資料1

現地調査内容要旨

Ⅰ．村落調査（2つの村）

・調査日　：2004年9月1日
・調査対象：Pu　Tru村（UP，DOWNの2つの村）
・調査内容：
①Pu　Tru村　（UP）

・家族・村の構成：
-世帯主はMuridさん(99才)、子供4人、孫を含め家族は総勢17名。
-民族はプノン。
-1979年以前は現在地よりさほど遠くない、ヴェトナムに近い地点にいたが内戦の終結に伴い、現在の地点に移動。

・主な生計と日常生活
-焼畑農業及び松脂の収集。
-畑の面積は1～3ｈａ、主に米、とうもろこし、バナナ、すいか。
-土壌の肥沃状態により、1年～最長3年で耕作地を変える。化学肥料は使っていない。
-植え付けは5月、収穫は11月又は12月。
-牛4頭、水牛5頭、豚20匹、鶏100羽を所有。
-燃料は主に薪で２～３日毎に大人が村の近郊から調達。ケロシンを夜間のランプ用に使用するが、非常に限られた量。
-草原に火入れし、食用のウサギを捕獲。薬草も採取。
-病気としては、マラリヤがある。医療費は基本的には無料だが、食料その他の物で病院にお礼をする。重病でかなり大変な場合は、村全体でお礼をする。

・生活習慣
-冠婚葬祭以外に、収穫祭をするが食物は持ち寄り。
-結婚年齢は、男性22歳、女性20歳以上。

・宗教
-アミニズム

・家計収入・その他
-米の収穫は40サス、現金が必要な時は、果物、卵、牛を売るか物、例えば中古のオートバイと交換する。
-１ﾘｯﾄﾙ1500ﾘｴﾙのケロシンを月に3ﾘｯﾄﾙ購入。
-月にUS$30程度の現金が必要になるが、松脂を採取して換金している。
-必要に応じて町に若者を働きにだすが、一日3,000ﾘｴﾙにしかならず、働き口も常にあるわけでは無い。ゴム農園等の事業があり安定した現金収入が入るのであれば、是非農園で働きたい。
-テレビやラジオが無く情報が入ってこない。夜間照明のことも考えれば電気が必要。

②Pu　Tru村（DOWN）

・家族・村の構成：
-世帯主はLoed Nimさん(50才)、村人総勢110名。
-民族はプノン。
-年世代にも亘って現在の地点生活。

・主な生計と日常生活
-焼畑農業及び松脂の収集。

-畑の面積は 2～３ｈａ、主に米、とうもろこし、バナナ、すいか、いも。
-1 箇所 2 年で耕作地を変える。化学肥料は使っていない。
-植え付けは 4～5 月、収穫は 11 月又は 12 月。
-象を村で 4 頭所有、牛を村で 300 頭を飼育（所有者はプノンペン在住の富裕層）、その他水牛、豚、鶏を所有。
-燃料は主に薪で２～３日毎に大人が村の近郊から調達。
-草原に火入れし、食用のウサギを捕獲。薬草も採取。
-病気としては、マラリヤがある。医療費は基本的には無料。

・生活習慣

-冠婚葬祭以外に、収穫祭をするが食物は持ち寄り。
-結婚年齢は、男性 20 歳、女性 18 歳以上。

・宗教

-アミニズム

・家計収入・その他

-米の収穫は 20 サス、現金が必要な時は、薬草、果物、卵、牛を売るか物、例えば中古のオートバイと交換する。
-時より観光客が来るが象に乗せて近くの滝まで案内すると一人につき 10 ﾄﾞﾙの現金収入となる。去年は 30 人ぐらい来たが今年はまだ 10 人ぐらいしか来ていない。
-月に US$15 程度の現金が必要になるが、薬草を採取して換金している。
-必要に応じて町に若者を働きにだすが、1 日 1 ﾄﾞﾙ程度にしかならず、働き口も常にあるわけでは無い。村の周りにゴムノキを植えられたらこまるが、農園等の事業があり安定した現金収入が入るのであれば、年齢に関係なく働ける者は全てゴム農園で働きたい。
-村内に学校があるが教室が暗くて勉強をする環境として良くない。電気があれば室内照明として利用できる。

Ⅱ．電力需要調査

・調査日　：2004年9月1日
・調査対象：セン・モノロム病院（ベッド数27、医師　5人、看護婦20人）
・調査内容：以下は Dr. Sea Sokmeangのコメント

-日系企業がモントギリでゴム農園のプロジェクトを計画しているという話しを聞いているが、地域の雇用促進、インフラ整備及び税収につながるはなしで、歓迎したい。
-病院では電力不足が最大の問題で、電力不足により手術が出来ない時がある。
-自家発電用のディーゼル発電機が75kwと50kwの２機があるが、50kwは故障後、修理費用が工面できず修理していない。
-薬類は殆ど全てが常温で保存できるが、手術室の機器及び空調、検査・研究の空調及び室内灯、井戸からの水のくみ上げに電力が必要。
-現在、主な電力として、近くの個人電力事業者から水力発電による電力の供給を受けているが、雨季でも供給が安定せず、自家発電機を動かしている。
-ディーゼルオイルは、1ﾘｯﾄﾙ当たり1700ﾘｴﾙし、年間で約1,000ﾘｯﾄﾙ程度使用している。
-水力発電の電気代は1800ﾘｴﾙ(約50ｾﾝﾄ)/kwhと非常に高い。
-2005年にアジア開発銀行の資金で病院の拡張が計画されているので、ゴム園等の事業が営まれた場合にも、当病院一箇所で十分対応可能と考えられる。
-薬品は政府からの支給。
-医師の給与は、US$100～150/月。看護婦はUS$30/月。

