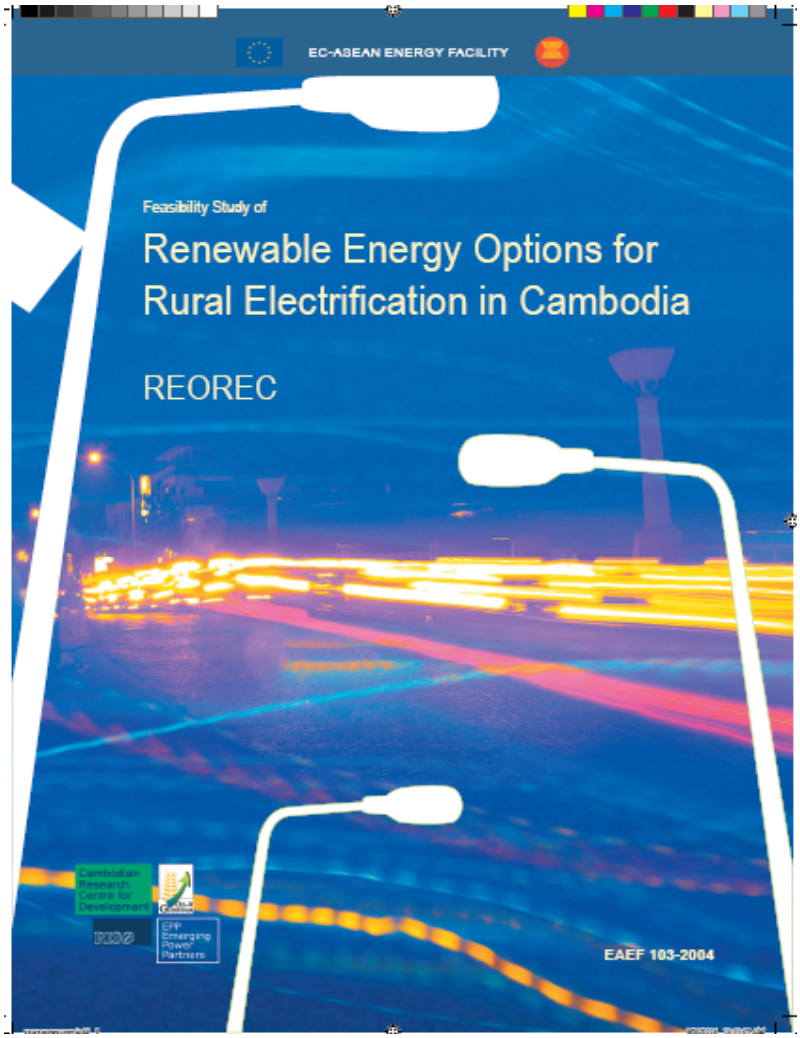

Figure 5. Investment brief for the projects

Outputs: Feasibility Studies, Pricing Options for RE-based Electricity Generation, Investment Briefs

Annex 4: Feasibility Study of a 100 kW Rice Husk-Fired System in Thma Koul District, Battambang Province.
Annex 5: Feasibility Study of A 200 kW Corn Cobs-Fired Gasification System in Malai District, Banteay Meanchey Province.
Annex 6: Feasibility Study of a 1 MW Rice Husk-Fired Power Generation Plant in Battambang Province.
Annex 7: Feasibility Study of a Methane-Fired Power Generation Plant in Kien Svay District, Kandal Province.
Annex 8: Report on Pricing Options for RE-based Electricity Generation.
Annex 9: Investment Brief for All Projects.

8. TASK 5: PROJECT ANNOUNCEMENT FOR PRIVATE SECTOR PARTICIPATION

Objectives:

- To provide recommendations on policy and incentives for the promotion of renewable energy in line with the ongoing formulation of Cambodia's national rural electrification plan and national renewable energy master plan.
- To generate a pipeline of renewable energy projects which could be facilitated for private financing by local, ASEAN and European investors.

8.1 Task 5.1: Workshop and Consultative Meetings

- **First Consultative Meeting.** The first consultative meeting on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia was held on 03 July 2006, at Teo Hotel, Battambang City. The meeting aimed to present the results of feasibility studies to representatives of the selected clusters, namely feasibility study of a 200 kW corn cob-fired gasification system in Malai District, Banteay Meanchey Province, and feasibility study of a 100 kW rice husk-fired system and 1 MW rice husk-fired power generation plant in Battambang Province. The meeting also discussed potential electricity supply options for these clusters. Over 30 participants from concerned government agencies, local authority and the private sector participated in the meeting.

