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"Renewable Energy Resource Maps of Cambodia and Clusters/Market Packages for Feasibility Studies"

TASK 2

RENEWABLE ENERGY ASSESSMENT AND CLUSTER IDENTIFICATION REPORT

December 2005

Phnom Penh, Cambodia

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1. INTRODUCTION

Implementing renewable energy projects are cost-effective at current energy and technology costs in developing countries using off-the-shelf commercial rural energy technologies. Such technical-economic opportunities are defined by their technical characteristics for reducing energy consumption and by indicators of their cost-effectiveness. Moreover, several technologies already have become cost-competitive with fossil-fuel-based technologies in many applications, or would become competitive if implementation costs could be lowered through practical experience and commercialisation in the marketplace.

Cambodia has an abundant supply of renewable energy resources, however barriers exist that prevent significant utilisation of these resources. Several foreign-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:

a) proximity to suitable power loads,
b) existing and planned power infrastructure, or
c) environmentally sensitive areas.

The specific objectives of Task 2 of the REOREC project were 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.
- identify three clusters of villages where a renewable energy based rural electrification project may be possible, and which would be the subject of feasibility studies under Task 3 of this project.

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. The procedures used and resulting outputs are described in the following sections.

2. RENEWABLE ENERGY RESOURCE MAPS OF CAMBODIA

Objectives of the Renewable Energy Resource Maps

The key objectives for producing these maps were as follows:

a) 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;

b) To consolidate the output of any relevant previous studies regarding renewable energy assessments in Cambodia;

c) To generate primary resource data where appropriate to fill any significant gaps in the existing studies;

d) To combine the renewable energy resource data with other relevant rural electrification data (eg: village locations, power infrastructure, exclusion zones etc) to make more useful maps; and

e) 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 include:

- 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.

Desk Study of Existing Assessments

CRCD conducted a desk study of existing renewable energy resource assessments for Cambodia and the region. The following studies were used as key sources for each of the relevant energy types:

Biomass Energy

- Verwoerd, F. 2001, *Energy from Biomass in Cambodia*, A thesis for the Masters of Science program at Asian Institute of Development, School of Environment, Resources and Development, Thailand
- Tin, P., De Lopez, T.T., Sau, S., Hing, K. & Jude, M. 2003 *Survey of Rice Mills in Siem Reap, Banteay Meanchey and Battambang Provinces*, Cambodian Research Centre for Development, Phnom Penh.
- Williamson, A., De Lopez, T.T., Tin, P. & McIntosh B., 2004, *Sustainable Energy in Cambodia: Status and Assessment of the Potential for Clean Development Mechanism Projects,* IGES
- MacNaughton, A. 2004, *Unpublished field notes on Cassava, Noodle Processing and other Enterprises*

Micro Hydropower

- Nippon Koei Co Ltd and KRI International Corp (Tokyo), July 2005, *The Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia* ;Japanese International Cooperation Agency (JICA),
- Chao Praya Engineering Consortium 1995, *Review and Assessment of Water Resources for Hydropower and Identification of Priority Projects*, Chao Praya Engineering Consortium, Vienna.
- Mekong Secretariat 1971, *Inventory of Promising Tributary Projects in the Lower Mekong Basin – Khmer Republic*, Mekong Secretariat, Bangkok.
- Meritec Ltd, 2003, *Pre-Investment Study of Community-Scale Hydro Projects, Cambodia*, Meritec Ltd for the New Zealand Ministry of Foreign Affairs and Trade, Auckland.

Wind Energy

- Truewind Solutions LLC 2001, *Wind Energy Resource Atlas of South East Asia*, World Bank, Washington D.C.
- Three E 2003, *Sihanoukville, Wind Measuring Campaign, Intermediate Report 2*, Three E, Phnom Penh.

Solar Energy

- National Aeronautics and Space Administration (NASA – USA) *Surface Meteorology and Solar Energy (Release 5.1)*, as found at http://eosweb.larc.nasa.gov/sse/ ; October 2005.

- New Energy and Industrial Technology Development Organization (NEDO) 2002, *Assistance Project for the Establishment of an Energy Master Plan for the Kingdom of Cambodia*, New Energy and Industrial Technology Development Organization, Tokyo.

Field Surveys for Missing Primary Data

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.

Some potentially significant biomass resources were therefore excluded from this study as they are not directly relevant for rural electrification, but may still be viable energy source worthy of further study in Cambodia. Notable examples are municipal solid wastes, sewerage treatment plants, and various industrial wet wastes located in close proximity to Phnom Penh and Sihanoukville.

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 in Cambodia, and availability of residues in Cambodia:

a) **Rice processing** – after milling, the rice husk can be use in a small 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);

b) **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;

c) **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;

d) **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.

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.

Focus regions were identified for each of the targeted agricultural residue types, as follows:

- Rice – north west region, around Battambang
- Maize ('red corn') – Thai border area from Poipet to Pailin;
- Cassava ('tapioca') – Memot district in Kompong Cham, plus one large site in Kompong Speu;
- Piggeries – Kompong Speu, Takeo and Kandal.

A dedicated survey team was sent to each region to collect basic site data. The five main parts to the surveys are described below and the full questionnaires are provided in Annex 1:

a) Provincial Department Interview + Investigation
    - relevant local activity and sites;
    - production figures;
    - longer term trends; and

- other possible sources of data in the area.

b) Crop and Livestock Production Site Survey
   - GPS location reading;
   - crop production or livestock numbers;
   - residue/waste production quantities; and
   - residue/waste types, qualities, seasonal availability and market value.

c) Processing Site Survey
   - GPS location reading;
   - production volumes and capacity;
   - residue/waste production quantities; and
   - residue/waste types, qualities, seasonal availability and market value.

d) Transportation Costs Survey
   - suitable local transport methods for biomass sources;
   - estimates of transport cost estimates (per km and type); and
   - estimate of total transport capacities and seasonality.

e) Electrical Demand Survey
   - Identify any existing Rural Electricity Entrepreneurs (REEs);
   - Estimate REEs basic load and latent demand in area; and
   - Identify and estimate other potential electrical loads in area.

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 are of biomass energy where many technologies and processes are in various stages of commercialisation.

Field Survey Results

The general findings of the field surveys are briefly describe below, and summarised in spreadsheets provided at Annex 2. The survey teams collected a range of data additional to that required by the questionnaires. Some of this is particularly relevant for the project, and suggests the need for further more comprehensive surveys to be conducted in the area of potential biomass resources in Cambodia.

Piggeries

The survey team used industry data from the Ministry of Agriculture, Forestry and Fisheries in order to identify piggeries with more than about 1000 pigs. A total of six piggery sites were surveyed, with average population that ranged from 600 to 1000 head of pigs.

All piggeries surveyed use the same basic effluent disposal process, that involved drainage to a series of between 1 and 10 open lagoons. In addition to diesel fuel for electricity, some of the businesses used coal (imported from Vietnam) for on-site feed preparation where soy beans must be cooked. One piggery also used coal in simple small braziers for heating the piglets at night time (the same site also used a solar PV panel for charging a battery on site).

Rice Mills

A cluster of 8 rice mills were surveyed near Battambang, and were chosen in order to complement the existing data collected by the COGEN3 project in 2003. They were relatively large mills, with hourly

production capacities from 700 kg up to 4000 kg. Five of the mills reported using some (between 10% and 60%) of the rice husk for activities (either cooking fuel or selling to brick kilns). All mills were belt-driven by a diesel engine (ie: no electric drives) and all had small gen-sets on site, used mainly for lighting, except one that was supplied by a local REE.

Corn Farms

Corn is increasingly popular in the North West of Cambodia, and the official figures of production seem not to have kept pace with actual developments. Most of the crops used are 'red corn' that is dried and used for animal feed. The conditions for farmers has improved in the last 3 years since 5 processing sites have been established in Cambodia. This has meant that farmers can generally obtain greater value for their whole corn fruit at the farm gate. Often whole corn fruit is delivered to the processing site (either by the farmer, or a trader).

However in some areas (especially Malais District) small traders and some farmers have bought their own corn threshing machine and offer the service of threshing the corn grains at the farmer gate so they can sell just the grains, for a premium, to the processor. This trend has important implications on the viability of using the corn cobs for power generation, because of the transport costs and logistics involved in collecting small amounts of corn cobs from a large number of farms.

Corn-drying Silos

A total of 5 large corn-drying silos were found in Cambodia (4 currently operating and one large new site under construction and nearing completion at Pailin). Various smaller grain drying operations also exist, ranging from household-level dryers up to small scale commercial grain dryers that use a basic fan-forced coal-fired drying bed in a batch operation.

Tapioca Starch Factories

Two large commercial factories are currently operating in Cambodia: one in Memot district of Kompong Cham province, owned by a Cambodian company, and another in Phnom Sruoch district of Kompong Speu province which is owned by a large Korean company. A third factory is operating in Ponhea Kreak District of Kompong Cham (close to Memot) but has only about one tenth of the capacity of the larger factories. One new factory is currently under construction in the same area, near the town of Stung on National Highway 7. This apparently has Vietnamese and Cambodian investors and will have a similar capacity to the two other large sites.

Cashew Processing

One cashew processing site is operating close to Kompong Cham town. This site produces a significant quantity of cashew shells and currently uses some of these to fire a small steam boiler producing low grade process steam. Excess shells have been stockpiled at the site for some years with the intention of using them for power generation in the future.

Kapok Processing

Throughout Cambodia hundreds of small businesses can be found that trade and process seed pods from the Kapok tree *(sp. Ceiba Pentandra,* or "Krop Kohwe" in Khmer*).* The seed pods contain cotton fibres that are widely used to fill cushions and mattresses. The pods also contain small seeds with a high (around 20% by weight) oil content that are used for stock and fish feed. The empty seed pods are either discarded or used as cooking fuel. Whole seed pods and the processed fibres and seeds are exported to Vietnam, but no data could be found on the quantities or nature of this trade. This Kapok trade presents an attractive biomass energy source because the oil from the seeds can be used as a diesel fuel substitute in some types of engines, and the empty seed pods may be used in a furnace or biomass gasifier. Further study is required on the nature of the industry, especially the locations, quantities and existing values and uses of the various Kapok products.

Palm Oil Processing

There is one large palm oil plantation and processing factory in Cambodia, located at Prek Nil in Kompong Soam province. The process produces a number of waste streams with high energy content and good potential for utilization with a range of technologies. The main waste streams are liquid effluent (17%), dry fibre (11%), shells (5.5%) and sludge (5%). The process requires a significant supply of steam, and a new

boiler has been installed that can be fired with the waste shells. Currently the effluent streams are stored in a series of large open lagoons adjacent to the factory.

Rubber Factories

Rubber has been one of Cambodia's main export industries for a long time, and at least back to the French colonial days. Today there are significant private and government owned plantations and processing sites, mostly in Kompong Cham province. The survey teams did not focus on these sites, and so accurate details on the number, size and locations are not possible. However discussions with a manager at one site revealed that the process produces a significant effluent stream that is currently stored in large open lagoons. Experience from other countries, such as Vietnam, suggests that this effluent can be a valuable energy source to substitute for some of the significant energy costs of the process.

Renewable Energy Resource Maps of Cambodia

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 are described below, and the complete set of maps can be found at Annex 6. Electronic versions of the maps are available for free download from the CRCD website – **www.camdev.org**,

Map Components and Layers	Data Sources [1]	Notes
Base Layers for all Maps		
▪ National Borders	Department of Geography, 2005	
▪ Provincial Borders	Department of Geography, 2005	
▪ Provincial Capital Towns and Province Names	Department of Geography, 2005	
▪ Major Rivers and Tonle Sap Lake	JICA 2002	
Map 01 Cambodian Population Density		
▪ Village locations	Village Gazette 1998	Village point data is not always geographically accurate due to survey issues, plus difficulties in defining the geographic centre of villages that often stretch along roads and merge with other villages.
▪ Population Density by Commune	Commune Database 2004	Missing data in 5 small areas.
Map 02 Roads and Protected Areas		
▪ Major and Secondary Roads	JICA / MPWT 2002	

[1] See References section for full source details

Map Components and Layers	Data Sources [1]	Notes
▪ Land-mined Areas	L1 Survey Data	
▪ Protected Areas	Ministry of Environment, Protected Areas Office; and Ministry of Fisheries, Forestry and Agriculture	This layer indicates the areas protected under various classifications of the Ministry of Environment (MOE). Special considerations must be made before planning rural electrification projects in these areas – contact MOE and relevant partner organisations for details.
Map 03 Power Grid Plans		
▪ Power Grid Plans	EDC 2004, MIME 2004	This data was digitised from a diagram provided by EDC's Planning, MIS and Tariff Office and presentations by MIME's Department of Planning. Locations of infrastructure are not geographically accurate (in some cases the precise routes have not yet been planned), and dates of planned projects are not provided.
▪ Private Cross-Border Imports	EAC 2004 *(listed in Annual Report)*	Digitised from list of EAC licensees so the point does not accurately mark the actual point of import, but rather coincides with the centre of the town or village cited as the import location in the EAC records.
Map 04 Biomass – Land Use and Selected Sources of Agricultural Residues		
▪ Land Use	JICA 2002	
▪ Sample of Rice Mills in South East	AQIP 2005	These rice mill locations are not accurate as the points have been taken as the centre of the village that is recorded as the address of the business.
▪ Sample of Rice Mills in North West	Cogen3 2003 REOREC Field Surveys 2005	This layer combines the sites surveyed as part of the Cogen 3 study in 2003, plus the REOREC field surveys in 2005. The locations were recorded using a GPS so are reasonably accurate.
▪ All other sites	REOREC Field Surveys 2005	This layer contains the rest of the sites visited as part of the REOREC field surveys, 2005.
Map 05 Biomass Energy Crops – Soil Fertility		
▪ Soil Fertility	FA/CTSP 2003	This data is a simplified representation of a series of complex physical and chemical classifications of soil types. Further details on how this data was derived can be found on page 30 of FA/CTSP 2003.
Map 06 Biomass Energy Crops – Dry Periods		

Map Components and Layers	Data Sources [1]	Notes
▪ Dry Periods	FA/CTSP 2003	This data is derived from annual rainfall distribution data across Cambodia and neighbouring regions, and is intended to indicate areas that experience 'water stress' or extended dry periods (set at an arbitrary 4 months) that otherwise may not be clearly indicated by data of average annual rainfall. See pages 23-4 of FA/CTSP 2003 for further details.
Map 07 Micro Hydro – Topography		
▪ Potential Micro Hydro Sites	Nippon Koei 2005	These sites are listed in JICA's recent report from the Master Plan Study and indicate sites that have been surveyed by members of the JICA study team, (as distinct from sites identified by desk studies). Details of the sites are available in NIPPON KOEI 2005.
▪ Digital Elevation Model	JICA 2002	
▪ Minor Rivers	JICA 2002	
Map 08 Micro Hydro – Rainfall		
▪ Rainfall	FAO 2004	
▪ Potential Micro Hydro Sites	Nippon Koei 2005	*See description for Map 07*
Map 09 Wind Energy		

Map Components and Layers	Data Sources [1]	Notes
▪ Annual Average Wind Speeds at 30m above ground	World Bank 2002	This data was generated for the World Bank 2002 by a sophisticated simulation model based on a number of actual meteorological, topographic and physical data. The output of the model was a time series of simulated wind speeds for a full year, at 1km resolution across the entire South East Asia region at both 30m and 65m above ground level. The data presented in this map is a rendered interpolation of the average annual wind speeds across Cambodia simulated at 30m above ground level. Some important notes: 1. This data is valuable for assessing regional potential, comparing different regions, and identifying high potential sites for further investigation, however any significant wind energy project will require actual on-site measurements and long term correlation; 2. The resolution of the model is 1km, which means that the effects of features smaller than this, such as small hills or ridges, are not reflected in the map. Thus this map should only be used to estimate the 'background wind energy potential' for a particular area (up to 1sq.km), and then actual wind measurements should be used for more detailed calculations for particular locations. 3. Six Wind Rose Charts are presented on the map to provide an indication of the direction of the wind, which is an essential factor in designing a wind energy project. More details on the simulation model, and additional data outputs can be found at World Bank 2002.
Map 10 Solar Energy		
▪ Average Insolation	NASA 2005	This layer was created by taking NASA's low resolution insolation data and interpolating across Cambodia. This coarse interpolation did not consider possible effects of meteorological zones or specific topographic features, however this was judged to be inconsequential due to the small insolation variance across the country. In general: most areas of the country have very good solar resources. However despite the high annual average, the long periods of cloudy days during monsoon season presents a significant design challenge for photovoltaic systems, requiring additional storage capacity. Solar thermal systems will generally be less affected due to the high ambient temperatures throughout the year.

3. CLUSTER/MARKET PACKAGES FOR FEASIBILITY STUDIES

Methodology for cluster identification, selection 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 this 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 (eg: JICA's Master Plan Study).

The following basic selection criteria was 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 this REOREC project.

Criteria	Comments
Agreement of Electricity Authority of Cambodia (EAC)	At this early 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 40km 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 was 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 (eg: 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 dev't 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 was 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.