Ⅲ. 関連省庁および企業との面談

①カンボジア政府工業・資源エネルギー省

・面談日　：2004 年 9 月 3 日
・面談者　：Dr. SAT SAMY（事務次官）
・面談内容：

-丸紅がモントギリでゴムノキの CDM 植林事業を計画しているのは知っている。
植林案件の実施に伴う地域電化で、再生可能エネルギーを電源とするプロジェクトを提案して頂き感謝している。日本企業の提案案件は他国の提案案件と比較し、その実現性が高いので大いに期待している。

-植林は農林水産省だが、再生可能エネルギーは、私の工業・資源エネルギー省が対応する。
何か問題・要望があれば、私か私の秘書の Mr. Toeh Savanna に何でも言ってほしい。

-植林事業の候補地内にある学校に、太陽光と風力を組み合わせたハイブリットのサンプル発電設備を設置し、ライトを点燈したり、テレビを見れるようにすると言うのは、非常に良いアイデア。　設備の維持管理については、地域行政及びその村の村長と良く調整する必要がある。

-カンボジアでは、現在フンセン首相が、個人の寄付をベースに 200 箇所の学校、寺院、橋等に太陽光の電灯設置運動を推進している。また、政府としては、2020 年までにカンボジアの全ての地域に再生可能エネルギーで電力供給することを目的としたマスタープランを作成する予定になっている。

-カンボジアには、太陽光を使った電灯の製造会社があり、風力との組み合わせによるハイブリット化には、国としても個人的にも非常に興味がある。

②ＪＩＣＡカンボジア事務所

・面談日　：2004 年 9 月 3 日
・面談者　：橋本　信雄（JICA 専門家、Power Development Advisor）
・面談内容：

-モントギリの州都であるセン・モノロムでは、個人事業主の電力供給事業が営まれているが、規模が小さすぎて、地域の需要を満たしていない。また、料金も首都のプノンペンと比較し、約 2.5 倍程度となっており、地域の発展の妨げとなっている（プノンペンは US$20 ｾﾝﾄ/kwh に対しセン・モノロムは US$50 ｾﾝﾄ/kwh 程度)。

-JICA は現地の状況に鑑み、無償ベースの小規模水力発電設備の建設計画を具体化すべく、作業を進めている。具体的には、同地域で三箇所の地域に各々62KW、65KW 及び 48KW の発電設備を設置し、州都のセン・モノロム（人口 8～9 千人）に供給する予定。

-タイムスケジュールとしては、本年度は基本設計、来年度の建設着工を予定している。

-カンボジア政府は、2020 年までにカンボジアの全ての地域に再生可能エネルギーで電力供給することを目的としたマスタープランを作成する予定になっている。

IV．記録写真	
・Pu　Tru 村　（UP） -村落風景	
・Pu　Tru 村　（UP） -小型のハイブリット発電設備の設置を予定している学校	
・Pu　Tru 村　（DOWN） -住居	

・Pu　Tru 村　（DOWN） -学校	
・セン・モネロン病院 -建物外観	
・モントギリ　水力発電所 -建物外観	

・モントギリ　水力発電所 -ダム	
・モントギリ -山間風景	

資料2

2004年11月25日

セミナー議事録

日時：2004年11月12日 9:30 - 11:30
出席者：Pu Tru　Loe　(UP) Village　(V1)　　６名
　　　　Pu Tru　Krom (DOWN) Village (V2)　　６名
　　　　Orang Village　　　　　　　　(V3)　　　６名

日本側：　池嶋、　Mr.　Kol

ゴム植林について
V1 子供たちの将来を考えてゴム植林に賛成する。化学物質による汚染が心配。
A（池嶋）　植林には肥料を使用するが，環境面に気を配った肥料と使用法を取る。

V2 植林事業を歓迎する。新たな植林地を得るために木を伐採しないでほしい。また，あまり村に近いところを植林地に選択しないでほしい。牛の放牧に支障をきたす。
A 新規植林の対象地は草地なので伐採はしない。また，墓地などの村にとって大切な土地は避ける。村から労働者が通う距離を考慮して植林地を決めたい。我々としては，放牧に関連する野焼きについて心配している。

V3 環境省の職員にも相談したが，集落範囲に植林することになるのか。
A まず，集落範囲の定義を教えてほしい。
V3 周囲3kmと考えている。
A 最終的には3000人の労働力が見込まれている。雇用は地元優先としたい。
V1 村民数は限られている。当然外部から雇用することになると思うので，良い人たちを連れてきてほしい。

A ところで若い人たちはゴム園で働きたいと思っているか。
V1-3 働きたい。
V1 日雇いか。また，賃金はどのくらいになるか。
A 雇用形態はこれから決めることになる。賃金についても同様だが，国や地方政府が定めた決まりなどがあればそれに従うつもり。

V2 中国系のプロジェクトも進行しているようだが地元に対する説明もないので心配している。
（ベトナムのプロジェクトという情報もある）
A 実際のところ我々も把握していない。プーリャンに中国系のプロジェクトがある。集落範囲については分からない。3kmといえばよいかもしれない。