- **Second Consultative Meeting.** The second consultative meeting on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia was organized on 05 July 2006 in Phnom Penh. The meeting aimed to present the results of the feasibility study of a methane-fired power generation plant in Kien Svay District, Kandal Province to concerned stakeholders. The meeting also discussed potential electricity supply options for the selected cluster, the likely structure and operations of the rural energy enterprise and the costs of various levels of service, as well as the requirements for local government participation, particularly for financing the local mini-grid portion.

- **Regional Dissemination Workshop on Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia.** This workshop aimed to present the outputs of the activities of the project to the relevant stakeholders including the members of the RE-SSN, project developers, investors, bankers, equipment suppliers and other stakeholders. The specific objectives of the workshops were: to increase awareness on the renewable energy resources and their potential for rural electrification in Cambodia; to understand the barriers and opportunities for using renewable energy for rural electrification in Cambodia; to understand the roles of concerned stakeholders in implementing renewable energy projects for rural electrification in Cambodia; and to discuss strategy for promoting renewable energy for rural electrification in Cambodia.

8.2 Task 5.2: Presentation of Projects to Potential Investors

The presentation of the projects to potential investors was conducted in conjunction with the consultative meetings and regional dissemination workshop. Currently, the investment brief is being distributed by all partners to potential local, ASEAN and European investors.

8.3 Task 5.3: Site Visits and Study Tours

- **Field Visit to a Methane-Fired Power Plant in the Philippines.** This field visit was organised following the completion of feasibility studies on renewable energy options for rural electrification in Cambodia, one of which is methane capture from a piggery in Samrong Thom Village, Kien Svay District, Kandal Province. This field visit to a methane-fired power plant in the Philippines provided an excellent opportunity for the Cambodian participants, especially for the selected piggery owners, to get exposure to methane recovery practises using covered lagoon digesters. The participants

have been familiarised with a technically proven methane capture technology from piggeries; they have gained first hand experience on the construction and operation of the system, which can be adapted for use in Cambodia. However, the investment cost of the system seems to be high for an average Cambodian piggery. Therefore, if the technology is to be selected for application in Cambodia, there is a need to explore a variety of funding sources to make proposed projects feasible.

- **Field Visit to Chia Meng Rice Husk Cogeneration and 100 KW Gasifier Pilot Project at Suranaree University of Technology, Thailand.** This field visit was organised following the completion of the feasibility studies on renewable energy options for rural electrification in Cambodia,. These field visits provided opportunities for the Cambodian participants, including the selected rice miller and the corn silo owner to get exposure to renewable energy technologies for electricity and heat generation. Participants have gained first hand experience on the construction and operation of these systems, which can be adapted for use in Cambodia.

Outputs: Proceedings of the workshop and consultative meetings; Roadshow materials

Annex 10: Workshop proceedings
Annex 11: Minutes of meeting – Battambang
Annex 12: Minutes of meeting – Phnom Penh
Annex 13: Site visit report – Philippines
Annex 14: Site visit report – Thailand

9. PROJECT MANAGEMENT

The following table shows the personnel involved in the project:

Table 7. Personnel involved in the project

CRCD Telephone:(855-12) 915-351 Fax: (855-23) 218-370		
Name	Designation	E-mail
Dr. Tin Ponlok	Project Coordinator & RE Policy Specialist	etap@online.com.kh
Dr. Thanakvaro De Lopez	Rural Development/EIA Specialist	tdl@camdev.org
Mr. Andrew Williamson	Rural Development Specialist	wil@mobitel.com.kh
Mr. Romel M. Carlos	Project Dev't & Financial Advisor	romel.carlos@cogen3.net
Mr. Alan Dale Gonzales	Senior Business Advisor 1	alandale.gonzales@cogen3.net
Ms. Marisa Nidhiprabha	Senior Business Advisor 2	dblanco@loxinfo.co.th
Mr. Vazzan Tirangkura	RE Technology Specialist 1	vazzan.tirangkura@cogen3.net
Mr. Parinya Limthongsakul	RE Technology Specialist 2	parinya.limthongsakul@cogen3.net
RISØ Telephone: +45 4677 5170 Fax: +45 4632 1999		
Name	Designation	E-mail
Dr. Romeo Pacudan	Senior Energy Economist	romeo.pacudan@risoe.dk
Mr. Henrik Jacobsen	Senior Energy Economist	
CRA-W Telephone: +32 (0)81 627 153 Fax : +32 (0)81 615 847		
Name	Designation	E-mail
Dr. Yves Schenkel	Senior Technical Advisor	schenkel@cra.wallonie.be
Mr. Romain Crehay	Senior RE Policy Expert	crehay@cra.wallonie.be