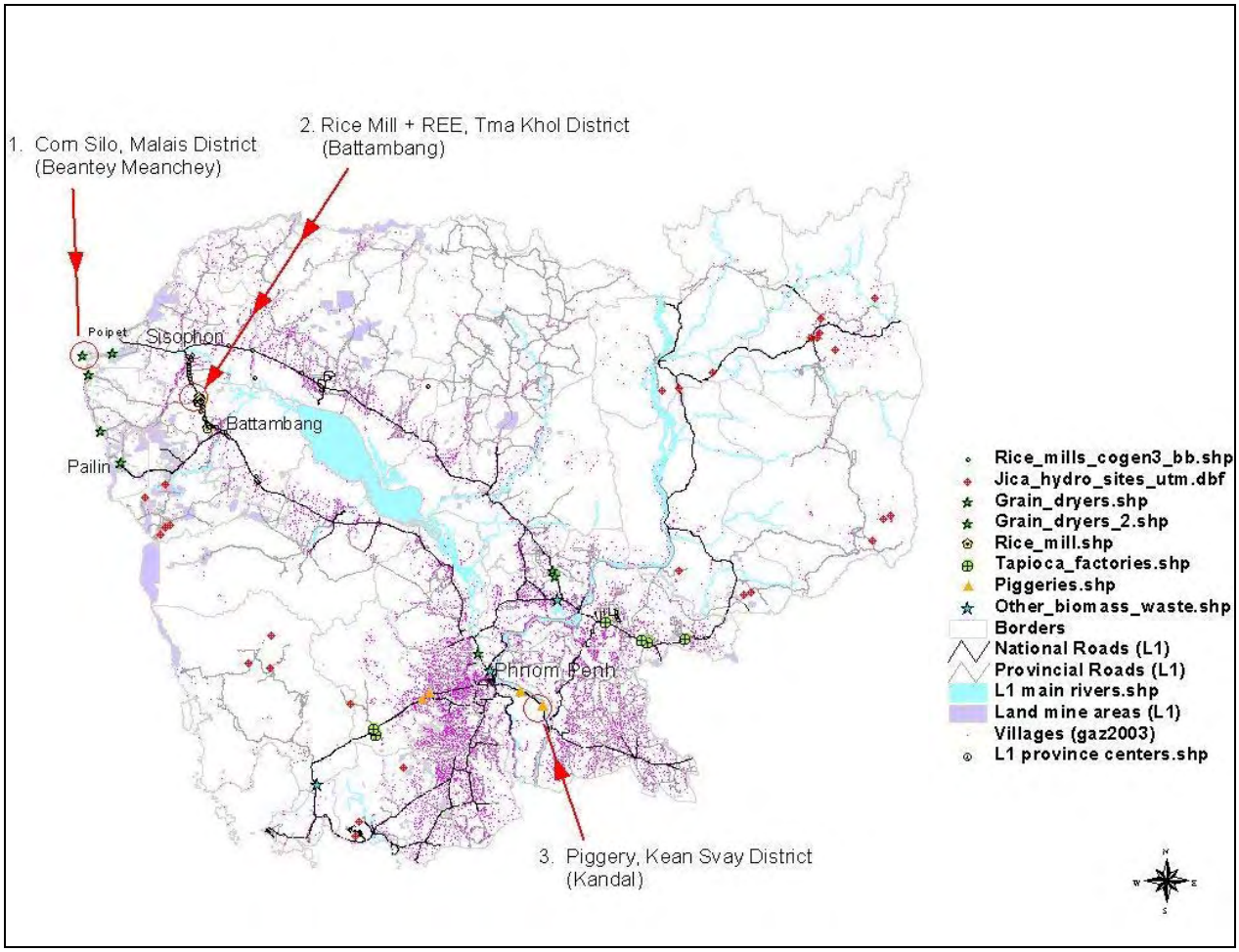
The above selection criteria was applied to all the potential sources of agricultural residues identified in the initial field surveys (see previous section). The following sites were prioritised as the most promising and suitable for further investigation under REOREC, as indicated on the map in Figure 1:

A. **Corn Drying Silo at Malais District, Beantey Meanchey Province** - with a cluster of 4 villages with almost 600 households, and including an REE business that just recently ceased operation due to the rising price of diesel fuel. There is potential for a small gasifier using waste corn cobs and providing excess power to local village (in which the local REE closed-down 2 months ago due to high diesel prices).

B. **REE and Rice Mill (co-located) at Tma Kohl District, Battambang Province** - with a cluster of 12 villages with just under 4000 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 1000 customers.

C. **Piggery at Kean Svay District, Kandal Province** - surrounded by almost 1000 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 1: Location of prioritised project areas



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 simple memorandum of understanding was seen as an essential step in order to establish the commitment and trust of the site owners. The agreement is displayed here at Annex 4.

Detailed site surveys were designed for each of the three sites, with the objectives listed in Table 1 below. A summary of the survey results is provided at Annex 3, but all commercially sensitive data has not been published here in compliance with the terms of the MOU with site owners.

Table 1: Objectives of detailed site surveys

Site 1: Corn Silo at Malais	
A. Biomass Supply	▪ confirm details of corn cob volumes, seasonality, ▪ market variability, supply variability, quality/moisture etc, ▪ alternative uses, alternative suppliers, ▪ transport costs from other silos etc

B. On-site Heat Demand	▪ confirm details of current furnace design, ▪ fuel consumption, drying capacity and volumes, ▪ variability, possible efficiency improvements etc
C. On-site Power Demand	▪ confirm details of existing generator capacities, ▪ load patterns, fuel consumption, maintenance costs etc
D. Possible External Heat/Power Loads	▪ none so far identified, but double-check including potential sale to local power distributor
E. Future Plans	▪ anything relevant potential changes
Site 2: Rice Mill+REE at Tma Kohl	
A. Biomass Supply	▪ confirm details of rice husk volumes, ▪ seasonality, market variability, supply variability, quality/moisture etc, ▪ alternative uses, alternative suppliers, ▪ transport costs from other mills, (including from the new mill they are planning to build within 100 metres)
B. On-site Power Demand	▪ confirm details of the mill's existing generator capacities, ▪ load patterns, fuel consumption, maintenance costs etc; ▪ (plus the planned demand from the new mill they are building by March 06)
C. REE Supply Load	▪ survey existing REE customer loads, record GPS locations, ▪ plus identify latent potential demand in area including other mills, ▪ take measurements of actual loads throughout day to produce load curve
D. On-site Heat Demand	▪ determine the energy required for potential paddy drying at this mill, ▪ plus at the new mill they are planning, plus at any other nearby mill
E. REE Distribution Network	▪ survey the existing REE mini-grid to inventorise and map with GPS the main components and specifications, ▪ plus measure the voltage drops and Power Factor through the grid
F. Future Plans	▪ any relevant potential changes
Site 3: Piggery at Kean Svay	
A. Biomass Supply	▪ confirm details of effluent volumes, water and biological content, variability, ▪ storage pond sizes and designs, water table level, ▪ disposal processes, current uses, possible other suppliers etc
B. On-site Power Demand	▪ confirm details of the piggeries existing generator capacities, ▪ load patterns, fuel consumption, maintenance costs, ▪ plus the potential for load-shifting if a part-time power export is desired
C. Possible REE Supply Load	▪ survey surrounding villages for potential customer loads,

	▪ determine existing power sources and price and suppliers, ▪ record GPS locations, determine willingness to pay, determine daily load patterns
D. On-site Heat Demand	▪ determine the heat loads required at the piggery including feed preparation and nursery heating
E. On-site Distribution Network	▪ survey the existing on-site mini-grid to inventorise and map with GPS the main components and specifications, ▪ plus measure the voltage drops and Power Factor through the grid
F. Future Plans	▪ any relevant potential changes

Results: clusters/market packages for feasibility studies

Summaries of each of the market cluster packages are provided below.

Cluster A: Phnom Ruong, Malais District, Beantey Meanchey Province

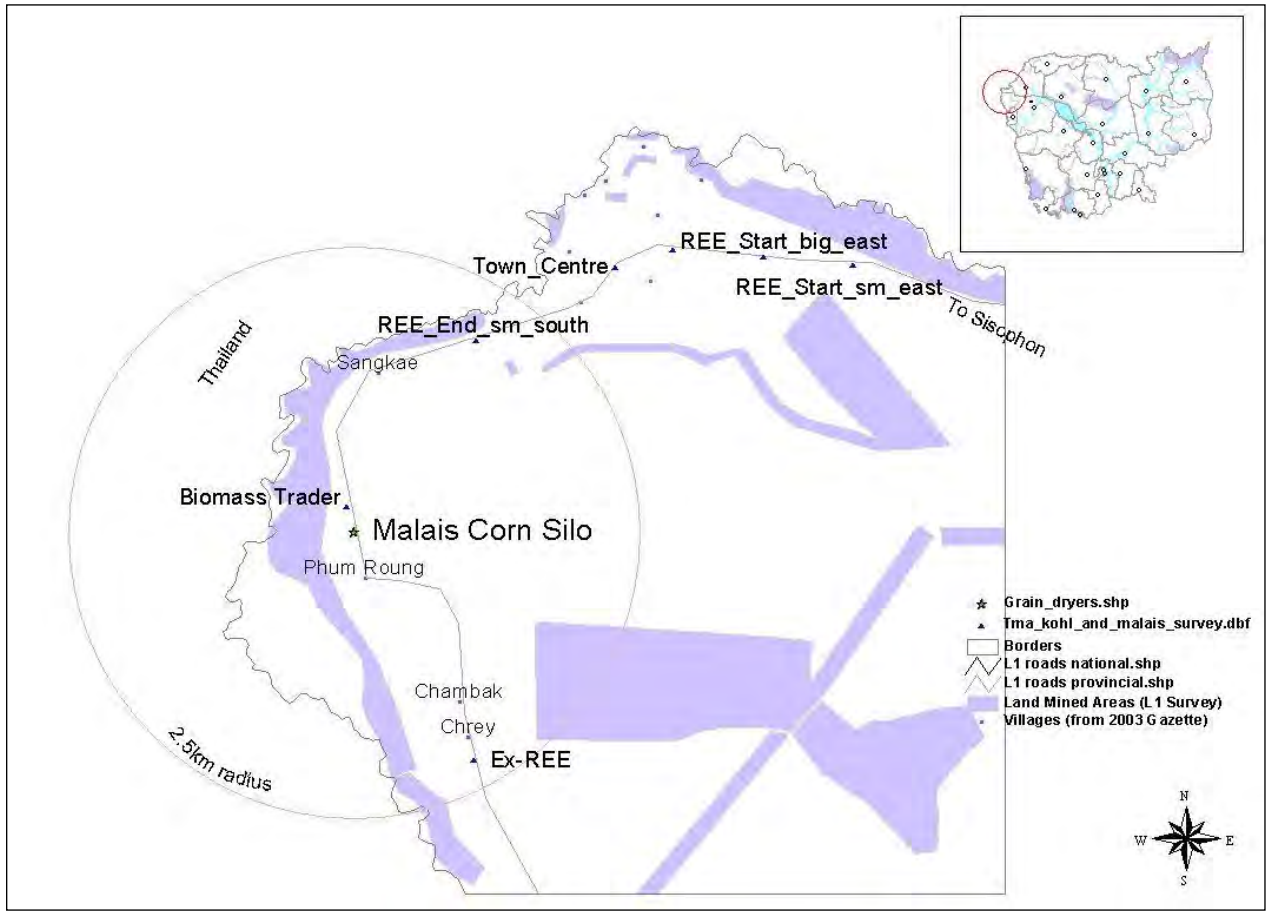


Table 2: Socio-eco Data on Village Cluster within 2.5km of Corn Silo (Source: SEILA Commune Database 2004)

Village Names	# of Families	# of People	% Female	% Under 18yrs	% of 6-14yrs go to School	% Pop over 15yrs + Illiterate	Total # Houses	% Houses with Thatch Roof	% Houses with Tiled Roof	% Houses with toilets	% Houses with Water	% Houses with a moto	% Houses with a TV	Travel time to Market (hours)
Sang Ke	162	840	47%	74%	96%	8%	146	36%	0%	10%	92%	25%	55%	5
Phnom Rung	105	472	50%	74%	90%	9%	102	44%	0%	28%	94%	27%	60%	15
Chrey	145	529	50%	84%	85%	28%	135	50%	0%	5%	93%	18%	15%	20
Chambak	180	882	55%	74%	97%	8%	180	44%	0%	8%	31%	31%	97%	18
Totals	**592**	2723												

Cluster B: REE and Rice Mill at Tma Kohl District, Battambang Province

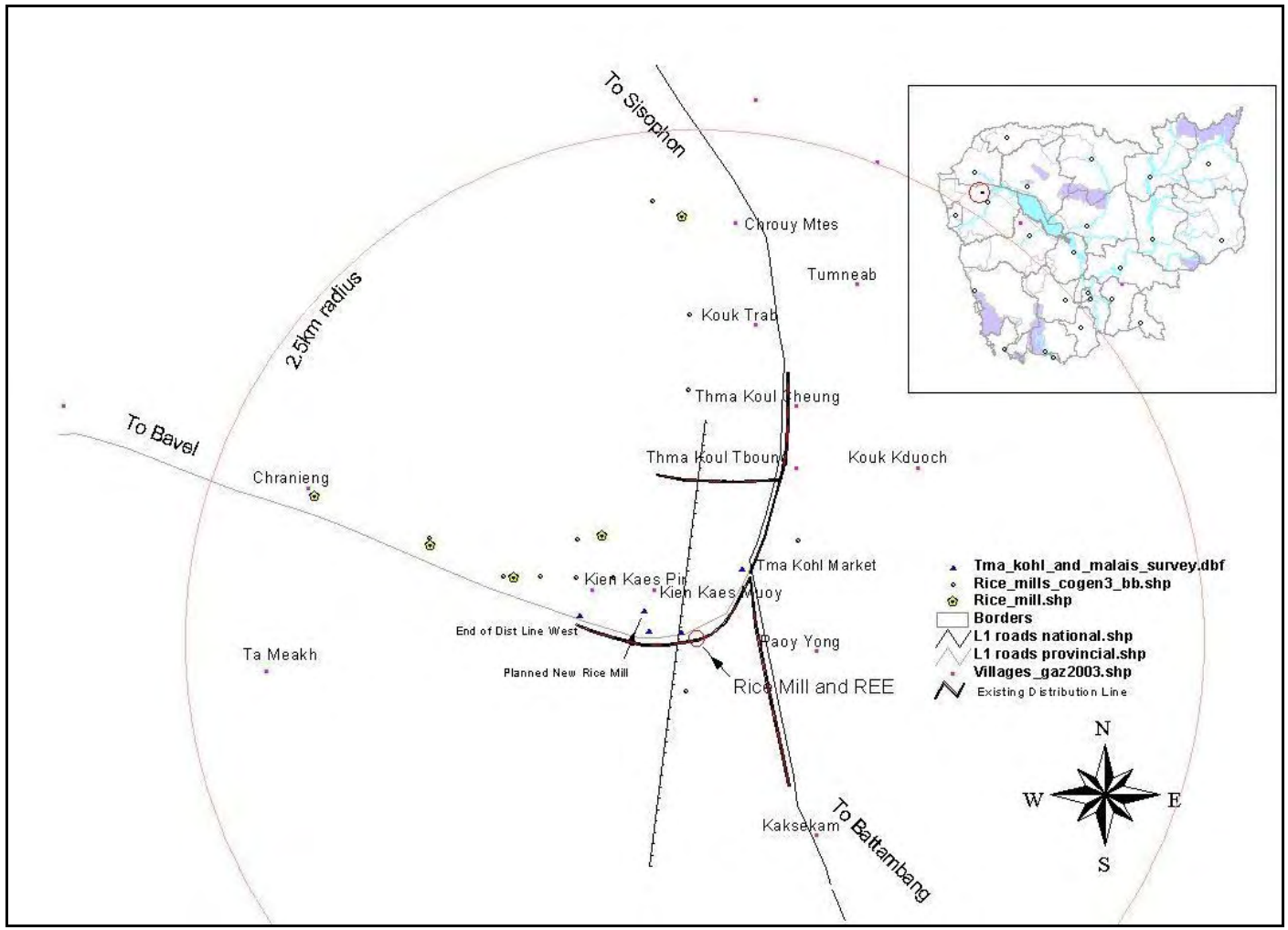


Table 3: Socio-eco Data on Village Cluster within 2.5km of REE (Source: SEILA Commune Database 2004)

Village Names	# of Families	# of People	% Female	% Under 18yrs	% of 6-14yrs go to School	% Pop over 15yrs + Illiterate	Total # Houses	% Houses with Thatch Roof	% Houses with Tiled Roof	% Houses with toilets	% Houses with Water	% Houses with a moto	% Houses with a TV	Travel time to Market (hours)
Thma Koul Tboung	300	1365	54%	37%	99%	10%	294	3%	2%	100%	87%	79%	101%	2
Paoy Yong	520	2491	50%	46%	87%	22%	487	3%	3%	31%	43%	21%	30%	1
Kaksekam	258	1284	52%	45%	95%	18%	217	26%	3%	47%	7%	35%	52%	2
Kouk Kduoch	518	2889	48%	48%	84%	9%	512	2%	1%	8%	17%	16%	39%	2
Thma Koul Cheung	323	1777	52%	35%	98%	2%	319	1%	2%	100%	24%	39%	75%	5
Kouk Trab	432	1991	51%	42%	98%	7%	415	2%	1%	42%	31%	32%	33%	0
Tumneab	95	472	53%	36%	95%	5%	84	4%	2%	83%	39%	69%	76%	1
Chrouy Mtes	246	1339	51%	37%	71%	10%	240	1%	1%	100%	1%	36%	90%	5
Kien Kaes Muoy	437	1915	46%	26%	41%	1%	399	18%	2%	61%	44%	14%	59%	10
Kien Kaes Pir	527	2685	52%	38%	84%	7%	493	18%	1%	21%	19%	28%	29%	15
Ta Meakh	248	1339	55%	47%	100%	11%	226	11%	0%	31%	4%	30%	42%	5
Chranieng	258	1481	43%	65%	70%	30%	258	58%	1%	49%	22%	21%	49%	15
Totals	**4162**	**21028**					**3,944**							

Cluster C: Piggery at Kean Svay District, Kandal Province

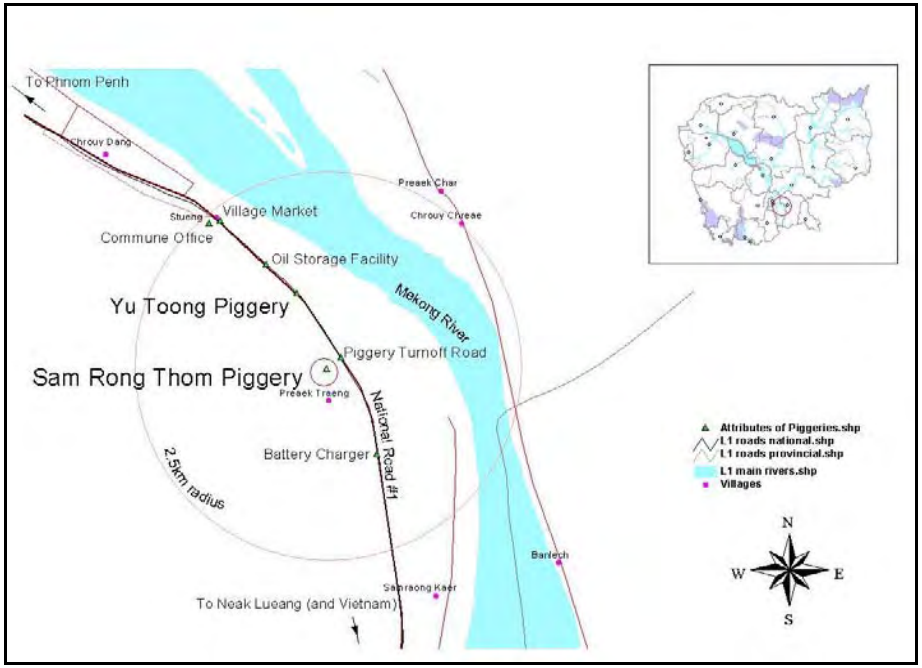


Table 4: Socio-eco Data on Village Cluster within 2.5km of Piggery (Source: SEILA Commune Database 2004)

Village Names	# of Families	# of People	% Female	% Under 18yrs	% of 6-14yrs go to School	% Pop over 15yrs + Illiterate	Total # Houses	% Houses with Thatch Roof	% Houses with Tiled Roof	% Houses with toilets	% Houses with Water	% Houses with a moto	% Houses with a TV	Travel time to Market (hours)
Stueng	583	2542	53%	72%	65%	26%	495	41%	7%	7%	114%	11%	40%	0
Preaek Traeng	519	2737	51%	57%	91%	9%	451	22%	9%	110%	107%	16%	94%	0
Totals	**1102**	**5279**					**946**							

4. CONCLUSIONS AND NEXT STEPS

This report has documented the main outputs of Task 2 of the REOREC project as being a set of Renewable Energy Resource Maps for Cambodia, and the identification of three village clusters with good potential for a rural electrification project based on existing renewable energy resources.