A とにかく，我々はあなたたちを尊重して計画を定める。
A 植林が必要とのことだが，なぜ必要か。
V1 私は木が好きだ。
V3 植林はどのように実施するのか。ゴム園内は立ち入り禁止にするのか。中国系プロジェクトは立ち入り禁止どころか牛が中に入ったら返さない。
A 我々はまったく構わない。牛も人も自由に通行できるし，何しろあなた方に働いてもらう予定だ。もし，牛が苗木を食べてしまったら我々はただ泣くだけ。もちろん，植林地に牛を近づけないという案もある。話し合って解決法を見つけていきたい。
A ところで，牛は村のものか，それとも外部の人からの委託で飼育しているのか。
V1 ほとんど村の持ち物
V2 10-20 頭までが村の持ち物。400 頭がプノンペンの住人からの委託でこれからも増える見込み。
V3 全て村の持ち物

発電需要について
A 各村から，電力が必要か，何に使うか，どのくらい必要か教えてほしい。
V1 電力は学校の照明に必要。必要時間は 1 時間程度。一度導入されれば需要は広がる。
A 電力は課金されることが予想されるが。
V1 お金はない。そのために働くことは大変だ。
A 無料ということはありえない。しかし，まず植林プロジェクトで雇用が安定し，その後に発電プロジェクトが続けば，電力の導入に無理はないと考える。

V2 学校の照明。子供たちが夜に勉強するための夜間照明は必要。その他テレビ等、あればあるに超したことはない。

V3 やはり学校の照明。今は、家庭でアルコールンランプを使用しているが，火事が起きる可能性がありいつも不安な状況で使用している。アルコールランプは、１日に１時間～1 時間半使用し、アルコールの消費量は１ヶ月あたり約 1～3 リットルとなり合計 1,500～4,500 リエル（1500 リエル/L 程度）になる。電気は、アルコールランプと異なり不安がないが、電気料金が高いと使用できない。

以上

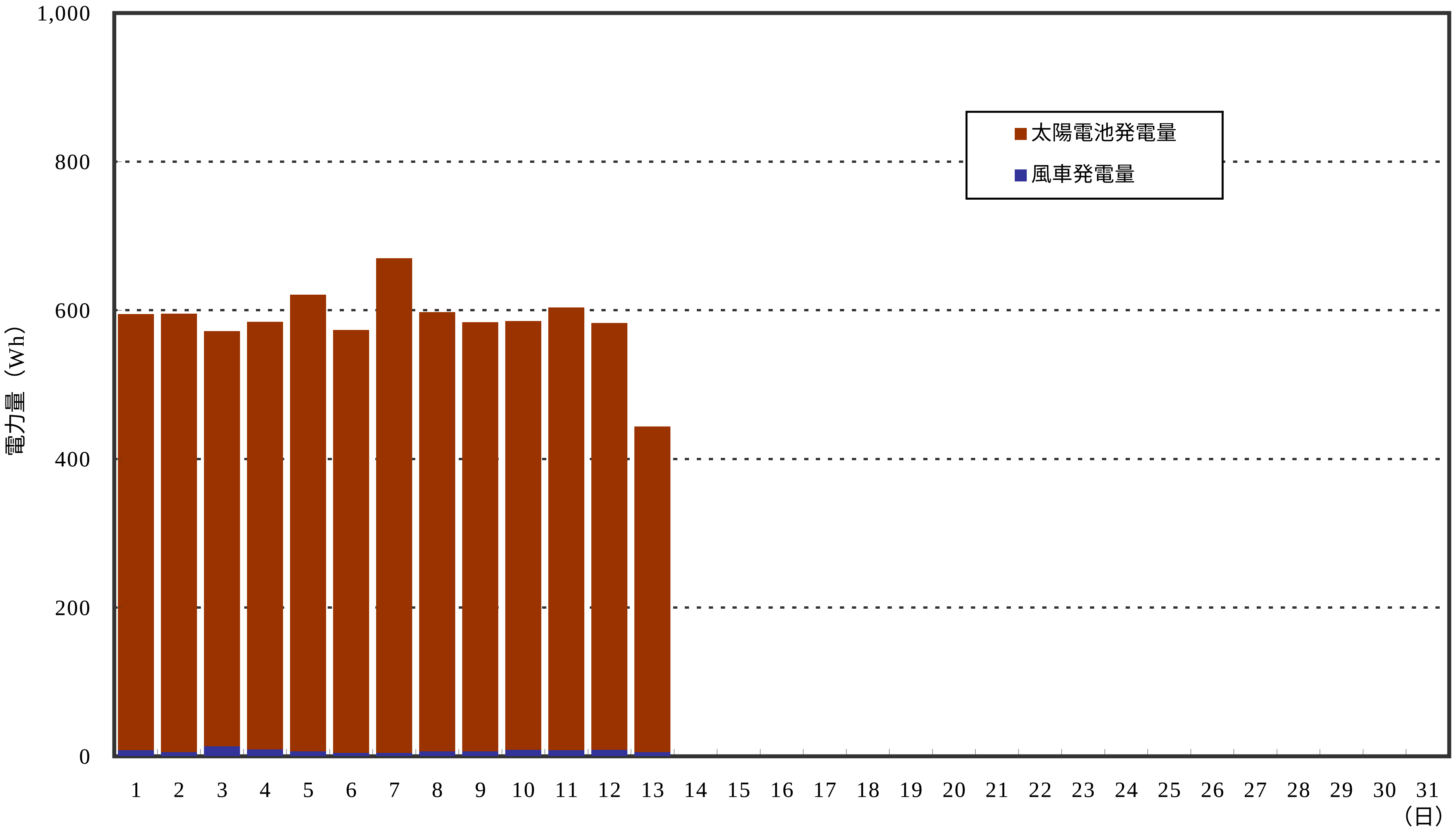


図3.17　1月における日別のハイブリッド発電システムの発電電力量比較（2005年）

カンボジア・モントギリ高原小規模ＣＤＭ向け

シグナスミル風力発電機用ハイブリッド電源システム

仕様書

目　　次

１．はじめに

本仕様書は丸紅株式会社様向け「カンボジア・モントギリ高原」小規模ＣＤＭ向け電源システムの納入条件について記載したものです。なお、記載の無い条件等については、双方協議の上決定とします。