EPP Telephone: +358 9 469 1201 Fax: +358 9 469 1207		
Name	Designation	E-mail
Mr. Herkko Lehdonvirta	Senior Business Advisor	herkko.lehdonvirta@pemfund.com

Dr. Romeo Pacudan resigned from his position as Senior Energy Economist of RISØ National Laboratory effective 01 March 2006. CRCD has proposed that RISØ remain in the REOROC consortium by nominating a replacement of Dr. Romeo Pacudan to complete the tasks assigned to it. Subsequently, RISØ replaced Dr. Romeo Pacudan with Mr. Henrik Jacobsen to conduct Task 4.4.

Tasks 1, 2 and 3 were completed during Year 1 of the project while some activities for Tasks 4 and 5 were completed during Year 2.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Summary of Findings and Achievements

- The project has demonstrated that Cambodia has significant renewable energy resources, including biomass in the form of agricultural residues and potential energy crops. The main residues from the processing of rice, maize, cassava and piggeries have been mapped by the project, and are now available from the worldwide web along with details of the larger processing sites in Cambodia.
- The project has compiled and summarised in the form of maps the results of previous renewable resource assessment (solar, hydro, wind), plus a series of geographical data relevant for the identification of viable rural electrification sites (national electricity grid, population, road network, river network, etc.). This geographical database will prove an invaluable tool for renewable energy developers.
- The renewable energy resources of Cambodia remain to date largely untapped. Yet, the sustainable development of the country cannot rely on the importation of fossil fuels alone. While increasing oil prices make renewable energy a more financially attractive alternative, a number of barriers and constraints still prevail: limited information and low levels of awareness on rural electrification options and renewable energy technologies, lack of trained personnel, small fragmented markets, inadapted financial institutions, unfavourable investment climate, preference for the development of a national grid over decentralised systems.
- The project has completed four feasibility studies and investment briefs for four specific renewable energy sites for rural electrification: a gasification system using rice husk, a gasification system using corn cobs, a direct combustion facility using rice husk, and an anaerobic digester of swine slurry. These four studies range from 100 kWe to 1 MWe of installed capacity and present the following common benefits: environmentally friendly and commercially proven technology; local sustainable development benefits in terms of rural economic development, transfer of technology and improved quality of the environment; attractive financial rates of return; support of local authorities and communities; and enthusiastic interest of the site owners.

10.2 Recommendations for Next Steps

- All technical and research reports, geographical database and feasibility studies produced by the project are accessible for free download from the Internet. These outputs need to be further disseminated to a greater number of stakeholders and in a more diverse fora, so that they may be used by international organisations and project developers. For instance, Japan's Institute for Global Environmental Strategies is financing the development of a Project Design Document for the Clean Development Mechanism, based on one of the feasibility studies. At this stage, the feasibility studies await potential investors, although some of the owners may proceed ahead with internal financing. International partnerships with foreign investors would likely bring additional expertise and capital to the successful implementation of the projects. The next steps is for project partners, with the support of government and the EC-ASEAN Energy Facility to further disseminate the investment briefs and feasibility studies among potential investors.

- The main focus of the Royal Government of Cambodia's present energy policy is to provide energy services and improve the living conditions of the rural population. In line with this objective, the implementation of a framework more favourable for countrywide renewable energy development is imperative. There is yet no specific policy devoted to the development of renewable energies in Cambodia. Various options can be explored by the Cambodian government to reduce the cost of generating power from renewable energies by targeting the costs of investments, the price of electricity, the operating costs, or a combination of the three. Thus, subsidies for renewable energies may be financed by a variety of instruments (direct capital subsidies, soft loans, VAT and import duty exemption, tax holidays etc.)