The Renewable Energy Resource Maps should prove to be a valuable tool for rural electrification planners, developers, suppliers and consumers in Cambodia, because of the following key features:

- The maps consolidate a range of data sets from over 20 sources within Cambodia and abroad;
- New data is presented with respect to sites of agricultural residues;
- The map layers, themes and formats are designed specifically for the purposes of rural electrification; and
- The maps will be available free in graphic format, as well as a GIS database viewer that allows manipulation, querying and customizing by the user.

These maps helped to identify the three village clusters selected for further study into the feasibility of rural electrification projects:

A. A corn processing facility on the Thai border with a cluster of 4 villages with almost 600 households, and including an REE business that just recently ceased operation due to the rising price of diesel fuel;
B. A rice mill between Battambang and Sisophon with a cluster of 12 villages with just under 4000 households, and the owner currently operates an REE but supplies only about 800 households due to limited capacity and high fuel prices;
C. A piggery south east of Phnom Penh, on the highway to Vietnam, surrounded by almost 1000 households with no electricity service.

As described previously in this report, sources of agricultural residues were selected for each of the three sites. This source of renewable energy was purposefully chosen as being representative of other good opportunities in Cambodia, and sufficiently unique from other research work that has been done before or is currently underway. There are significant potential benefits from basing rural electrification activities at existing agricultural businesses. For example these entrepreneurs are more likely to have the necessary capital, connections and expertise to establish a successful new business. Also, in the case of agricultural residues, it is generally more feasible to site the generator where the residues are being produced, so as to avoid collection and transport costs. However the possible drawbacks of this approach is that the operator's core business is usually not electricity provision, and therefore it is possible that customers could receive low quality service in the event that the power needs of the core business are a higher priority.

It is important to note that each of these sites will present particular challenges with respect to developing a feasible project. Among these are the lack of significant daytime base-loads, or the lack of sufficient biomass supply for economies of scale. Consequently the feasibility studies in the net phase of this project may consider a range of scenarios, before choosing one for more detailed analysis. This approach is important in order to balance the different requirements of our project scope, the owner's desires, and the physical reality at each site.

One significant discovery during the field surveys to the corn silos near the Thai border was a new local business that is collecting various waste biomass sources and selling them to power plants in Thailand. The owner claimed he was currently selling about 240 Tonnes per week of rice husk, which he collects in big double-trailer trucks from as far as 100km (on terrible roads). He has already traded a small quantity of corn cobs and is planning to start compressing and selling rice straw and hay. He also plans to collect sawdust from wood mills in Kompong Cham province (over 400km away).

This appears to be a significant and thus far unreported development in Cambodia's energy market, and is an important consideration for two of the feasibility studies here. This discovery highlights the need to assume rising prices for biomass energy sources, even if some may be considered 'waste' today. The feasibility studies in the next task of this project will consider the sensitivity of the project feasibility to the likely changes in biomass prices.

Next steps

The results of this task 2 will provide the basis for task 4 of the REOREC project which will conduct feasibility studies of the potential projects at each of the three sites described here. These studies will involve:

a. Technical project design;
b. Analysis of the cost of service delivery, connection rates and financial feasibility;
c. Assessment of potential environmental and social impact;
d. Pricing options for renewables-based rural electrification; and
e. Preparation of investment briefs for each project.

The environmental and social impacts of biomass energy projects are an important element of any feasibility study. These are particularly relevant in rural Cambodia where many 'waste' products such as rice husk are actually an important source of fuel or stock feed for local populations. Consequently a project that plans to change the existing market for these products could have adverse impacts on the local economy. For example, a poorly designed rural electrification project based on rice husk may succeed in providing cheaper electricity to the community, or more profits to the REE, but at the same time it may have increased the costs of basic cooking fuel for the rural poor who can not afford the electricity anyway. The feasibility studies will examine these issues for each of the projects to assess the likely impacts and suggest how possible adverse effects may be mitigated.

Production of the Renewable Energy Resource Maps has highlighted the lack of appropriate data in the public domain in Cambodia. The primary data surveys conducted for this project have provided a good indication of what is needed, and what is possible, with respect to gathering primary data on biomass sources in Cambodia. Further work must be done to complete the picture, starting with some of the industries highlighted in this report as having potential, but for which there is currently no useful data (eg: rubber processing factories). In addition the data sets and maps should be regularly maintained and updated to maximise their currency and usefulness.

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ANNEX 1 – SURVEY QUESTIONNAIRES

Survey of Provincial Departments for REOREC Project

Names of Surveyors: _____ Date of Survey:_____

A. General Details
Name of Official (interviewee):
Title:
Name of Ministry:
Name of Department:
Name of Office:
Province: Tel: Email:
Address:
B. Agricultural Production
The main crops produced in this province (List):
Current crop processing facilities in the province include: □ Rice Milling □ Cassava Processing □ Maize processing □ Peanut processing □ Kapok Processing □ Other:_____
The change in the number of facilities in the province in past 3 years: □ More □ Less □ Same
Large users of any type of energy (electricity, diesel, other) include (list): Description:_____ Location:_____ Description:_____ Location:_____ Description:_____ Location:_____ (continue on back of page if more room is needed)
The most recent data on agricultural production and processing in the province is: _____ (Please try to obtain a copy, or ask what we need to do to get one)
Do you have a map showing the location of farms, crop processors or other facilities? □ Yes □ No (Please try to obtain a copy, or ask what we need to do to get one)
C. Rice Production
The area of rice crops in your province: _____ Ha
The annual production of rice crops in your province: _____Ton of paddy per year
The number of large commercial mills in your province (>500kg/hour):_____
The number of small rice mills in your province (<500kg/hour):_____
Do you have a map showing the location of the rice mills? □ Yes □ No (Please try to obtain a copy, or ask what we need to do to get one, OR ask him to point-out on a map)
Are there any areas where the mills are grouped closely together? _____
The amount of paddy milled in this province each year: _____ T/year
Most common uses for the rice straw: (list) _____
The price of rice straw if sold: _____ Riels / kg
Most common uses for the rice husk: (list)

_____	_____
The price of rice husk if sold: _____ Riels / kg	The price of corn cobs if sold: _____ Riels / kg
D. Maize Production	E. Cassava Production
The area of maize crops in your province: _____ Ha	The area of cassava crops in your province: _____ Ha
The annual production of maize crops in your province: _____ Ton of seed per year	The annual production of cassava crops in your province: _____ Ton of seed per year
The number of large processors in your province:_____	The number of large processors in your province:_____
The number of small processors in your province:_____	The number of large cassava farms in your province (>50 Ha):_____
The number of sites that have installed large storage and drying silos: _____	Names and contact details for the large processors:_____ Location:_____Description:_____Owner:_____Tel:_____ Location:_____Description:_____Owner:_____Tel:_____ (continue on back of page if more room is needed)
Names and contact details for the large processors:_____ Location:_____ Description:_____Owner:_____Tel:_____ Location:_____ Description:_____Owner:_____Tel:_____ Location:_____ Description:_____Owner:_____Tel:_____ Location:_____ Description:_____Owner:_____Tel:_____ (continue on back of page if more room is needed)	Names and contact details for the large cassava farms:_____ Location:_____Description:_____Owner:_____Tel:_____ Location:_____Description:_____Owner:_____Tel:_____ Location:_____Description:_____Owner:_____Tel:_____ Location:_____Description:_____Owner:_____Tel:_____ (continue on back of page if more room is needed)
Do you have a map showing the location of the processors? □ Yes □ No (Please try to obtain a copy, or ask what we need to do to get one, OR ask him to point-out on a map)	Do you have a map showing the location of the processors? □ Yes □ No (Please try to obtain a copy, or ask what we need to do to get one, OR ask him to point-out on a map)
Are there any areas where the processors are grouped closely together? _____	Are there any areas where the processors are grouped closely together?
The amount of maize processed in this province each year: _____ T/year	
Most common uses for the waste corn cobs: (list)	

_____

The amount of cassava processed in this province each year:
_____ T/year

Most common uses for the waste stalks etc: (list)
_____

Is the waste ever sold? □ Yes □ No Price: _____Riels / kg

F. Piggeries

Total number of piggeries in your province: _____

Number of large piggeries (>1000 pigs): _____

Do you have a map showing the location of the piggeries? □ Yes □ No
(Please try to obtain a copy, or ask what we need to do to get one, OR ask him to point-out on a map)

Names and contact details for the large piggeries:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

(continue on back of page if more room is needed)

Are there any areas where the piggeries are grouped closely together?
_____

What do the large piggeries usually do with the waste?_____

G. Kapok (Krop Kohw)

Estimate of the number of Kapok trees in the province:
_____

Total production of Kapok cotton in your province: _____ tons / year

The proportion of Kapok that is processed in the province: _____ %

The number of Kapok processors in the province:
_____

Names and contact details for Kapok processors:

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

(continue on back of page if more room is needed)

The number of Kapok traders in the province: _____

Names and contact details for Kapok traders (if different from processors):

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

(continue on back of page if more room is needed)

Most common uses and value for Kapok seeds: _____
Price: _____R/kg

Most common uses and value for Kapok shells: _____
Price: _____R/kg

H. Peanuts

Area of peanut crops in the province: _____Ha

Total production of peanuts in your province: _____ tons / year (whole in shell)

The proportion of peanuts that are processed in the province: whole nuts:_____ % oil: _____%

The number of peanut processors in the province: _____

Names and contact details for peanut processors:

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

(continue on back of page if more room is needed)

Most common uses and value for peanut shells: _____ Price: _____R/kg

I. Cashew Nuts

Area of cashew crops in the province: _____Ha

Total production of cashew nuts in your province: _____ tons / year (whole in shell)

The proportion of cashew that are processed in the province: _____ %

The number of cashew processors in the province: _____

Names and contact details for cashew processors:

Location:_____Description:_____Owner:_____Tel:_____

Location:_____Description:_____Owner:_____Tel:_____

(continue on back of page if more room is needed)

Most common uses and value for cashew shells: _____ Price: _____R/kg

Thank you!

Survey of Corn Silos

A. General Details

Company Name:

Contact Person:

Address:

GPS Coordinates:

N

E

Telephone:

Fax:

E-mail

B. Storage Capacity

B.1. Maximum capacity to store whole corn fruit: _____ (tons or m^3 ?)

B.2. Maximum capacity to store maize grains: _____ (tons or m^3 ?)

B.3. Maximum capacity to store waste 'cob': _____(tons or m^3 ?)

B.4. Which months do you usually buy corn from farmers (please circle any):

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

C. Processing Operation

C.1. Usually how much of the corn is already separated from cob when delivered by farmer: _____%

(instead of buying the whole corn fruit, and having to remove the grains at the silo)

C.2. Maximum amount of corn grains that can be dried per hour:
_____tons - *low moisture*

_____tons - *high moisture*

C.3. Which months are you usually processing corn (please circle any):

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

C.4. Average number of hours of processing per day: _____ hours per day

C.5. Average output of grains per month: _____ tons per month

C.6. Do you currently use the silo to dry any other types of grains (eg: sesame etc)? □ Yes □ No

D. Waste Corn Cobs

D.1. Average quantity of cobs left after removing grain: _____tons of cobs per ton of fresh corn

D.2. Average quantity of other waste (flakes etc) left after removing grain: _____tons of waste per ton of fresh corn

D.3. Proportion of grain for various uses: □ Throw Away: ___%

□ Use on-site for fuel to dry grains:__% □ Use on-site for animal feed:____%

□ Sell to farmers for animal feed:____% □ Sell for fish feed:____%

□ Sell to householders for fuel: _____% □ Sell to traders:_____%

□ Sell to other business for fuel:____% □ Other (_____):___%

D.4. Proportion of waste flakes for various uses: □ Throw Away: ___%

□ Use on-site for fuel to dry grains: __% □ Use on-site for animal feed:____%

□ Sell to farmers for animal feed:____% □ Sell for fish feed:____%

□ Sell to householders for fuel: _____% □ Sell to traders:_____%

□ Sell to other business for fuel:____% □ Other (_____):___%

D.5. Average price for selling corn cobs: _____ Riels per kg

D.6. Average price for selling waste flakes: _____ Riels per kg

E. Grain Drying Operation

E.1. Maximum moisture content in grain before drying: _____ %

E.2. Minimum moisture content in grain before drying: _____ %

E.3. Average moisture content in grain after drying: _____ %

E.4. Energy source used for drying: □ Sun □ Waste Corn Cobs □ Other: _____

E.5. Maximum size of each silo batch for drying: _____ tons

E.6. Average time for each batch to complete drying: _____ hours

E.7. Total quantity of energy used for one batch of drying (if using silo etc): _____ (tons or litres ?)

F. Processing Equipment

F.1. Number of electricity generators on-site:

F.2. Rated power capacity of each: 1. ___(HP or kVA?) 2. _____(HP or kVA?) 3. _____(HP or kVA?)

F.3. Main use for the electricity generators (please list):

F.4. Quantity of diesel fuel used per month: _____ Litres / month

F.5. Cost of diesel fuel: _____ Riels per Litre

F.6. Is electricity purchased from a private local electricity producer: □ Yes □ No

F.7. *If yes:* Quantity of electricity used per month: _____ kWh / month

F.8. Name of private local electricity producer: _____
Telephone:_____

G. Local Operations

F.9. Closest villages to this site:
1. Name:_____ Population:_____ REE?: □ Yes □ No
BCS?: □ Yes □ No
2. Name:_____ Population:_____ REE?: □ Yes □ No
BCS?: □ Yes □ No 3. Name:_____ Population:_____
REE?: □ Yes □ No BCS?: □ Yes □ No

F.10. Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?) Cost:_____
($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?) Cost:_____
($ per km or other)

F.11. Large users of energy in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

F.12. Other large agricultural processors in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

Survey of Rice Millers

A. General Details	
Company Name:	
Contact Person:	
Address:	
GPS Coordinates	Telephone:
E	Fax:
N	E-mail

B. Production Capacity

B.5. Maximum processing capacity of the mill: _____ (kg/hour)

B.6. Number of hours mill operates per day in **dry** season: _____ hours / day

B.7. Number of hours mill operates per day in **wet** season: _____ hours / day

B.8. Total quantity of paddy milled per month: _____ kg / month

B.9. Number of **months** mill operates per **year:** _____ months per year

B.10. Usual months of milling operation (please circle):

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.11. Storage capacity for paddy = _____

B.12. Storage capacity for rice husk = _____

C. Rice Husk

C.1. Average quantity of rice husk produced per ton of paddy: _____ kg / ton paddy

C.2. Maximum Price at which rice husk is sold: _____ Riels per kg Month(s): _____

C.3. Minimum Price at which rice husk is sold: _____ Riels per kg Month(s): _____

C.4. Most common buyers of rice husk: □ Householders □ Farmers □ Businesses (_____) □ Other: _____

C.5. Percentage of buyers that use rice husk for: a.Cooking Fuel: _____% b.Fertilizer: _____% c.Brick Making: _____% d. Rice Wine: _____% e.Other (describe):_____ : _____%

D. Milling Equipment

Number of diesel engines used to power milling machines: _____

Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

Number of gasoline engines used to power milling machines: _____

Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

Number of electric motors used to power milling machines: _____

Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

Other types of engines or fuels used for milling (please list):

Number of electricity generators on-site:

Rated power capacity of each: 1. _____(HP or kVA?) 2. _____(HP or kVA?) 3. _____(HP or kVA?)

Main use for the electricity generators (please list):

Quantity of diesel fuel used per month: _____ Litres / month

Cost of diesel fuel: _____ Riels per Litre

Quantity of gasoline used per month: _____ Litres / month

Cost of gasoline: _____ Riels per Litre

Quantity of electricity used per month: _____ kWh / month

Is electricity purchased from a private local electricity producer: □ Yes □ No

Name of private local electricity producer: _____
Telephone:_____

Cost of electricity (if purchased from outside): _____ Riels per kWh

E. Local Operations

Closest villages to this site:
1. Name:_____ Have a REE?: □ Yes □ No BCS?: □ Yes □ No
2. Name:_____ Have a REE?: □ Yes □ No BCS?: □ Yes □ No
3. Name:_____ Have a REE?: □ Yes □ No BCS?: □ Yes □ No

Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)

Large users of energy in the area:

a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Other large mills in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

Survey of Corn Farmers

A. General Details

Farmer Name:

Farming Activities (tick any): □ Growing Corn □ Trading Corn (buying from other farmers)

□ Drying Corn □ Removing Corn from Cobs

□ Other Corn Processing: _____ □ Other Crops: _____

GPS Coordinates Telephone:

N

E

B. Corn Growing

B.1. Total area of corn crops on your farm: _____ Ha

B.2. The annual production of corn on your farm: _____Ton of whole corn per year

B.3. How many harvests of corn do you have per year? _____

B.4. Months of corn harvesting (please circle):
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.5. The proportion of corn you usually sell direct to silo:_____%
(Location:_____)

B.6. The proportion of corn you usually sell to trader:_____%

B.7. How do you usually sell your corn: □ Whole Fruits □ Grains Only

B.8. If grains only, how do you remove grains: □ By hand □ By own machine
□ Pay other person with machine

B.9. If by machine: how much does it cost to remove grains: _____ (*Riel per ton?)*

B.10. How is the corn transported to the buyer:
□ Farmer takes to buyer, at own expense (By: □ truck □ cart + buffalo/horse/cow □ other)
□ Buyer collects from the farm

E. Farm Equipment

F.13. Number of diesel engines used to power farm equipment: _____

F.14. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.15. Number of electricity generators on-site:

F.16. Rated power capacity of each: 1. ___(HP or kVA?) 2. _____(HP or kVA?) 3. _____(HP or kVA?)

F.17. Main use for the electricity generators (please list):

F.18. Quantity of diesel fuel used per month: _____ Litres /

month

F.19. Cost of diesel fuel: _____ Riels per Litre

F.20. Quantity of electricity used per month: _____ kWh / month

F.21. Is electricity purchased from a private local electricity producer: □ Yes □ No

F.22. Name of private local electricity producer: _____ Telephone:_____

F. Local Facilities

F.23. Closest villages to this site:
1. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No
2. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No
3. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No

F.24. Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)

F.25. Large users of energy in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

F.26. Other large corn farms in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

Survey of Piggeries for REOREC Project

A. General Details

Company Name:

Address:

GPS Coordinates
N
E

Telephone:
Fax:
E-mail

Contact Person:
Position:
Direct Tel.:
Direct Fax:
Mobile:
E-mail:

B. Piggery Population

B.13. Current number of pigs: Male:_____ Sow:_____

Piglets:_____

B.14. Maximum number of pigs at piggery at any one time:
_____

B.15. Months where there is close to maximum number of pigs:

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.16. Minimum number of pigs at any one time:
_____

C. Waste Management

C.6. Average total quantity of waste produced each day when number of pigs is maximum:_____ kg / day

C.7. Average total quantity of waste produced each day when number of pigs is minimum:_____ kg / day

C.8. Average volume of water used to clean the piggery when number of pigs is maximum: _____L/day

C.9. Current waste disposal method:
_____

C.10. Do you sell the waste? □ No □ Yes

If yes: Total proportion of waste that is sold (rather than disposed of): _____%

Proportion sold for use as fertilizer:_____% Value R/kg
_____

Proportion sold for other uses: _____% Other use: _____
Value:_____R/kg

C.11. Any plans to change the waste disposal method in future?