２．概　　説

本システムは、風力発電装置および太陽電池によって発電された直流電力を入力とし、充放電コントローラ、ダンプ抵抗器および小形サイクル用シール鉛蓄電池により、ＬＥＤ照明、テレビ、モニタリングシステムへ安定した電力を供給します。なお、負荷装置はタイマーにより所定の運転時間のみ動作します。

図 2-1 にシステム構成図、表 2-1 に主要構成機器を示します。

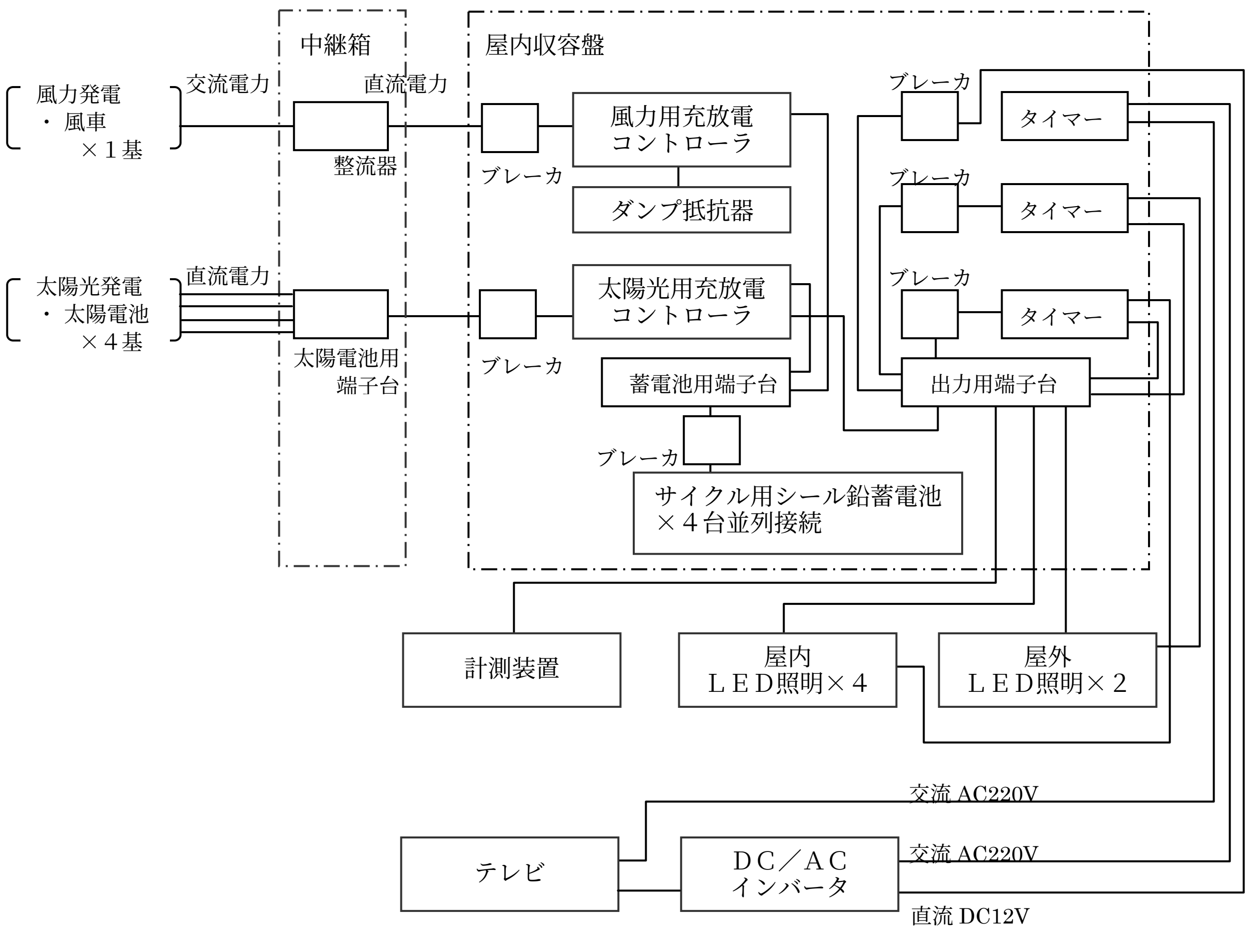


図 2-1　システム構成図

表 2-1　主要構成機器

システム名	設置場所	数量	主要構成機器
風力発電機	屋外	1 式	・シグナスミル社製（200W）
太陽電池	屋外	4 台	・MSK 社製（MPP125-80：80W）
中継箱	屋外	1 式	・整流器 ×1 台 ・端子台（6P） ×1 台
電源システム	屋内（教室内）	1 式	・屋内収容箱 ×1 台 ・風車用充放電コントローラ ×1 台 ・ダンプ抵抗器 ×1 台 ・太陽光用充放電コントローラ ×1 台 ・小形サイクル用シール鉛蓄電池 ×4 台 ・端子台（8P） ×2 台 ・タイマー ×3 台 ・遮断用ブレーカ ×4 台 ・計測信号変換器（検出器等含む） ×1 式
ＬＥＤ照明（屋外）	屋外	2 台	・LED 照明：SP-36（約 4.32W）
ＬＥＤ照明（屋内）	屋内（教室内）	4 台	・LED 照明 SP-36（約 4.32W）
テレビ	屋内（教室内）	1 台	・インバータ：DS600-212（220V 仕様）