D. Energy Consumption

D.1. Number of electricity generators on-site:

D.2. Rated power capacity and fuel type of each gen-set:
1. _____(HP or kVA?) Fuel: _____
2. _____(HP or kVA?) Fuel: _____
3. _____(HP or kVA?) Fuel: _____

D.3. Main use for the electricity generators (please list):

D.4. Quantity of diesel fuel used per month: _____ Litres / month

D.5. Cost of diesel fuel: _____ Riels per Litre

D.6. Quantity of gasoline used per month: _____ Litres / month

D.7. Cost of gasoline: _____ Riels per Litre

D.8. Quantity of electricity used per month: _____ kWh / month

D.9. Is electricity purchased from a private local electricity producer: □ Yes □ No

D.10. Name of private local electricity producer: _____
Telephone:_____

D.11. Cost of electricity (if purchased from outside): _____ Riels per kWh

D.12. Do you know any ways to generate power from pig waste instead of using diesel fuel? □ Yes □ No

E. Local Facilities

F.27. Closest villages to piggery:
1. Name:_____ Population:_____ REE?: □ Yes □ No
BCS?: □ Yes □ No
2. Name:_____ Population:_____ REE?: □ Yes □ No
BCS?: □ Yes □ No 3. Name:_____ Population:_____
REE?: □ Yes □ No BCS?: □ Yes □ No

F.28. Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?) Cost:_____
($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?) Cost:_____
($ per km or other)

F.29. Large users of energy in the area:
a. Description:_____
Location:_____
b. Description:_____

Location:_____
c. Description:_____
Location:_____

F.30. Other large piggeries in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

Survey of Cassava Farmers for REOREC Project

A. General Details

Farmer Name:

Farming Activities (tick any): □ Growing Cassava □ Trading Cassava (buying from farmers)

□ Drying Cassava □ Milling Cassava (grinding to powder)

□ Other Cassava Processing: _____ □ Other Crop Activities: _____

Address:

GPS Coordinates

N

E

Telephone:

Fax:

E-mail

Contact Person:

Position:

Direct Tel.:

Direct Fax:

Mobile:

E-mail:

B. Cassava Growing

B.11. Total area of cassava crops on your farm: _____ Ha

B.12. The annual production of cassava crops on your farm: _____Ton of cassava per year

B.13. Months of cassava harvesting (please circle):
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.14. Maximum amount of cassava harvested per month: _____ ton

B.15. Minimum amount of cassava harvested per month: _____ ton

B.16. Average amount of waste cassava stalks left after harvest: _____(m3/ha, or tons/ha)

B.17. Common uses for waste cassava stalks:
□ Leave in field □ Burn in field
□ Collect and dry for fuel □ Collect for stock feed
□ Collect and dry to sell □ Other:
_____

B.18. If the waste stalks are sold, who is the main buyer(s) and what are the uses:
□ Household for normal cooking fuel □ Household for making product (product:_____)
□ Business (products: _____)
□ Other: _____
Average Price: _____R/kg

B.19. The proportion of cassava you usually sell direct to processor:_____% (Location:_____)

B.20. The proportion of cassava you usually sell to trader:_____%

B.21. How is the cassava transported to the buyer:
□ Farmer takes to buyer, at own expense (By: □ truck □ cart + buffalo/horse/cow □ other)
□ Buyer collects from the farm

C. Cassava Drying

C.1. Proportion of cassava that you dry at farm before selling:
a. _____% , Months:_____
b. _____% , Months:_____

C.2. Weight of cassava before drying: _____ (tons or kg)

C.3. Weight of cassava after drying: _____ (tons or kg)

C.4. Usual method for drying: □ Sun drying on ground □ Other (what fuel?): _____

C.5. Maximum size of each batch for drying: _____ tons

C.6. Average time for each batch to complete drying: _____ hours

D. Storage Capacity

B.17. Maximum capacity to store fresh (wet) cassava: _____ (tons or m^3 ?)

B.18. Maximum capacity to store dried cassava: _____ (tons or m^3 ?)

B.19. Maximum capacity to store waste cassava stalks: _____ (tons or m^3 ?)

E. Farm Equipment

F.31. Number of diesel engines used to power farm equipment: _____

F.32. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.33. Number of gasoline engines used to power farm equipment: _____

F.34. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.35. Number of electric motors used to power farm equipment: _____

F.36. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.37. Other types of engines or fuels used for farm equipment (please list):

F.38. Number of electricity generators on-site:

F.39. Rated power capacity of each: 1. ___(HP or kVA?) 2. _____(HP or kVA?) 3. _____(HP or kVA?)

F.40. Main use for the electricity generators (please list):

F.41. Quantity of diesel fuel used per month: _____ Litres / month

F.42. Cost of diesel fuel: _____ Riels per Litre

F.43. Quantity of gasoline used per month: _____ Litres / month

F.44. Cost of gasoline: _____ Riels per Litre

F.45. Quantity of electricity used per month: _____ kWh / month

F.46. Is electricity purchased from a private local electricity producer: □ Yes □ No

F.47. Name of private local electricity producer: _____ Telephone:_____

F. Local Facilities

F.48. Closest villages to this site:
1. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No

2. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No
3. Name:_____ Have an REE?: □ Yes □ No BCS?: □ Yes □ No

F.49. Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?) Cost:_____ ($ per km or other)

F.50. Large users of energy in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

F.51. Other large cassava farms in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

Survey of Cassava Processors for REOREC Project

A. General Details

Company Name:

Company Activities (tick any): □ Growing Cassava □ Trading Cassava (buying from farmers)
□ Drying Cassava □ Milling Cassava (grinding to powder)
□ Other Cassava Processing: _____ □ Other Crop Activities: _____

Address:

GPS Coordinates
N
E

Telephone:
Fax:
E-mail

Contact Person:
Position:
Direct Tel.:
Direct Fax:
Mobile:
E-mail:

B. Storage Capacity

B.20. Maximum capacity to store cassava: _____ (tons or m^3 ?)

B.21. Which months do you usually buy cassava from farmers (please circle any):
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.22. Maximum time that you would usually store the cassava before processing: _____ months

B. Production Capacity

B.23. Maximum cassava processing capacity: _____ (kg/hour)

B.24. Average number of hours that plant operates per day: _____ hours / day (which months:_____)

B.25. Average number of **months** that plant operates per **year:**

_____ months per year

B.26. Usual months of processing operation (please circle):

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B.27. Total quantity of cassava processed per year: _____ tons / year

B.28. Average quantity of waste cassava residue produced: _____kg of waste per ton of fresh cassava

B.29. The common uses for this residue (list): _____

B.30. If it is sold, who are buyers:
a. Type of buyer: _____ Price: _____ R/kg
b. Type of buyer: _____ Price: _____ R/kg
c. Type of buyer: _____ Price: _____ R/kg

B. Cassava Drying

B.1. Proportion of cassava that is dried at factory before processing:
a. _____% , Months:_____
b. _____% , Months:_____

B.2. Average weight of a batch of wet cassava before drying: _____ ton

B.3. Weight of the batch of cassava after drying: _____ ton

B.4. Usual method for drying: □ Sun drying on ground □ Silo with boiler/heating □ Other: _____

B.5. Energy source used for drying: □ Sun □ Other: _____

B.6. Maximum size of each batch of cassava for drying: _____ tons

B.7. Average time for each batch to complete drying: _____ hours

B.8. Total quantity of energy used for one batch of drying (if using a fuel in silo): _____ (tons or litres ?)

C. Cassava Processing Operation

C.1. The cassava is chopped: □ By hand □ By machine

C.2. The cassava is ground: □ By hand □ By machine

C.3. Maximum amount of cassava that can be processed per hour: _____kg of dry cassava

C.4. Average number of hours of processing per day: _____ hours per day

C.5. Average output of powder per month: _____ tons per month

C.6. Which months are you usually processing cassava (please circle any):

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

F. Processing Equipment

F.52. Number of diesel engines used to power processing machines: _____

F.53. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.54. Number of gasoline engines used to power processing machines: _____

F.55. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or kW?) 3. _____(HP or kW?)

F.56. Number of electric motors used to power processing machines: _____

F.57. Rated power capacity of each: 1. _____(HP or kW?) 2. _____(HP or

kW?) 3. _____(HP or kW?)

F.58. Other types of engines or fuels used for milling (please list):

F.59. Number of electricity generators on-site:

F.60. Rated power capacity of each: 1. ___(HP or kVA?) 2. _____(HP or kVA?) 3. _____(HP or kVA?)

F.61. Main use for the electricity generators (please list):

F.62. Quantity of diesel fuel used per month: _____ Litres / month

F.63. Cost of diesel fuel: _____ Riels per Litre

F.64. Quantity of gasoline used per month: _____ Litres / month

F.65. Cost of gasoline: _____ Riels per Litre

F.66. Quantity of electricity used per month: _____ kWh / month

F.67. Is electricity purchased from a private local electricity producer: □ Yes □ No

F.68. Name of private local electricity producer: _____ Telephone:_____

G. Local Facilities

F.69. Closest villages to this site:
1. Name:_____ Population:_____ REE?: □ Yes □ No BCS?: □ Yes □ No
2. Name:_____ Population:_____ REE?: □ Yes □ No BCS?: □ Yes □ No
3. Name:_____ Population:_____ REE?: □ Yes □ No BCS?: □ Yes □ No

F.70. Average transport costs:
a. Truck capacity:_____(kg, T, m3 ?)
Cost:_____ ($ per km or other)
b. Truck capacity:_____(kg, T, m3 ?)
Cost:_____ ($ per km or other)

F.71. Large users of energy in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

F.72. Other large cassava processors in the area:
a. Description:_____
Location:_____
b. Description:_____
Location:_____
c. Description:_____
Location:_____

Thank you!

ANNEX 2 – SUMMARY OF RESULTS OF INITIAL MAPPING SURVEY

		Rice Mill 1	Rice Mill 2	Rice Mill 3	Rice Mill 4	Rice Mill 5	Rice Mill 6	Rice Mill 7	Rice Mill 8
A. Contact Details									
A.1	Company Name:	Song Hong Co.Ltd	Kheng Hout Co. Ltd	Sea Meng Co. Ltd	Leng Chouy Co. Ltd	Chea Try Bun Rath Co.Ltd	Se Khorn Co. Ltd	Kov Meng Co. Ltd	Ouk Ly Co. Ltd
A.2	Contact Person:	Mr. Song Hong	Mr. Chay Seang	Mr. Sea Meng	Mr. Leng Chouy	Mr. Chea Try Bun Rath	Mr. Se Khorn	Mr. Kov Meng	Mr. Ouk Ly
A.3	Address (Number and Road)	NR No.5	From NR No. 5 about 1km	From NR No. 5 about 1Km	NR No. 5	From NR No 5 about 1.5km	From NR No. 5 about 1.6km	NR No. 5	NR No. 5
A.4	Province	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang
A.5	District	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang	Battambang
A.6	Commune	Chrey	Chrey	Kauk Khmom	Thmarkol	Tameun	Kokhmom	Kokhmom	Tameun
A.7	Village	Thai San	Thai San	Kean Kes 2	Thmarkol	Ta Sey	Chro Neang	Kean Kes	Ta Sey
A.8	GPS Easting	103° 08' 41.3"	103° 08' 17. 5"	103° 04' 41. 1"	103° 05' 09. 1"	103° 04' 44.5"	103° 04' 22. 2"	103° 04' 54. 8"	103° 05' 21. 8"
A.9	GPS Northing	13° 06' 34.6"	13° 06' 14.8"	13° 15' 53. 7"	13° 15' 55. 5"	13° 17' 41. 8"	13° 16' 01. 3"	13° 15' 48. 6"	13° 16' 46. 5"
A.10	Telephone:	012 927 788	012 445 235	012 911 583	012 889 085	016 882 923	012 899 725	012 666 620	
A.11	Fax:								
A.12	E-mail								
B. Production Capacity									
B.1.	Maximum processing capacity of the mill: (kg/hour)	4000	1000	1000	1600	900	700	1600	1000
B.2.	Number of hours mill operates per day in dry season: (hours / day)	12	10	12	12	8	8	13	10
B.3.	Number of hours mill operates per day in wet season: (hours / day)	12	10	12	12	8	8	13	8
B.4.	Total quantity of paddy milled per month: (kg / month)	750,000.00	250,000.00	300,000.00	480,000.00	100,000.00	106,400.00	600,000.00	200,000.00
B.5.	Number of months mill operates per year: (months per year)	10	10	10	10	9 to 10	10	10	10
B.6.	Usual months of milling operation: (Jan-Mar, Oct, Dec ... etc)	Jan to Oct	Jan to Oct	Jan to Oct	Jan to Sep and Dec	Jan, Mar to Oct and Dec	Jan to Oct	Jan to Oct	Jan to Oct
B.7.	Storage capacity for paddy (ton)	10,000.00	2,000.00	4,000.00	500	15	2000	3000	15
B.8.	Storage capacity for rice husk (ton)	2500m³	300m³	400m³	625m³	375m³	3600m³	275m³	1200m³
C. Rice Husk									
C.1.	Average quantity of rice husk produced per ton of paddy: (kg / ton paddy)	200 to 250kg	180 to 200kg	200kg	160 to 200kg	150kg	250kg	200kg	150 to 200kg
C.2.	Maximum Price at which rice husk is sold: (Riels per kg), months?	100R/1bage (20kg)	100R/1bage (18kg)	500000R/1truck 12t	3000000R/year	200R/1bage (30kg)			
C.3.	Minimum Price at which rice husk is sold: (Riels per kg), months?	50R/1bage (20kg)				150R/1bage (30kg)			
C.4.	Most common buyers of rice husk:	Brick Making	Brick Making and Cooking Fuel	Thai (70%)	Brick Making	Brick Making			
C.5.a	Percentage of buyers that use rice husk for: Cooking Fuel :		10%	10%					
C.5.b	Percentage of buyers that use rice husk for: Fertilizer :								
C.5.c	Percentage of buyers that use rice husk for: Brick Making :	40%	50%	20%	40%	50%			
C.5.d	Percentage of buyers that use rice husk for: Rice Wine :								
C.5.e	Percentage of buyers that use rice husk for: Other (describe) :	60% throw away	40% throw away						
D. Milling Equipment									
D.1.	Number of diesel engines used to power milling machines:	1	1	1	1	1	1	1	1
D.2.	Rated power capacity of each: (eg: 10HP, 30kW, 150kW)	3000 HP	280 HP	260 HP	346 HP	260 HP	260 HP (HINO 500)	260 HP	75
D.3.	Number of gasoline engines used to power milling machines:								
D.4.	Rated power capacity of each: (eg: 10HP, 30kW, 150kW)								
D.5.	Number of electric motors used to power milling machines:								
D.6.	Rated power capacity of each: (eg: 10HP, 30kW, 150kW)								
D.7.	Other types of engines or fuels used for milling (please list):								
D.8.	Number of electricity generators on-site:	1	1	1	1	1	1	1	
D.9.	Rated power capacity of each: (eg: 10HP, 30kW, 150kVA)	12 HP	10 HP	12	10	10	10	12	
D.10.	Main use for the electricity generators (please list):	Lighting at night time	Lighting at night time	Lighting at night time	Lighting at night time	Lighting at night time	Lighting at night time	Lighting at night time	
D.11.	Quantity of diesel fuel used per month: (Litres / month)	8000	3650	4400	5000	3300	2850	5500	1000
D.12.	Cost of diesel fuel: (Riels per Litre)	2582	2582	2618	2545	2582	2618	2636	2618
D.13.	Quantity of gasoline used per month: (Litres / month)								
D.14.	Cost of gasoline: (Riels per Litre)								
D.15.	Quantity of electricity used per month: (kWh / month)								10
D.16.	Is electricity purchased from a private local electricity producer: (Yes/No)	No	No	No	No	No	No	No	Yes
D.17.	Name + *telephone* of private local electricity producer:								Local Generator
D.18.	Cost of electricity (if purchased from outside): (Riels per kWh)								3200 to 3500R/kWh
E. Local Operations									
E.1.a	First Closest villages to this site: Name :	Ken Keas	Ken Keas	Thmarkol	Kean Kes	Chro Neang	Kokhmom	Kok Trap	Kok Trap
E.1.b	First Closest villages to this site: Has REE? (Yes/No)	No	No	No	No	No	No	No	No
E.1.c	First Closest villages to this site: Has BCS? (Yes/No)	No	No	No	No	No	No	No	No
E.1.d	Second Closest villages to this site: Name :	Ta Sey	Ta Sey	Samrong	Ta Sey	Kean Kes	Thmarkol	Kean Kes2	Kokhmom
E.1.e	Second Closest villages to this site: Has REE? (Yes/No)	No	No	No	No	No	No	No	No
E.1.f	Second Closest villages to this site: Has BCS? (Yes/No)	No	No	No	No	No	No	No	No
E.2.a	Average transport costs: Truck Capacity :	10000-15000R/1t (30-40Km)	10000R/1t (10-20Km)	3500R/100kg (100-150km)	1500-200R/100kg (20-30km)	2500-300R/70kg (70km)	4000R/100kg (150-200km)	1500R/100kg (20km)	1000 to 1500R/100kg (12km)
E.2.b	Average transport costs: Truck Cost :								
E.3.a	Large users of energy in the area: Description	No	No	No	No	No	No	No	No
E.3.b	Large users of energy in the area: Location	No	No	No	No	No	No	No	No
E.4.a	Other large mills in the area: Description	Rice Mill	Rice Mill	Rice Mill	Rice Mill	Rice Mill	Rice Mill	Rice Mill	Rice Mill
E.4.b	Other large mills in the area: Location	Kok Khmom, Ta Mern	Kok Khmom, Ta Mern	Chraneang	Samrong, Chroy Sdao	Bovil	Kokhmom	Bavel	Bavel

		Piggery 1	Piggery 2	Piggery 3	Piggery 4	Piggery 5	Piggery 6
A. Contact Details							
A.1	Company Name:	Chan Socheat (?)		Sam Rongthom Animal Husbandry		TACA Pig Farm	Yuu Wat Company (Taiwan?)
A.3	Address (Number and Road)	National Rd #3, K.Speu		Nat Road #1, Kean Svay, Kandal		Sdav Kanlen Village, Kean Svay, Kandal	
A.4	GPS Easting	443931	448629	526103	510914		0510496
A.5	GPS Northing	1264575	1268385	1259530	1269099		1269542
A.6	Telephone:	011 883 362		011 564 173		12868674	
A.7	Fax:			023 213 946			
A.8	E-mail			none			
A.9	Contact Person:	Chan Socheat		Mr Leng Sun Rafael		Som Borin	
A.10	Position:	Manager		Manager		owner?	
A.11	Direct Tel.:			011 564 173			
A.12	Direct Fax:			99 900 469			
A.13	Mobile:			011 564 173		12868674	
A.14	E-mail:			none			
B. Piggery Population							
B.1.a	Current number of pigs: Male:			50			
B.1.b	Current number of pigs: Sow:			> 1000		2000	
B.1.c	Current number of pigs: Piglets			< 9000			
B.2.	Maximum number of pigs at piggery at any one time:	4000 (expanding to 5000	1500	10000	800		1000, but expanding
B.3.	Months where there is close to maximum number of pigs: (please list)			constant			
B.4.	Minimum number of pigs at any one time:			constant			
C. Waste Management							
C.1.	Avge total quantity of waste produced each day when **max** num. of pigs (kg / day):					10000kg/day (5kg/day each)	
C.2.	Avge total quantity of waste produced each day when **min** num. of pigs (kg / day):						
C.3.	Average volume of water used to clean the piggery when number of pigs is max.: (L/day)					60 cu.m	
C.4.	Current waste disposal method:	10 lagoons	1 lagoon for liquids, and	1 big lagoon (more?)	lagoon	3 lagoons	
C.5.a	Do they sell the waste? (Yes/No)	no	no	no	no	no	
C.5.b	If yes: Total proportion of waste that is sold (rather than disposed of): (%)	n/a	n/a	n/a	n/a	n/a	
C.5.c	Proportion sold for use as fertilizer: (%)	n/a	n/a	n/a	n/a	n/a	
C.5.d	Value as fertilizer (R/kg) :	n/a	n/a	n/a	n/a	n/a	
C.5.e	Proportion sold for other uses: (%)	n/a	n/a	n/a	n/a	n/a	
C.5.f	Other use: (description)	n/a	n/a	n/a	n/a	n/a	
C.5.g	Value as other use (R/kg) :	n/a	n/a	n/a	n/a	n/a	
C.6.	Any plans to change the waste disposal method in future?	no	no	interested in biogas	no		
D. Processing Equipment							
D.1.	Number of electricity generators on-site:	4 + 2 water pumps,		5	PV panels for battery ch	5	
D.2.	Rated power capacity of each: (eg: 10HP, 30kW, 150kW)	100HP, 30HP, 100HP, 15kW (pls pumps: 30HP, 22H		100kVA, 125kVA, +?	18kW motor for grinder	3 x 11HP, 2 x 20HP, PV system to charge batteries	
D.3.	Main use for the electricity generators (please list):	lighting, food prep	Lights, pig food prep	lighting plus food prep	lighting	water pumping + prep food	
D.4.	Quantity of diesel fuel used per month: (Litres / month)	2000	800 L/month	8-10000 L/mth	600L	900	
D.5.	Cost of diesel fuel: (Riels per Litre)	market	market	market		0.6	
D.6.	Is electricity purchased from a private local electricity producer: (Yes/No)	no	yes	no	no	no	
D.7.	If yes: Quantity of electricity used per month: (kWh / month)	n/a		n/a	n/a		
D.8.a	Name of private local electricity producer:	n/a		n/a	n/a		
D.8.b	Telephone number of private local electricity producer:	n/a		n/a	n/a		
D.9.	Do you know any ways to generate power from pig waste instead of using diesel fuel? (Yes/No)	Yes - interested in biogas		Yes - biogas	no		
E. Local Operations							
E.1.a	First Closest villages to this site: Name :			About 300 families live close by			
E.1.b	First Closest villages to this site: Has REE? (Yes/No)						
E.1.c	First Closest villages to this site: Has BCS? (Yes/No)						
E.1.d	Second Closest villages to this site: Name :						
E.1.e	Second Closest villages to this site: Has REE? (Yes/No)						
E.1.f	Second Closest villages to this site: Has BCS? (Yes/No)						
E.2.a	Average transport costs: Truck Capacity :						
E.2.b	Average transport costs: Truck Cost :						
E.3.a	Large users of energy in the area: Description						
E.3.b	Large users of energy in the area: Location						
E.4.a	Other large piggeries factories in the area: Description		We are largest - ohers v	Uncles piggery 5mins away on river front			
E.4.b	Other large piggeries factories in the area: Location						
Extra Comments...							
				Also use 10T/mth of coal from VN ($130/T)		* Data taken from CCO survey for PhilBio	* Unable to visit site, so basic description from MAFF staff member
				5 families live on site			
				300 light bulbs thoughout (60W or 100W)			
				Use 15-20T/day of stock feed			

		Corn Silo 1	Corn Silo 2	Corn Silo 3	Corn Silo 4	Corn Silo 5
A. Contact Details						
A.1	Company Name:	Corn Silo Preak Tatain	Malay Corn silo	Mitapheap Pailin Coltd	Kouch Tech Sran Agriculture Production Co. Ltd	Chhea Kao Trading Co. Ltd
A.2	Contact Person:	Mr Ouk Srun	Mr Tep Kounal, Mr. Som Yin	Mr. Moul Sam, Chhea Chan Reuon	Mr. Heng	Mr. Chhea Kao
A.3	Address (Number and Road)	National Road #5		NR No. 57		
A.4	Province	Kandal	Banteay Meanchey	Pailin	Battambang	Battambang
A.5	District	Ponhea Leu	Malai	Sala Krom	Sampove Leun	Kamrieng
A.6	Commune	Preak Tatain	Boeng Beng	Steng Kach	Ta Sda	Beng Rang
A.7	Village	Preak Tatain	Phnom Roung	Kgok	Ta Sda	O Krouy
A.8	GPS Easting	482569	212976	102° 35' 33. 5"	102° 23' 07. 3"	102° 27' 44. 8"
A.9	GPS Northing	1295258	1498750	12° 53' 11. 5"	13° 25' 35. 8"	13° 04' 58. 1"
A.10	Telephone:	012 91 41 51	012 688810	016 554 999, 016 550 000	012 202 280	012 372 134
A.11	Fax:					
A.12	E-mail					
B. Storage Capacity						
B.1.	Maximum capacity to store whole corn fruit: (tons or m3 ?)		4000 T	120	3000 t	5000 t
B.2.	Maximum capacity to store maize grains: (tons or m3 ?)	240 T	80 T	25 to 30	2000 t	5000 t
B.3.	Maximum capacity to store waste 'cob': (tons or m3 ?)				600 t	100 t
B.4.	Which months do you usually buy corn from farmers (please list):	July - Nov	June - Oct	Oct to Jan	Jul to Dec	Jul
C. Processing Operation						
C.1.	How much of corn is already separated from cob when delivered by farmer: (%)	unknown, but mixture	unknown, but mixture		20%	10%
C.2.a	Maximum amount of corn grains that can be dried per hour: (tons) - low moisture:	10	22	25 to 30	100 t	20 t
C.2.b	Maximum amount of corn grains that can be dried per hour: (tons) - high moisture:	7.5	18	20	25 t	15 t
C.3.	Which months are you usually processing corn (please list):	July - Nov	June - Oct	Nov	Jul to Dec	Jul
C.4.	Average number of hours of processing per day: (hours per day)	16 h	24	24	15	8 to 10
C.5.	Average output of grains per month: (tons per month)		8-10000 T/year	18000	3000 t	500
C.6.	Do you currently use the silo to dry any other types of grains? (Yes/ No)	Yes - Soy	No (but possible)	No	Yes	No
D. Waste Corn Cobs						
D.1.	Average quantity of cobs left after removing grain: (tons of cobs/ton fresh corn)			180 to 200 kg/1ton of fresh corn	200 kg/ 1ton of fresh corn	200kg/1ton of fresh corn
D.2.	Avg qty of other waste (flakes etc) left: (T of waste per T fresh corn)	0.006				
D.3.a	Proportion of cobs for various uses: Throw Away: (%)	0	15			
D.3.b	Proportion of cobs for various uses: Use on-site for fuel to dry cobss: (%)	0.9	0			
D.3.c	Proportion of cobs for various uses: Use on-site for animal feed: (%)	0	0			
D.3.d	Proportion of cobs for various uses: Sell to farmers for animal feed: (%)	0	0		20	20%
D.3.e	Proportion of cobs for various uses: Sell for fish feed: (%)	0	0			
D.3.f	Proportion of cobs for various uses: Sell to householders for fuel:(%)	0.05	0			
D.3.g	Proportion of cobs for various uses: Sell to traders: (%)	0	0	Thai, China and Vietnam	80 (CP)	70% (CP)
D.3.h	Proportion of cobs for various uses: Sell to other business for fuel: (%)	5% (fish farm cooking)	0			
D.3.i	Proportion of cobs for various uses: Other: (Describe other use)		0			
D.3.j	Proportion of cobs for various uses: Other: (%)	0	0			
D.4.a	Proportion of flakes for various uses: Throw Away: (%)		90-100% ?			
D.4.b	Proportion of flakes for various uses: Use on-site for fuel to dry flakess: (%)		0			
D.4.c	Proportion of flakes for various uses: Use on-site for animal feed: (%)		0			
D.4.d	Proportion of flakes for various uses: Sell to farmers for animal feed: (%)		<10% (for free)?			
D.4.e	Proportion of flakes for various uses: Sell for fish feed: (%)		<10% (for free)?			
D.4.f	Proportion of flakes for various uses: Sell to householders for fuel:(%)		0			
D.4.g	Proportion of flakes for various uses: Sell to traders: (%)		0			
D.4.h	Proportion of flakes for various uses: Sell to other business for fuel: (%)		0			
D.4.i	Proportion of flakes for various uses: Other: (Describe other use)		0			
D.4.j	Proportion of flakes for various uses: Other: (%)		0			
D.5.	Average price for selling corn cobs: (Riels per kg)	25 to 37.5	n/a			
D.6.	Average price for selling waste flakes: (Riels per kg)		n/a			
E. Grain Drying Operation						
E.1.	Maximum moisture content in grain before drying: (%)	27	0.28		29%	28
E.2.	Minimum moisture content in grain before drying: (%)	17	0.18		22%	25
E.3.	Average moisture content in grain after drying: (%)				14%	14
E.4.	Energy source used for drying: (eg: Sun, Waste Corn Cobs, Other: ?)	Cobs	Waste corn cobs	Waste Corn Cobs	Waste Corn Cobs	Waste Corn Cobs
E.5.	Maximum size of each silo batch for drying: (tons)	60	continuous		100t	100 t
E.6.	Average time for each batch to complete drying: (hours)		n/a		6 to 10	4
E.7.	Total quantity of energy used for one batch of drying : (tons or litres ?)	8 cu.m	7 cu.m (per hr?)		33 liters/1h	18 liters/1h
F. Processing Equipment						
F.1.	Number of electricity generators on-site:	2	2		2	1
F.2.	Rated power capacity of each: (eg: 10HP, 30kW, 150kW)		2 x 125kW		160 HP, 160 HP	150 kVA
F.3.	Main use for the electricity generators (please list):	Factory motors, controls, lights	Factory motors			
F.4.	Quantity of diesel fuel used per month: (Litres / month)		18L/hour		10000	5400
F.5.	Cost of diesel fuel: (Riels per Litre)		market		2650	2700
F.6.	Is electricity purchased from a private local electricity producer: (Yes/No)		No	Yes	No	No
F.7.	If yes: Quantity of electricity used per month: (kWh / month)		n/a	3276		
F.8.a	Name of private local electricity producer:		imported from Thailand	Thai Company		
F.8.b	Telephone number of private local electricity producer:					
G. Local Operations						
G.1.a	First Closest villages to this site: Name :			Tvear Ampil	Kilo Meter No.9	O Krouy
G.1.b	First Closest villages to this site: Has REE? (Yes/No)			No	No	No
G.1.c	First Closest villages to this site: Has BCS? (Yes/No)			Yes	Yes	Yes
G.1.d	Second Closest villages to this site: Name :			Sala Krav	Kilo Meter No.13	O Da
G.1.e	Second Closest villages to this site: Has REE? (Yes/No)			No	No	No
G.1.f	Second Closest villages to this site: Has BCS? (Yes/No)			Yes	Yes	Yes
G.2.a	Average transport costs: Truck Capacity :				1.5	1
G.2.b	Average transport costs: Truck Cost :				1500 to 2500	1000 to 1500
G.3.a	Large users of energy in the area: Description			Chinese Silo	Fresh Water Enterprise	Casino
G.3.b	Large users of energy in the area: Location			Sala Krom	Near Sampove Leun Market	Beng Rang
G.4.a	Other large silos in the area: Description		Sampeu Leuwn	No	No	No
G.4.b	Other large silos in the area: Location		17km or 30min drive away	No	No	No
Extra Comments...						
		Grate Furnace is approx 1m x 1m x 3m	Has a mobile separator, 10T/hr, sometimes he takes to farmers			
		Currently expanding to 80-100T capacity, and expect to use same quantity of cob fuel	He buys at various prices depending if separated from cob, and moisture content (300-350R/kg for whole corn, 400-450R for grains only)			
		They built all equipment themselves in Cambodia, based on silos on Thai border	He buys from farmers within 5 - 20km radius			

ANNEX 3 – SUMMARY OF RESULTS FROM DETAILED SITE SURVEYS

Cluster A: Phnom Ruong, Malais District, Beantey Meanchey Province

Company Details	
Company Name:	Malais Corn silo
Contact Person:	Mr Tep Kounal (part owner), Mr. Som Yin (factory manager); Em Leap (Deputy Director); Long Rin (finance)
Address (Number and Road)	Phnom Roung Village, Boeng Beng Commune, Malay District, Bantey Meanchey Province
Province	Banteay Meanchey
District	Malai
Commune	Boeng Beng
Village	Phnom Roung
GPS Easting (UTM 48P, WGS84)	0212976
GPS Northing	1498750
Telephone:	012 688810
Fax:	*none*
E-mail	*none*
Supply and Storage of Corn Cobs	
Maximum capacity to store whole corn fruit: (tons or m3 ?)	160 T min (20 trucks each 10 wheels, approx 8T)
Maximum capacity to store maize grains: (tons or m3 ?)	80 T
Maximum capacity to store waste 'cob': (tons or m3 ?)	160 T min (20 trucks each 10 wheels, approx 8T)
Which months do you usually buy corn from farmers (please list):	June - Oct
Other corn supply comments	Has a mobile separator, 10T/hr, sometimes he takes to farmers
	He buys at various prices depending if separated from cob, and moisture content (300-350R/kg for whole corn, 400-450R for grains only)
	He buys from farmers within 5 - 20km radius
Processing Operation	
How much of corn is already separated from cob when delivered by farmer: (%)	unknown, but mixture
Maximum amount of corn grains that can be dried per hour: (tons) - low moisture:	22 T
Maximum amount of corn grains that can be dried per hour: (tons) - high moisture:	18 T
Which months are you usually processing corn (please list):	June - Oct
Average number of hours of processing per day: (hours per day)	12 T
Average output of grains per month: (tons per month)	8-10000 T/year

Do you currently use the silo to dry any other types of grains? (Yes/ No)	No (but possible)
Waste Corn Cobs	
Average quantity of cobs left after removing grain: (tons of cobs/ton fresh corn)	cob = 18% of whole fruit weight (no leaves)
Approximate density of corn cobs (rough measurement of single sample with high moisture)	230 kg/cu.m
Proportion of flakes for various uses: Throw Away: (%)	90-100%
Proportion of cobs for various uses: Other: (Describe other use)	Heating fuel: making rice wine, household cooking, night fires to keep insects from stock
Average price for selling corn cobs: (Riels per kg)	Free
Grain Drying Operation	
Maximum moisture content in grain before drying: (%)	28%
Minimum moisture content in grain before drying: (%)	18%
Average moisture content in grain after drying: (%)	14%
Energy source used for drying: (eg: Sun, Waste Corn Cobs, Other: ?)	Waste corn cobs
Maximum size of each silo batch for drying: (tons)	80 T
Average time for each batch to complete drying: (hours)	4 to 5 hrs (2 or max 3 batches/day)
Total quantity of energy used for one batch of drying : (tons or litres ?)	7 cubic metres
Processing Equipment	
Number of electricity generators on-site:	3
Rated power capacity of each: (eg: 10HP, 30kW, 150kW)	1x12kW plus 2 x 125kW (Size TBC - Namsan Engineering, 294 894655, 759 Rana3 Road, Vannana, Bangkok, 10120)
Main use for the electricity generators (please list):	Factory motors (fans, grain elevators etc)
Is Load curve available for plant?	Requested
Quantity of diesel fuel used per month: (Litres / month)	18L/hour
Cost of diesel fuel: (Riels per Litre)	market price
Is electricity purchased from a private local electricity producer: (Yes/No)	No
If yes: Quantity of electricity used per month: (kWh / month)	n/a
Previous REE at Chum Bok Village	
Name of owner	Mr Map
Telephone	012 192 044 9
Duration of REE business	approx 3 years (clsoed REE 2 months ago)
Previous tariff	2000 R when started, then raised until 3500R/kWh
Engine Size	25 kW
Comments	Insufficient capacity - he estimates 50kW needed for his cutomers
Estimated total demand in area (not including silo)	approx 200 households in 2km radius
Average household consumption	20 - 30 kWh/mth
Battery charging prices now	70A = 20B, 50A = 15B, 40A = 10B, 6V = 5B
Biomass Trader located opposite Corn Silo	
Name	Mr Heng

Telephone	012 63 26 40
Rice husk supply area	100km, as far as Tma Kole
Rice husk buying price	500 B /T
Rice husk selling price	?? (up to $18/T in Thailand?)
Quantity rice husk sold	240 T / week (5x12T trucks, 4 times /wk)
Quantity corn cob sold since starting	180T (30 trucks x (5 - 6 T/truck))
Future plans	Sawdust from K.Cham; straw from local area (installing a bale compresser soon)
Name	Mr Heng

Cluster B: REE and Rice Mill at Tma Kohl District, Battambang Province

Company Details	
Company Name:	Malimex
Contact Person:	Mr Ly See
Address (Number and Road)	
Province	Battambang
District	Thmorkol District
Commune	Kok Khmom Commune
Village	Kien Kes Village
GPS Easting (UTM 48 P, WGS84)	0293107
GPS Northing	1466662
Telephone:	012 942 408
Fax:	*none*
E-mail	*none*
Production Capacity	
Maximum processing capacity of the mill: (T/hour)	2
Number of hours mill operates per day: (hours / day)	12 (6am-6pm)
Number of months mill operates per year: (months per year)	10
Usual months of milling operation: (Jan-Mar, Oct, Dec …etc)	Dec to Oct
Storage capacity for rice husk (ton)	20000
Rice Husk Values	
Maximum Price at which rice husk is sold: (Riels per kg), months?	$30/truck
Minimum Price at which rice husk is sold: (Riels per kg), months?	free
Most common buyers of rice husk:	trader
Milling Equipment	
Number of diesel engines used to power milling machines:	2