３．構成機器

（1）シグナスミル風力発電機

□主な特長

・風の方向に関係なく回転します。
・微風で起動し、低風速時の回転トルクが向上しています。
・同じクラスのプロペラ型と比較して、低騒音、低振動で回転します。
・製造工程が少なく、低価格の風車を大量に供給できます。
・形状が優しく「都市型の風車」として街の美観に融合します。

□諸　元

表 3-1 に主要諸元を、出力特性を図 3-1 に示します。なお、出力特性は 2004 年 5 月 1 日の風洞試験結果値を基に算出した値です。（直径 1.0m、ブレード長 1.2m）

表 3-1　シグナスミル風力発電機の主要諸元

項　目	諸　元
回転直径	1000 mm
ブレード枚数	5 枚
ブレード長さ	1200 mm
起動風速	1.2m/s
発電開始風速	3.5m/s
風速 12m/s 時の発電電力	43W
最大耐風速	60m/s

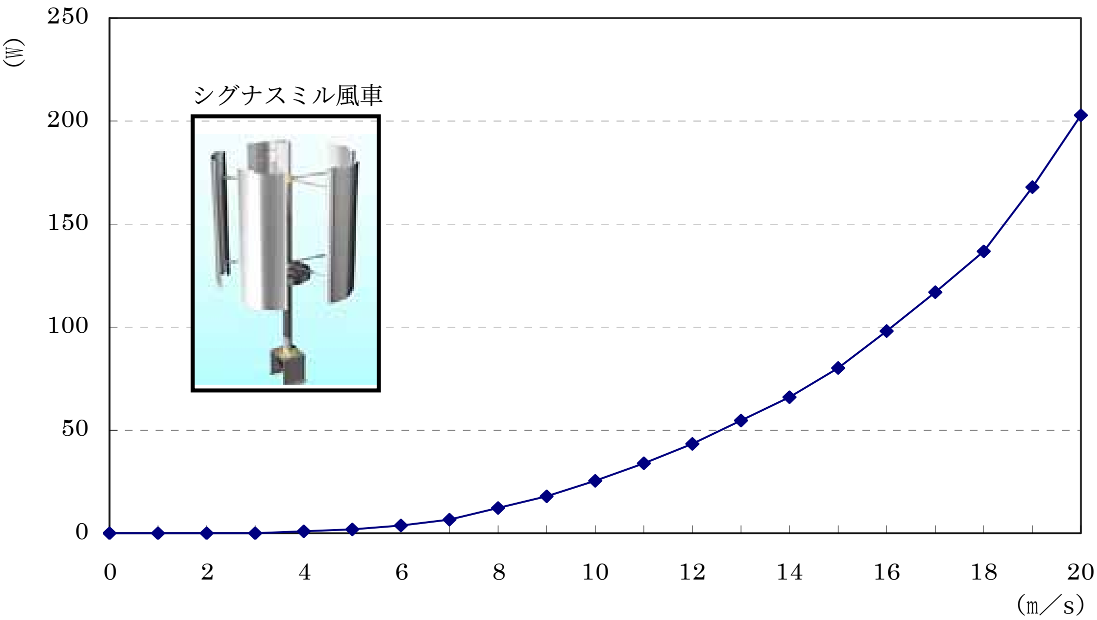


図 3-1　風車出力特性（パワーカーブ）

（2）風力用充放電コントローラ

□主機能

・発電電力を効率よく 12V 用蓄電池に充電しつつ、負荷に電力を供給する。

・蓄電池が浮動充電状態に達すると定電圧で、出力が常に最大電力を取り出す最適充電制御を行う。

・発電電力制御として、蓄電池電圧を監視し、自動的にダンプ抵抗器の運転制御を行う。

・過充電、過放電防止回路を内蔵し、蓄電池を自動的に回路から切り離す制御を行う。

□諸　元

表 3-2 に主要諸元を示す。

表 3-2　風力用充放電コントローラの主要諸元

項　目		単位	定格及び特性	記事
型　式		－	SWS－300－CONT	
周囲温度		℃	-10～50	
湿　度		%	5～95	結露がないこと
直流入力側	運転電圧範囲*1	V	2.5～27	
直流出力側	蓄電池端子電圧	V	14.0～14.7	入力電圧　3V～13V（昇圧コンバータ動作時） 負荷電流　1A＋ 蓄電池充電電流　1A 時
		V 以下	14.8	入力電圧　13V～27V 直送制御時 降圧コンバータ動作時
	電流変動範囲 負荷電流＋ 蓄電池充電電流	A	0～12	昇圧コンバータ動作時
			0～20	直送制御時
			0～20	入力電圧 21V 以上 降圧コンバータ動作時
ダンプ抵抗器切替	動作開始	V	14.0～14.8	初期設定　14.7V
	動作停止		12.0～13.0	初期設定　12.5V
警報及び検出	過電圧検出	V	15.3±0.2	
	低電圧検出	V以下	8	
	過放電検出電圧	V	10.8±0.2	
	過放電復帰電圧	V	12.0±0.2	