Rated power capacity of each: (eg: 10HP, 30kW, 150kW)	260HP and 22HP (to start blower for big one) * Planning to install 460HP (?) engine to drive new polishing machine
Number of gasoline engines used to power milling machines:	0
Rated power capacity of each: (eg: 10HP, 30kW, 150kW)	n/a
Number of electric motors used to power milling machines:	0 (belt drive)
Number of electricity generators on-site:	0 (REE reported separately)
Quantity of diesel fuel used per month: (Litres / month)	7500
REE Equipment	
Diesel Engine 1	450HP
Generator 1	160kW
Diesel Engine 2	330HP
Generator 2	75kW
Fuel Consumption Engine 1	40 L/Hr
Fuel Consumption Engine 2	25 L/Hr
	* "we will install concrete poles next Feb to comply with EAC request"
	* "Previously used 5 engines, but they broke down and diesel too exp."
Future Plans	* "now we have 305kW installed for day load
REE Customers	
Existing customers	834 (from sales)
Curent average consumption (owner's estimate)	60 - 70 kWh/mth
Potential total customers (Owner's suggestion)	1000
Current tariff	2700 R/kWh
Dist network total length	2.9 km
Voltage at end of line (how often, min/max?)	110 V

Cluster C: Piggery at Kien Svay District, Kandal Province

Company Details		
Company Name:	Sam Rongthom Animal Husbandry	
Address (Number and Road)	Nat Road #1, Kean Svay, Kandal	
GPS Easting (UTM 48P WGS84)	0526103	
GPS Northing	1259530	
Telephone:	011 564 173	
Fax:	023 213 946	
E-mail	none	
Contact Person:	Mr Leng Sun Rafael	Mr Srun Sour
Position:	Manager	Owner
Direct Tel.:	011 564 173	011 773 907
Direct Fax:	99 900 469	
Mobile:	011 564 173	
Pig Population		
Current number of pigs: Male:	50	
Current number of pigs: Sow:	> 1000	

Current number of pigs: Piglets	< 9000
Maximum number of pigs at piggery at any one time:	10000
Months where there is close to maximum number of pigs: (please list)	constant
Minimum number of pigs at any one time:	constant
Harvest weight	80 - 100 kg
Average weight	65 kg (1000 sow@200kg + 9000 fatteners@50kg)
Pig Breeds	Yorkshire, Land Race, Duroc
Waste Management	
Avge total quantity of waste produced each day when **max** num. of pigs (kg / day):	10 tons per day (rough estimate)
Average volume of water used to clean the piggery when number of pigs is max.: (L/day)	Approx 50 cu.m used per day, but includes on-site drinking, cleaning etc
Water source	5 bore wells (water table aprox 10m)
Flooring material	concrete
Current waste disposal method:	1xBig (100m x 60m x 4m deep) and 1xSmall (30m x 40m x 4m deep), plus canals that flow waste by gravity to lagoons
Processing Equipment	
Number of electricity generators on-site:	5
Rated power capacity of each: (nb: estimate by the maintenance contractor from PP)	120kVA, 100kVA, 100kVA, 80kVA, 40kVA
Main use for the electricity generators (please list):	
Food preparation	5 x 30kW motors for 5hours/day (15-20T/day stock feed prepared on site)
Electric lights	300 light bulbs 60/100W for lighting and heating piglets every night
Cooling fans	5 x 750W for 7hrs/day
Water pumping (electric)	5 x 10HP pumps for 10hrs/day
Quantity of diesel fuel used per month: (Litres / month)	8000 Litres every 25 days, but about 300L is used in on-site trucks
Cost of diesel fuel: (Riels per Litre)	$0.60 / Litre
Generator Maintenance Cost (source?)	$0.20 /day
Other energy sources used	Coal (cheap coke from Vietnam)
Application	Cooking soy beans
Process	500kg batches roasted for 1 hour in drum over coal grate with electric mixer
Quantity	200kg to 300kg per day (approx 10 batches/day, 7am-3pm)
Cost	$130-$140 per T (annual: $15,600)
Is electricity purchased from a private local electricity producer: (Yes/No)	no

ANNEX 4 – SITE PARTNER AGREEMENTS

MEMORANDUM OF UNDERSTANDING

FOR THE CONDUCT OF

A FEASIBILITY STUDY OF ENERGY GENERATION
BASED ON <Corn cobs, rice husk or piggery effluent>

This Memorandum of Agreement (MoU) is made between the following two parties:

Party A, the Cambodian Research Centre for Development (CRCD), a locally registered non-profit, non-government organization with its office located at house #4, Street 63, Phnom Penh, Cambodia, represented by Mr Andrew Williamson (telephone: 012 564 085);

AND

Party B, <insert address and contact details>.

Background

Party A, in collaboration with the Ministry of Environment, is implementing a project in Cambodia entitled "Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia". The project is funded by the European Union and involves investigating potential sites where renewable energy sources can be used to provide electricity for local communities.

Party B is currently operating a <insert> business that generates biomass waste and is interested to know if it would be feasible to use this waste to generate electricity.

Both parties herewith have agreed on the following:

Party A Commitments

1. Party A agrees to conduct a thorough study into the costs, benefits and requirements of establishing an energy generation project based on the corn waste at Party B's site at no cost to Party B.
2. Party A agrees to protect the commercial interests of Party B by not releasing, without prior approval, any information that is of a confidential nature or that Party B has specifically requested

not to have released. Specifically, Party A will ensure that no confidential information will be used for any purposes outside of this study.

3. Party A agrees to provide to Party B a copy of the results of the study and any other useful information generated during the course of the study including maps, diagrams, etc.
4. Party A agrees that Party B is free to use the results of the study in any way he/she chooses and will not, in any way, be obliged to undertake any investments or action based on the results of the study.

Party B Commitments

1. Party B gives permission for Party A to conduct a study into the feasibility of establishing a project to generate electricity from the waste biomass at the <> site.
2. Party B agrees to allow Party A to visit all areas of the <> site that are relevant for the study, provided that Party A notify and request permission in advance.
3. Party B agrees to provide all the information and specific data that Party A requests about the site, such as technical specifications of the machinery installed; operating times, outputs, and their variability; current energy use and expenditures, capacity, any relevant future plans, etc.
4. Party B agrees to discuss the results of the study with Party A, and with potential investors or organizations that may be interested to help facilitate it.
5. Party B understands that the results of the study will be shared with potential investors, and that the basic details of the study will be public information, but this will not include any sensitive commercial information.

Both Parties agree to enter this MoU in good faith and will endeavour to communicate any concerns and to resolve any disagreements amicably.

Party A	Party B
By:_____	By:_____
Representative of Party A	Representative of Party B
Witness	Witness
By:_____	By:_____
Date:_____	Date:_____

ANNEX 5 – PICTURES OF TASK 2 SITE VISITS

Corn Silo at Malais District, Beantey Meanchey	
 Picture 1: National Highway 5 from Sisophon to Poipet (near Malais) afar heavy rain	 Picture 2: Stockpiled corn cobs behind Malais corn silo
 Picture 3: Whole corn fruit prior to threshing	 Picture 4: Grate furnace fired on corn cobs
 Picture 5: Grain drying silo structure	 Picture 6: Rice husk being loaded at new Malais Biomass Trader for delivery across border to Thai businesses

Picture 7: Weighing 1m^3 of corn cobs to estimate density

Picture 8: Private mobile corn threshing machine

Piggery at Kean Svay District, Kandal Province

Picture 9: Maternity section of piggery

Picture 10: Coal-fired kettle drum for roasting soy beans for feed

Picture 11: Effluent lagoon

Picture 12: Open drainage channel from pens to lagoon

Picture 13: Collecting effluent sample from lagoon

Picture 14: Feed preparation facility

Rice Mill REE at Tma Kohl, Battambang District

Picture 15: Rice husk stockpiled behind rice mill facility

Picture 16: Existing REE Powerhouse

TTY Tapioca Factory at Memot District, Kompong Cham Province

Picture 17: On-site generator sets

Picture 18: Effluent lagoon

Picture 19: Steam boiler

Picture 20: Starch powder drying column and boilers

Mong Reththy Palm Oil Processing Plant, Kompong Soam Province

Picture 21: Palm oil processing plant

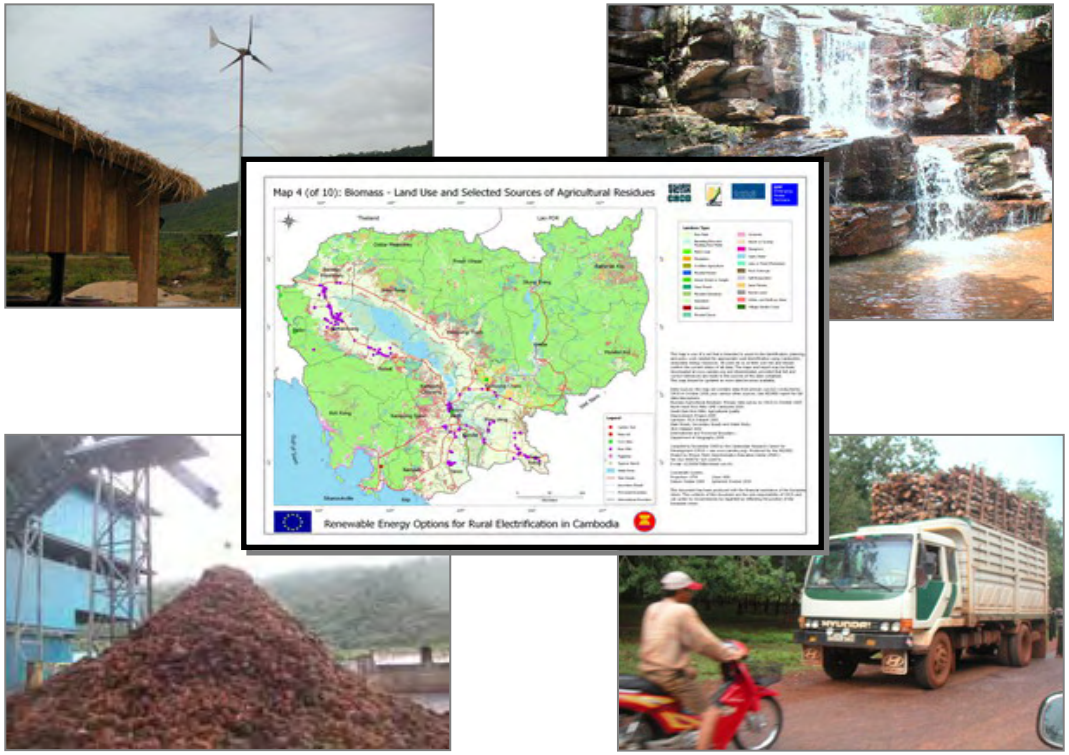
Picture 22: Effluent lagoon

Picture 23: Waste fibre

Picture 24: Empty fruit bunches

Renewable Energy Options for Rural Electrification in Cambodia

ANNEX 6 – RENEWABLE ENERGY RESOURCE MAPS OF CAMBODIA



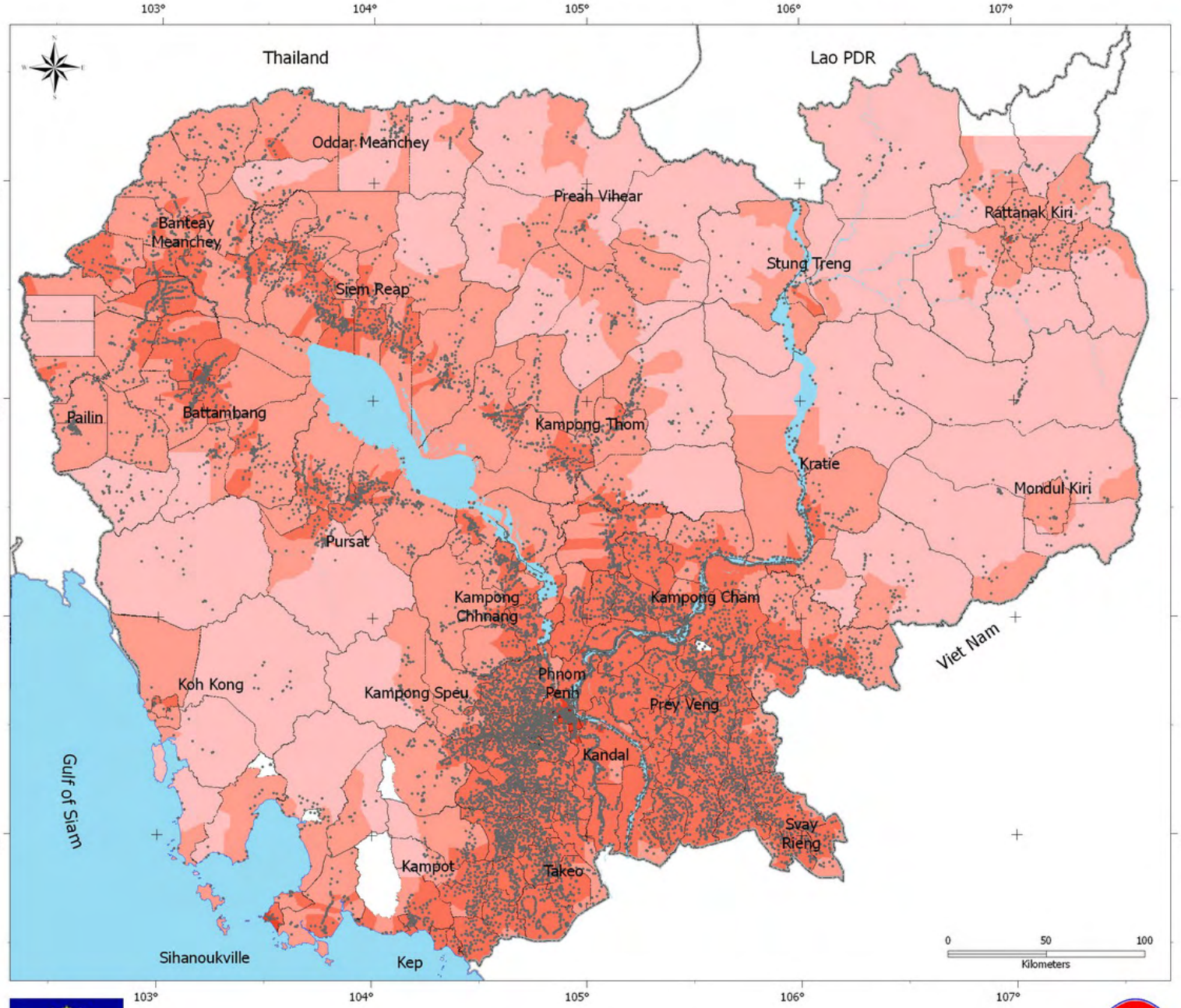
Intended Use of Maps

These maps are intended to assist in the identification, planning and policy work needed for appropriate rural electrification using Cambodia's renewable energy resources All users do so at their own risk and should confirm the current status of all data. The maps and report may be freely downloaded at www.camdev.org and disseminated, provided that full and correct references are made to the sources of the data contained. These maps should be updated as more data becomes available. They are designed to be printed at A3 size for sufficient clarity.

Compiled in November 2005 by the Cambodian Research Centre for Development (CRCD – *see www.camdev.org*). Produced for the REOREC Project by Phnom Penh Geoinformatics Education Centre (PGEC - *contact 012 880878 / 023 216876, email 012880878@mobitel.com.kh)*.

This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of CRCD and can under no circumstances be regarded as reflecting the position of the European Union.

Map 1 (of 10): Cambodian Population Density



Legend

Population Density by Commune (persons per km2)

- 0.2 - 10.0
- 10.1 - 100.0
- 100.1 - 1000.0
- 1000.1 - 5000.0
- 5000.1 - 164437.5
- No data
- Village Location
- Water Body
- District Boundary
- Provincial Boundary
- International Boundary

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Population Density: Commune Database 2004
District, Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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Coordinate System:
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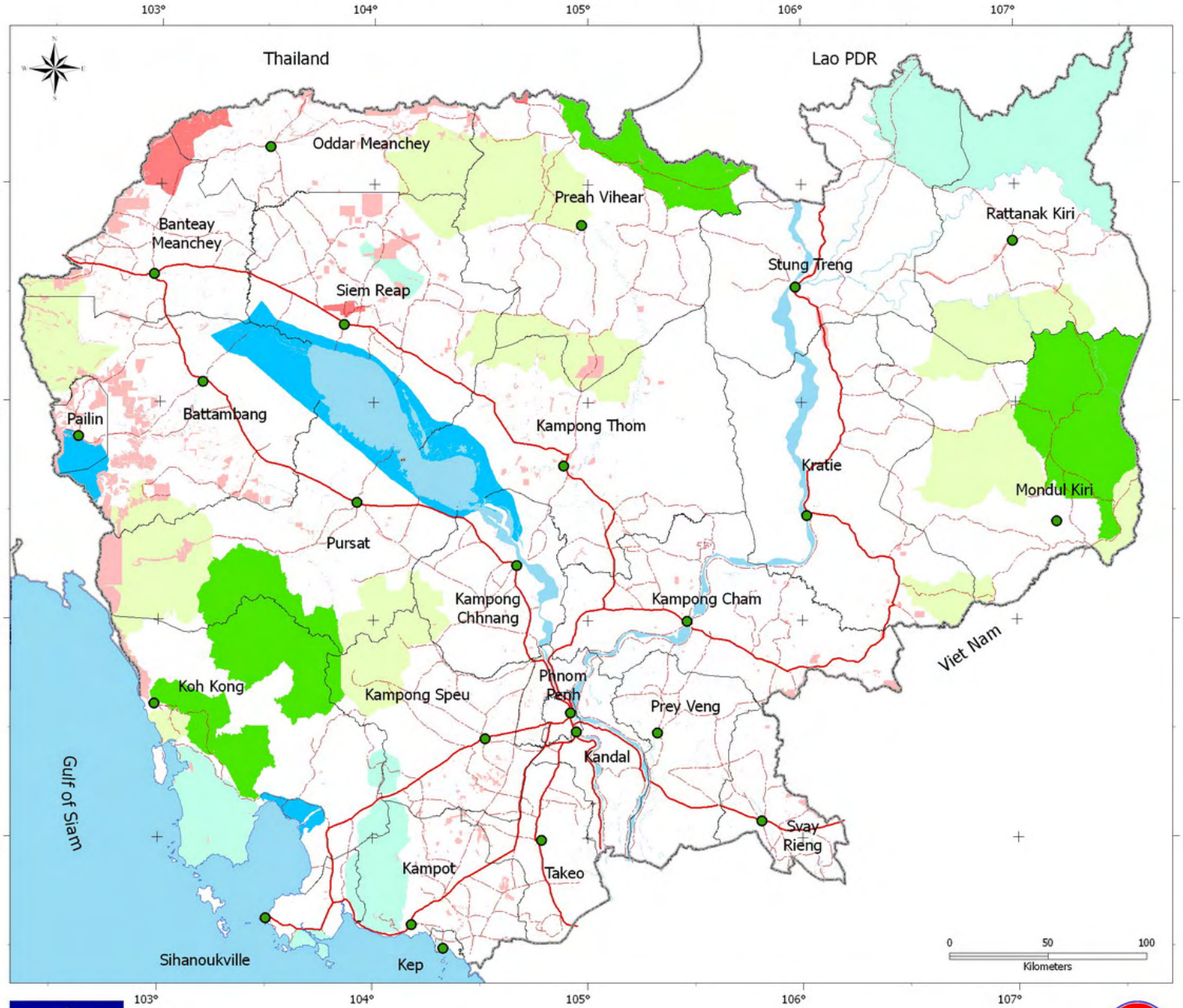
Renewable Energy Options for Rural Electrification in Cambodia

Map 2 (of 10): Roads and Protected Areas



Legend

- Provincial Center
- Land-mined Areas

Wilderness Areas

- Multiple Use
- National Park
- Protected Forest
- Protected Landscape
- Wildlife Sanctuary
- Water Body
- Main Roads
- Secondary Roads
- Provincial Boundary
- International Boundary

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Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Wilderness Areas: MoE
Protected Forests: FA, MAFF
Main Roads, Secondary Roads and Water Body: JICA Dataset 2002
International and Provincial Boundary: Department of Geography 2005
Note: Users should check with the Protected Areas Office at the Ministry of Environment for the current status of protected areas.