□寸　法

・W170×H240×D70mm

（３）ダンプ抵抗器

□主機能

・蓄電池の電圧値が規定値以上となった場合、ダンプ抵抗器によって発電電力を消費し、蓄電池電圧の上昇ならびに風車の回転数（出力電圧）を抑制します。

□諸　元

・定格 300W（抵抗器：30W／15Ω／12 個）

・図 3-2 に主回路を示します。

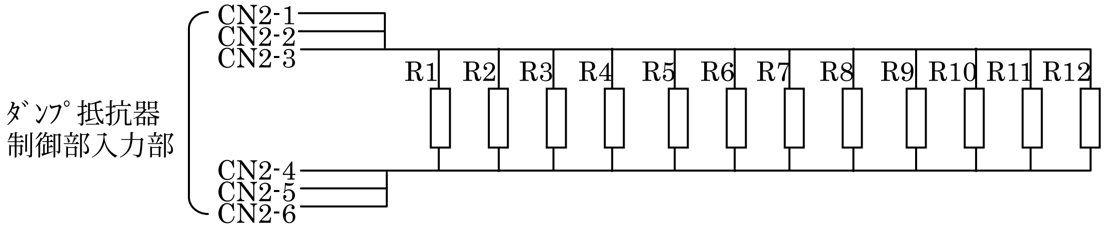


図 3-2　ダンプ抵抗器主回路

□寸　法

・W200×H240×D50mm

（４）太陽電池

□主要諸元

表 3-3 に主要諸元を示します。

表 3-3　太陽電池の主要諸元

項　目	諸　元
型式	MPP125-80
セル素材	シリコン多結晶セル
質量	9.0kg
保存温度	-20　～　40□
公称最大出力	80W
公称開放電圧	21.5V
公称短絡電流	5.30A
公称最大出力動作電圧	17.2V
公称最大出力動作電流	4.64A

□寸　法

・W815×H802×D50mm

（5）太陽光用充放電コントローラ

□主機能

・発電電力を効率よく 12V 用蓄電池に充電しつつ、負荷に電力を供給します。

・蓄電池が浮動充電状態に達すると定電圧で、出力が常に最大電力を取り出す最適充電制御を行います。

・過充電、過放電防止回路を内蔵し、蓄電池を自動的に回路から切り離す制御を行います。

□諸　元

表 3-4 に主要諸元を示します。

表 3-4　太陽光用充放電コントローラの主要諸元

項　目		単位	定格及び特性	記事
型　　式		ー	SPS-450-CONT	
定格出力容量		W	450	
保存温度		℃	-10～40	
湿　　度		%	5～95	結露がないこと
質　　量		kg	2 以下	
形式	定格	ー	連　続	
	冷却方式	ー	自然空冷	
直流入力側	定格電圧	V	21	
	最大許容入力電圧	V	35	
	入力運転電圧範囲	V	12～27	
	起動電圧	V	12±0.3	注 1
	停止電圧	V	11±0.3	注 1 ﾏｲｺﾝ停止電圧 DC10V 以下
直流出力側	定格電圧	V	14.52	出力電流１A のとき
	電圧変動範囲	V	14.52±0.2%	
	定格電流	A	30	
	電流変動範囲	A	0～30	
	効率	%以上	85.5	定格電流で直送運転時
	待機電力	W以下	0.2	
	雑音電圧	mV以下	2	蓄電池未接続時
	脈動電圧	mV以下	200	蓄電池未接続時
	放射雑音	ー	ＶＣＣＩ　クラスA	
警報	過電圧検出電圧	V	15.3±0.2	注 2
	低電圧検出電圧	V以下	8	注 2
	過放電検出電圧	V	10.8±0.2	
	過放電復帰電圧	V	12.0±0.2	

注１：太陽電池からの供給電力があること。

注２：故障を検出した場合は運転を停止し、そのままの状態を継続すること。故障対応後、リセットＳWを押すことにより運転すること。

□寸　法

・W170×H240×D70mm

（６）小形サイクル用シール鉛蓄電池

□主機能

・発電電力の貯蔵

・発電不足時の電力供給

□諸　元

表 3-5 に主要諸元を示す。

表 3-5　小形サイクル用シール鉛蓄電池の主要諸元

項　目	単位	定格及び特性	記事
型　　式	－	50AH サイクルＰ形蓄電池	
公称電圧	V	12	
定格容量	Ah	50	10 時間率
保存温度	℃	0～40	
質　　量	kg	30 以下	
期待寿命	－	2000 サイクル	注１
設置方法	－	縦置き	