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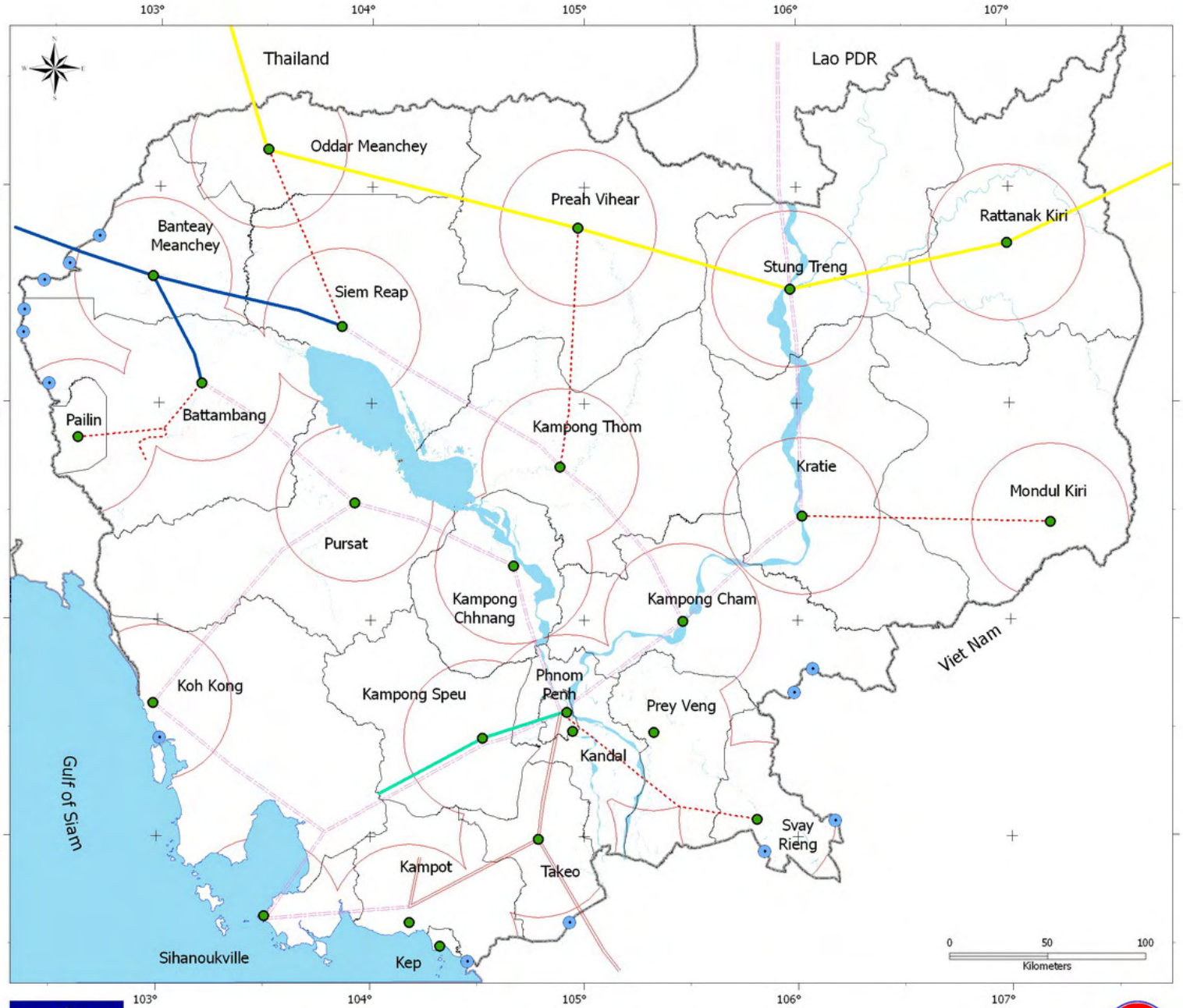
Renewable Energy Options for Rural Electrification in Cambodia

Map 3 (of 10): Power Grid Plans



Legend

- Provincial Center
- Power Imported Across Border

Tranmission Line

- 115 KV Existing
- 115 KV Project
- 115 KV Plan
- 220 KV Project
- 220 KV Project
- 500 MV Plan
- 40 Km radius
- Provincial Boundary
- International Boundary
- Water Body

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Power Grid Plans: Electricite du Cambodge's Planning Office 2004, Electricity Authority of Cambodia 2004
Provincial Center, Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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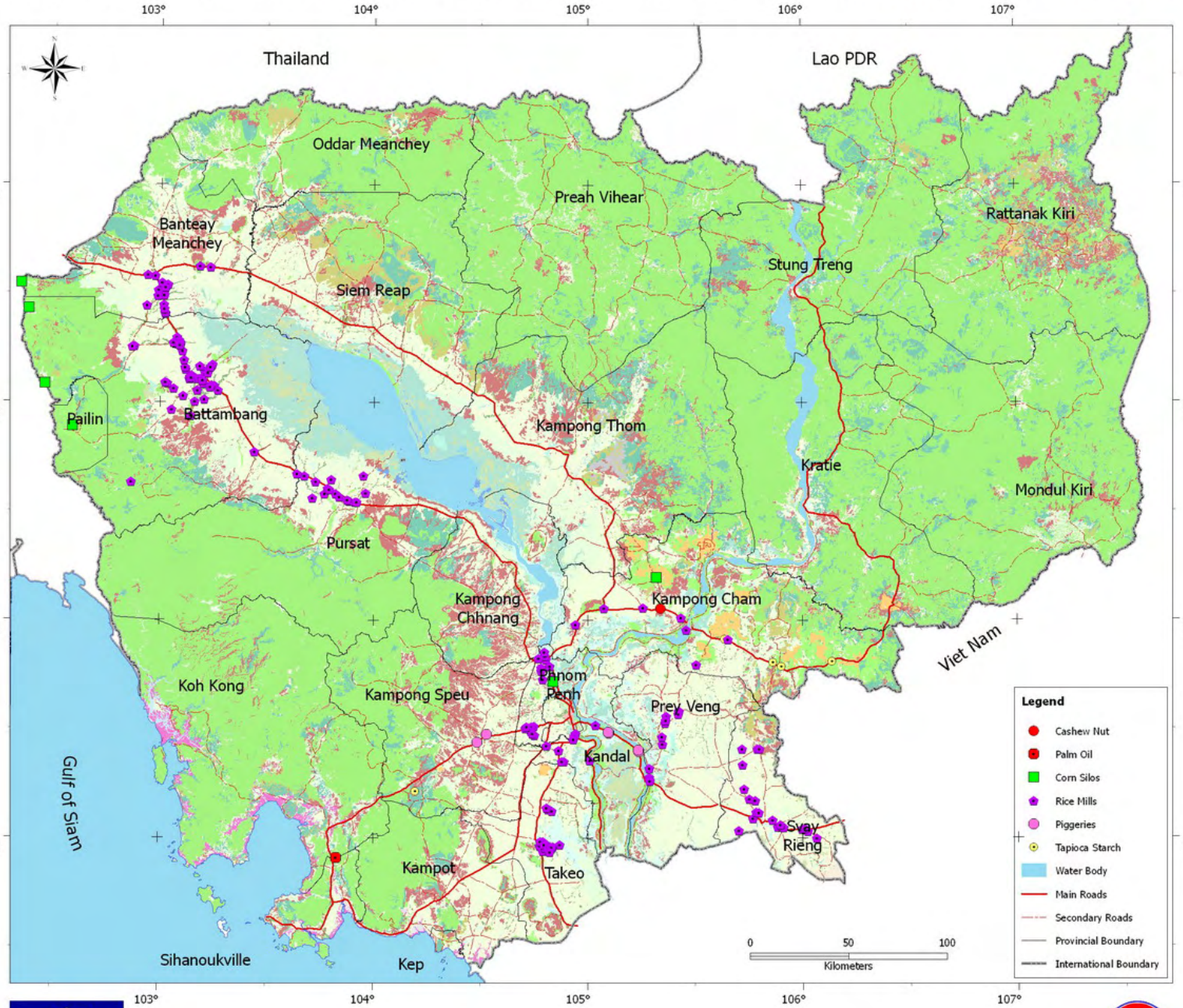
Renewable Energy Options for Rural Electrification in Cambodia

Map 4 (of 10): Biomass - Land Use and Selected Sources of Agricultural Residues



Landuse Type

- Rice Field
- Receding Rice and Floating Rice Fields
- Field Crops
- Plantation
- Swidden Agriculture
- Flooded Forest
- Dense Forest or Jungle
- Clear Forest
- Flooded Grassland
- Grassland
- Shrubland
- Flooded Shrub
- Orchards
- Marsh or Swamp
- Mangrove
- Open Water
- Lake or Pond (Perennial)
- Rock Outcrops
- Salt Evaporator
- Sand Terrain
- Barren Land
- Urban, and Built-up Areas
- Village Garden Crops

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Biomass-Agricultural Residues: Primary data survey by CRCD in October 2005
North West Rice Mills: SME Cambodia 2005
South East Rice Mills: Agricultural Quality Improvement Project 2005
Landuse: JICA Dataset 2002
Main Roads, Secondary Roads and Water Body: JICA Dataset 2002
International and Provincial Boundary: Department of Geography 2005

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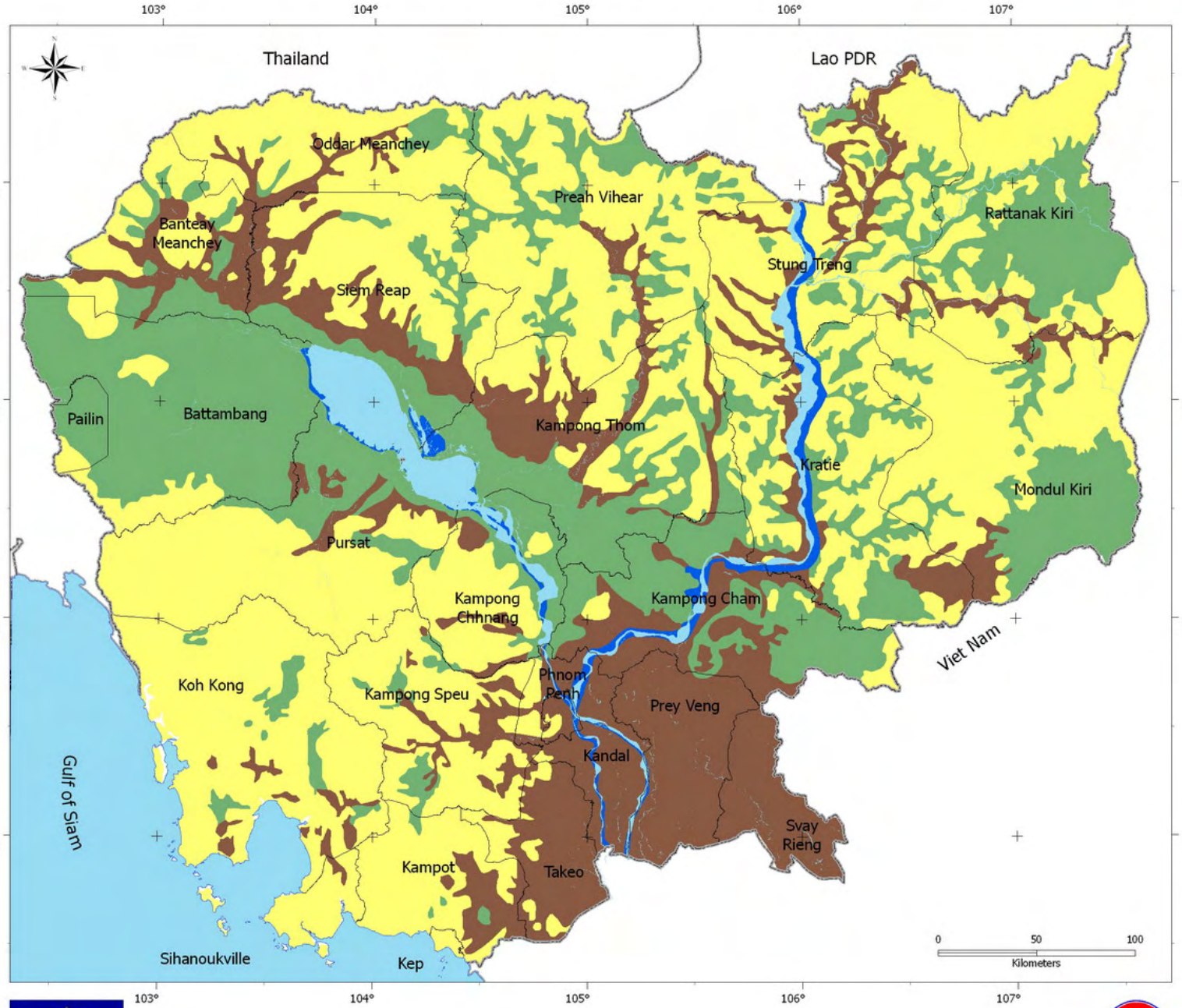
Renewable Energy Options for Rural Electrification in Cambodia

Map 5 (of 10): Biomass Energy Crops - Soil Fertility



Legend

Soil Fertility

- High Fertility Soil
- Medium Fertility Soil
- Low Fertility Soil
- Water
- Water Body
- Provincial Boundary
- International Boundary

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Biomass Energy Crops-Soil Fertility: Gene-Ecological Zonation of Cambodia (Tree Seed Project FA/ Danida /DED) 2003
Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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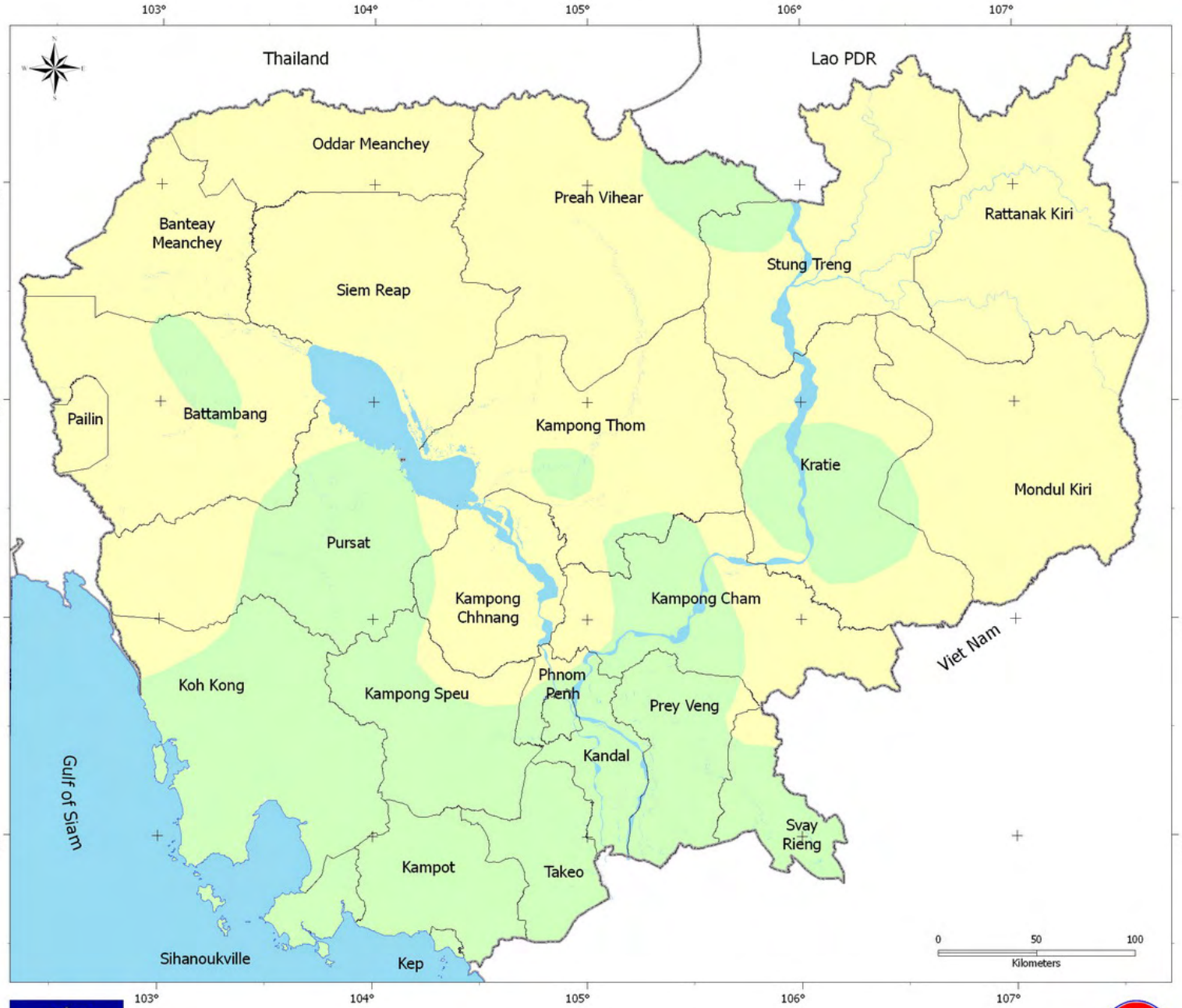
Renewable Energy Options for Rural Electrification in Cambodia

Map 6 (of 10): Biomass Energy Crops - Dry Periods



Legend

Dryperiod

- <= 4 months
- > 4 months
- Water Body
- Provincial Boundary
- International Boundary

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Biomass Energy Crops-Dry Periods: Gene-Ecological Zonation of Cambodia (Tree Seed Project FA/ Danida /DED) 2003
Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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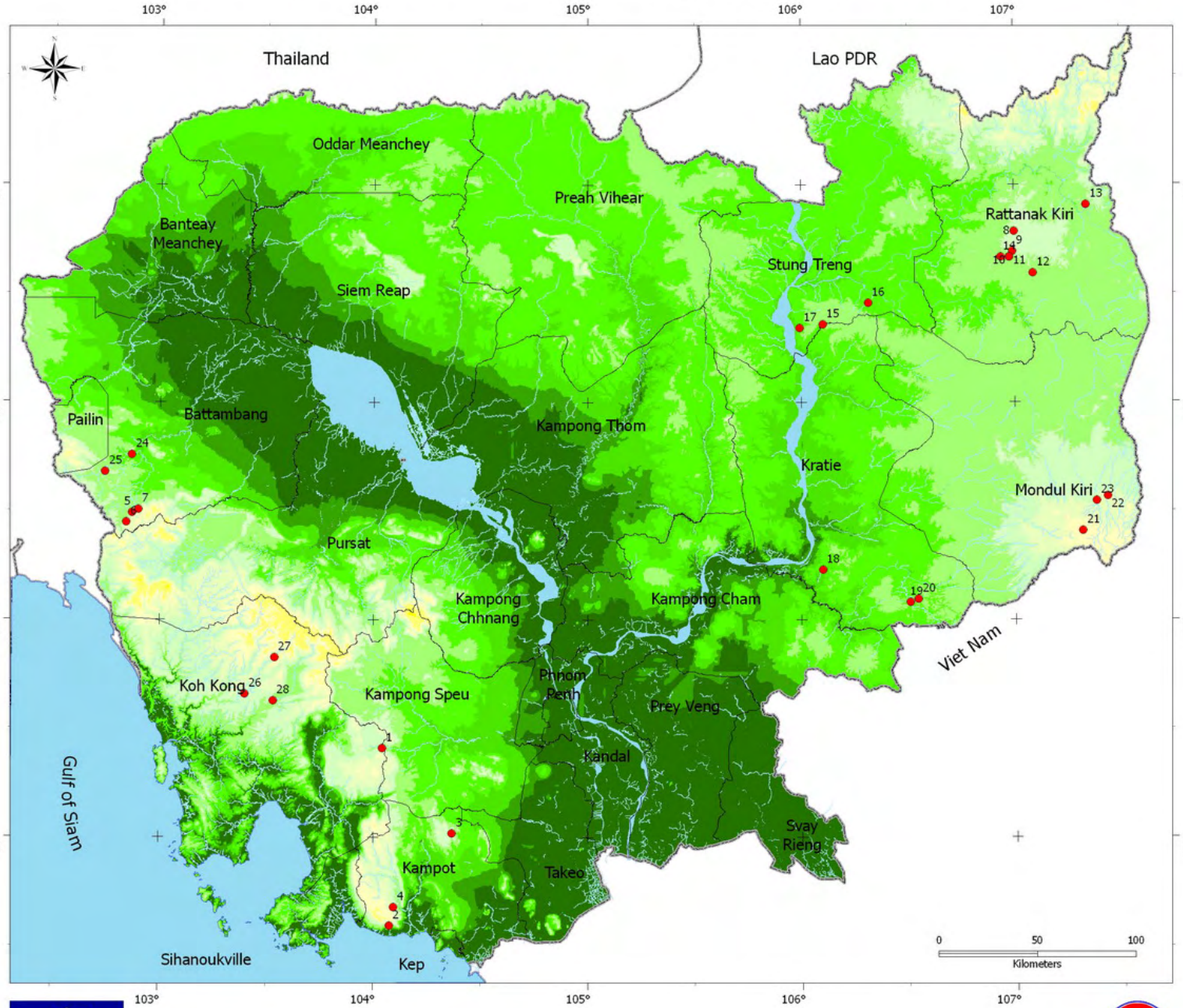
Renewable Energy Options for Rural Electrification in Cambodia

Map 7 (of 10): Micro Hydro - Topography and Rivers



Legend

- Potential Micro Hydro sites (JICA 2005)

Elevation above sea level

- 0 - 15 m
- 16 - 25 m
- 26 - 50 m
- 51 - 100 m
- 101 - 250 m
- 251 - 500 m
- 501 - 750 m
- 751 - 1,000 m
- 1,001 - 1,500 m
- 1,501 - 1,756 m
- Water Body
- River
- Provincial Boundary
- International Boundary

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Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
JICA MH sites: Japanese International Cooperation Agency (JICA)-Master Plan Study for Rural Electrification by Renewable Energy, 2005
Provincial and International Boundary: Department of Geography 2005
DEM, River and Water Body: JICA Dataset 2002

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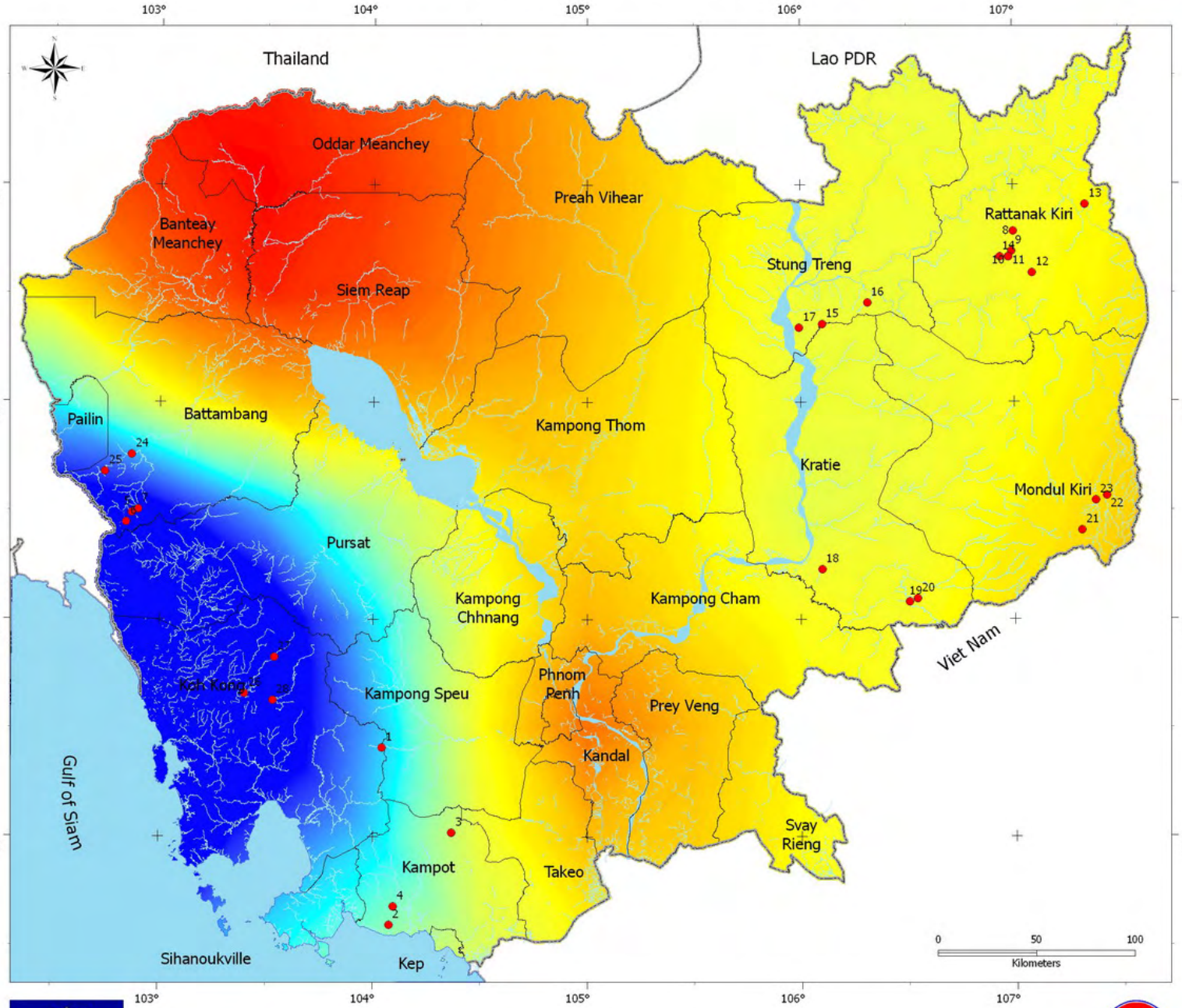
Renewable Energy Options for Rural Electrification in Cambodia

Map 8 (of 10): Micro Hydro - Rainfall



Legend

- Potential Micro Hydro sites (JICA 2005)

Average Annual Rainfall (mm)

- High : 3908
- Low : 1224
- Water Body
- River
- Provincial Boundary
- International Boundary

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This map should be updated as more data becomes available.

Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
JICA MH sites: Japanese International Cooperation Agency (JICA)-Master Plan Study for Rural Electrification by Renewable Energy, 2005
Rainfall: FAO 2004
Provincial and International Boundary: Department of Geography 2005
River and Water Body: JICA Dataset 2002

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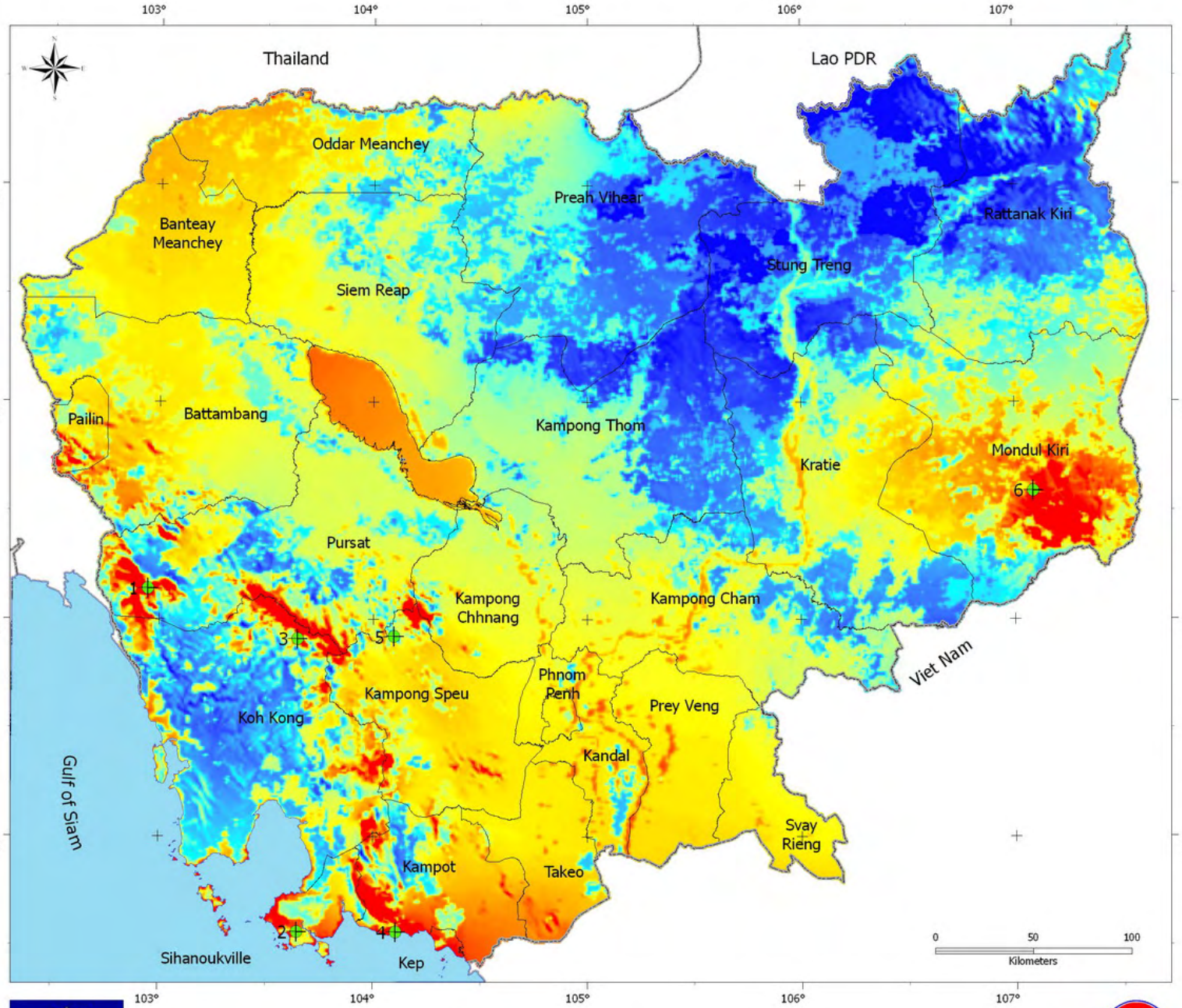
Renewable Energy Options for Rural Electrification in Cambodia

Map 9 (of 10): Wind Energy



Legend

Simulated Annual Average Wind Speed (m/s at 30m above ground)

High : 7

Low : 2

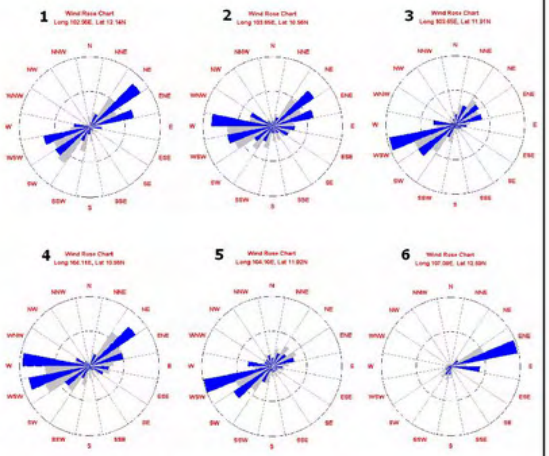
Water Body

Provincial Boundary

International Boundary

Wind Rose Charts Location

Percent of Total Wind Energy (Blue) and Time (Gray):
Circle Center = 0.0%
Inner Circle = 12.5%
Outer Circle = 25.0%



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Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Wind Energy: Wind Energy Resource Atlas of South East Asia (World Bank 2002)
Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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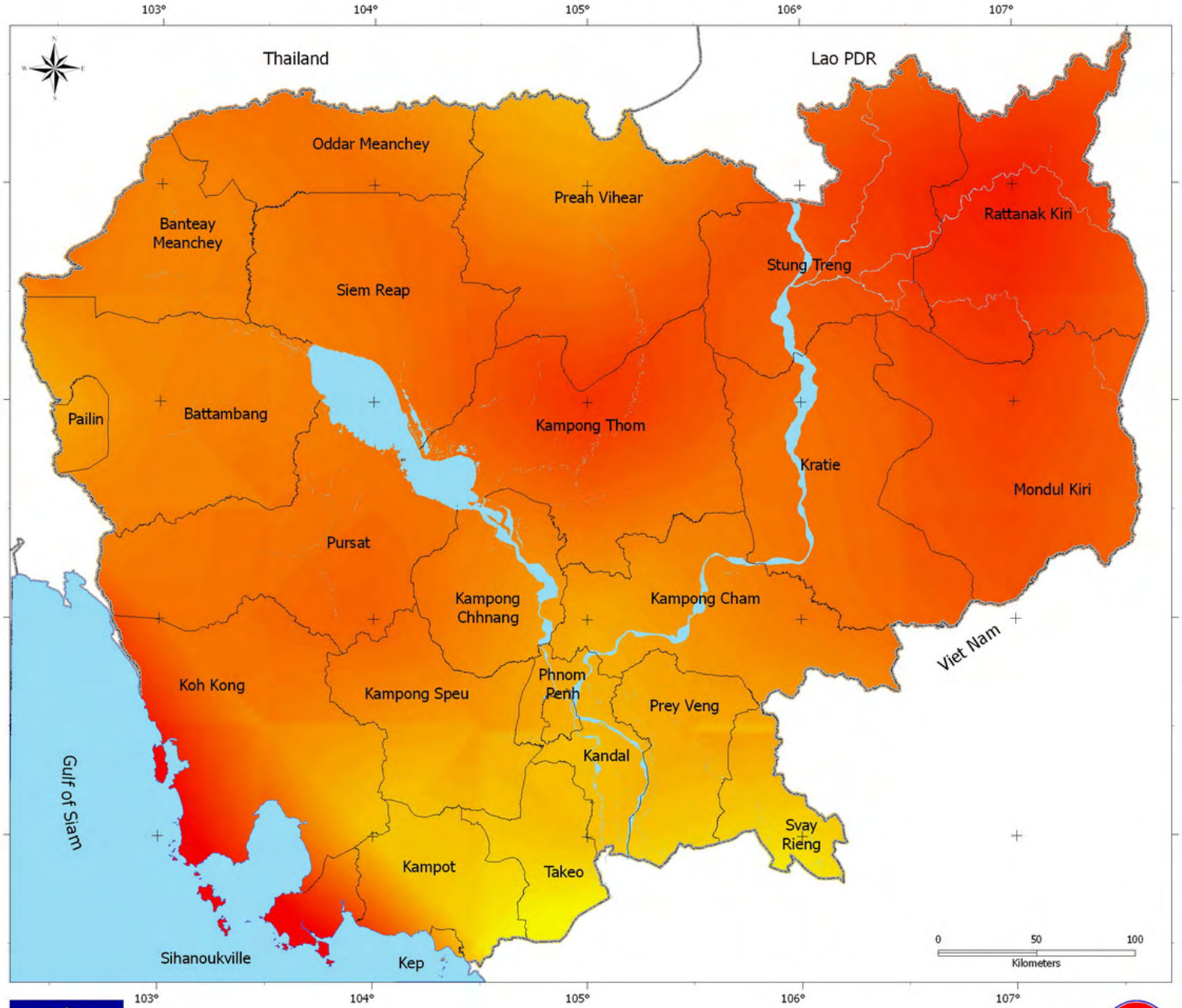
Map 10 (of 10): Solar Energy



Legend

Average Insolation (kWh/m2/day)

- High : 6.5
- Low : 6.2
- Water Body
- Provincial Boundary
- International Boundary

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Data Sources: the map set contains data from primary surveys conducted by CRCD in October 2005, plus various other sources. See REOREC report for full data descriptions.
Nasa Solar: National Aeronautics and Space Administration (NASA-USA) Surface Meteorology and Solar Energy
Provincial and International Boundary: Department of Geography 2005
Water Body: JICA Dataset 2002

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