注１：放電深度（DOD）70%、周囲温度 25℃、充電制御を行った場合

□寸　法

・W150×H300×D175 ㎜、重量：約 26 kg　／　１台

※蓄電池容量（個数）は、発電シミュレーションにより算出。（12V50AH×4 台）

（７）インバータ

□主機能

・直流電圧をテレビ用動作電圧（交流 220V）に変換

□諸　元

表 3-6 に主要諸元を示す。

表 3-6　インバータの主要諸元

項　目	単位	定格及び特性	記事
型　　式	－	DS600-212	
公称電圧	V	12	選択式
定格周波数	Ah	50	選択式
定格容量	VA	50	

□寸　法

・W180×H72×D295 ㎜、重量：約 2.7 kg

（８）ＬＥＤ照明

□主機能

・36 個の白色高輝度ＬＥＤ（白色発光ダイオード）を内臓したスポットライト

□諸　元

表 3-7 に主要諸元を示す。

表 3-7　ＬＥＤ照明の主要諸元

項　目	単位	定格及び特性	記事
型　式	－	SP-36	
公称電圧	V	12	直流電圧
定格容量	W	4.32	

□寸　法

・約 W173×H121×D113 ㎜、重量：約 400g　／　１台

（９）屋内収容箱

□主機能

・充放電コントローラ、ダンプ抵抗器などの電源装置および、計測信号変換器（検出器等含む）入出力ブレーカ、端子台を収容する。

□諸　元

・構造：屋内用自立閉鎖型　・材質：ステンレス

・表 3-8 に収容箱内の構成品一覧を示す。

表 3-8　構成品一覧

名　称	個　数	定　格	記事
配線用遮断器	6	30A / 20A / 5A	入出力ブレーカ
端子台	2	-	電源用
直流電流センサ	3	HCS-AP	計測用関連機器
タイマー※	3	DC 用、AC 用	
風力用充放電コントローラ		300W	
ダンプ抵抗器		300W	
太陽光用充放電コントローラ	1	450W	
小形サイクル用型シール鉛蓄電池	4	12V50Ah	

※タイマー動作時間（動作時間は現地時間）

①屋外ＬＥＤ照明　…　18:00　～　22:00　（4 時間）

②屋内ＬＥＤ照明　…　8:00　～　12:00　（4 時間）

③テレビ　…　18:00　～　19:00　（1 時間）

□寸　法

・W500×H1250×D300 ㎜

４．システム動作概要

（１）気象条件が良い（強風および晴天の）場合

図 4-1 に示すように風車および太陽電池の発電電力は、負荷装置に供給すると共に、蓄電池への充電を行います。

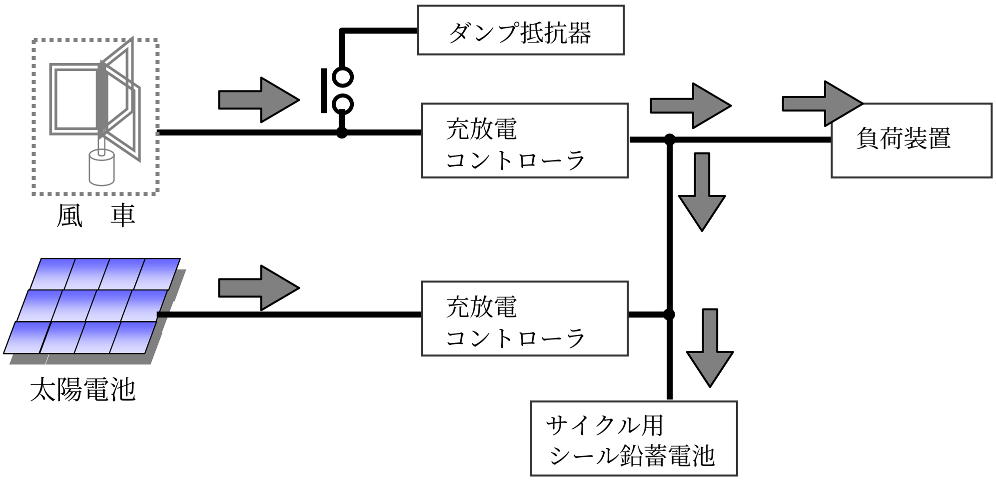


図 4-1　気象条件が良い場合の動作

（２）気象条件が良くない（無風、微風および曇天の）場合

図 4-2 に示すように蓄電池により負荷装置へ電力を供給します。更に、蓄電池容量が低下し、放電終止電圧に達した場合、図 4-3 に示すように負荷装置を切り離します。ここで、切り離された負荷装置は、蓄電池容量が回復された後、自動的に接続されます。

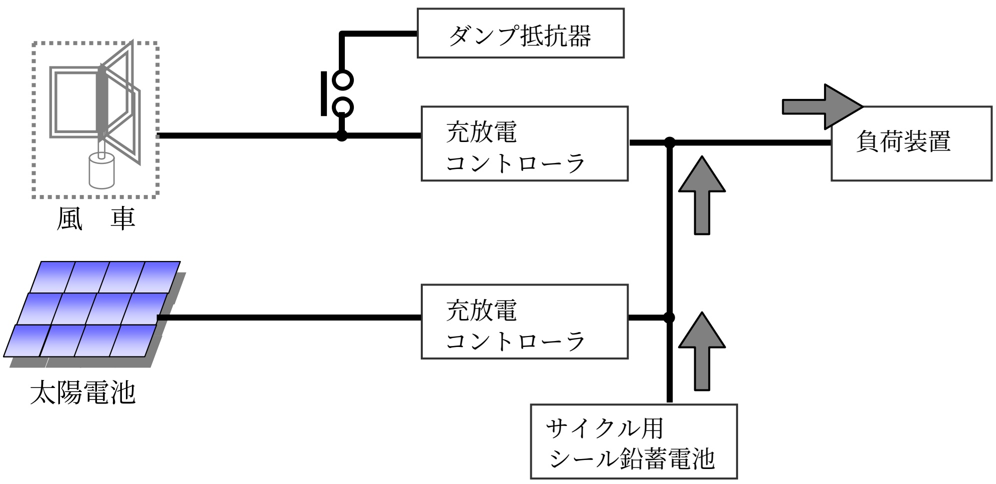


図 4-2　気象条件が良くない場合の動作（蓄電池電圧正常時）

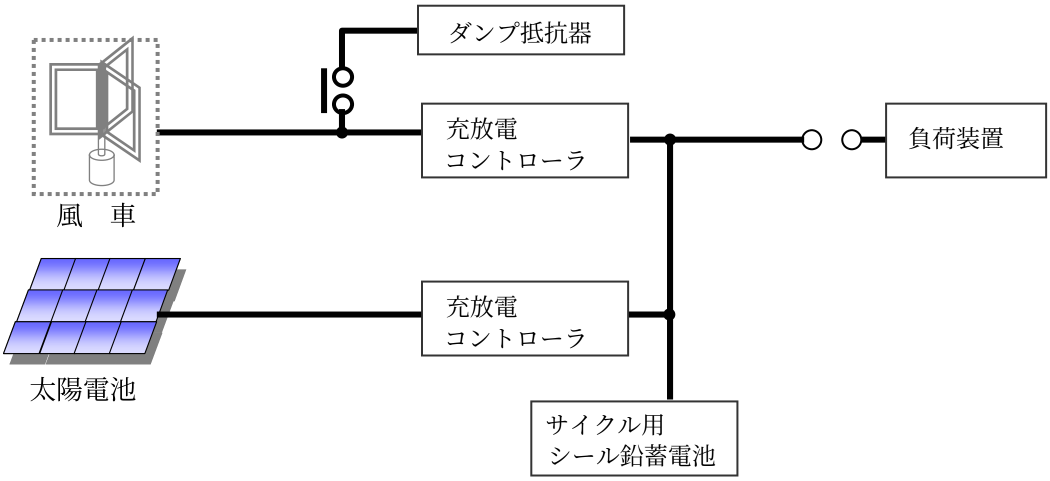


図 4-3　気象条件が良くない場合の動作（蓄電池電圧低下時）

（３）連続的に気象条件が良い（連続的に強風や晴天が続いた）場合

風車および太陽電池から十分な発電電力が得られ、蓄電池容量が満充電状態となった場合は、各コントローラによって、発電電力を制御し、余剰電力による蓄電池電圧の上昇を制御します。図 4-4 に示すように風車の余剰電力は、蓄電池電圧が規定値□に達した場合、自動的にダンプ抵抗器を投入し、ダンプ抵抗器によって余剰電力を消費します。一方で、太陽電池はコントローラによって、蓄電池への充電電流を制御し、余剰電力は太陽電池が熱として放出します（太陽電池表面温度が上昇します。

□ ダンプ抵抗器動作電圧：ＯＮ　→蓄電池電圧１４．５Ｖ
：ＯＦＦ→蓄電池電圧１２．５Ｖ
なお、上記電圧値は任意に設定できます。現状の運用状況に応じて変更します。

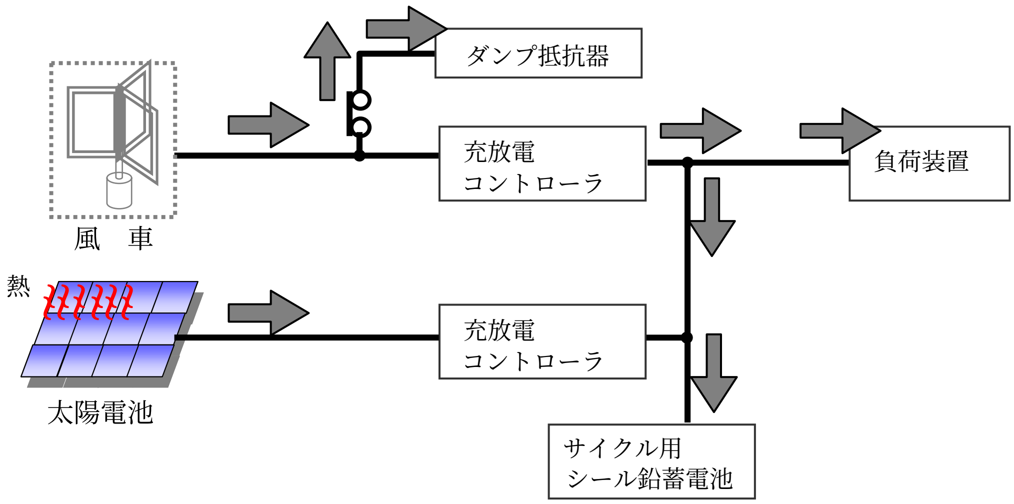


図 4-4　連続的に気象条件が良い場合の動作（蓄電池電圧上昇時：満充電時）

カンボジア・モントギリ高原小規模ＣＤＭ向け

モニタリングシステム

仕様書

目　　次

1．はじめに

本仕様書は「カンボジア・モントギリ高原」小規模ＣＤＭ向けモニタリングシステムの納入条件について記載したものです。本システムのモニタリング項目は、株式会社丸紅様、株式会社シグナスミル様との協議により決定した事項に準拠します。なお、記載の無い条件等については、双方協議の上決定とします。

2．概　　説

本システムは、シグナスミル風車および太陽電池を用いたハイブリッド電源システムの発電データおよび、風速値などの気象データを収集し、所定期間記録するシステムです。図 2-1 に本システムのブロック図、表 2-1 に主要構成装置の概要を示します。

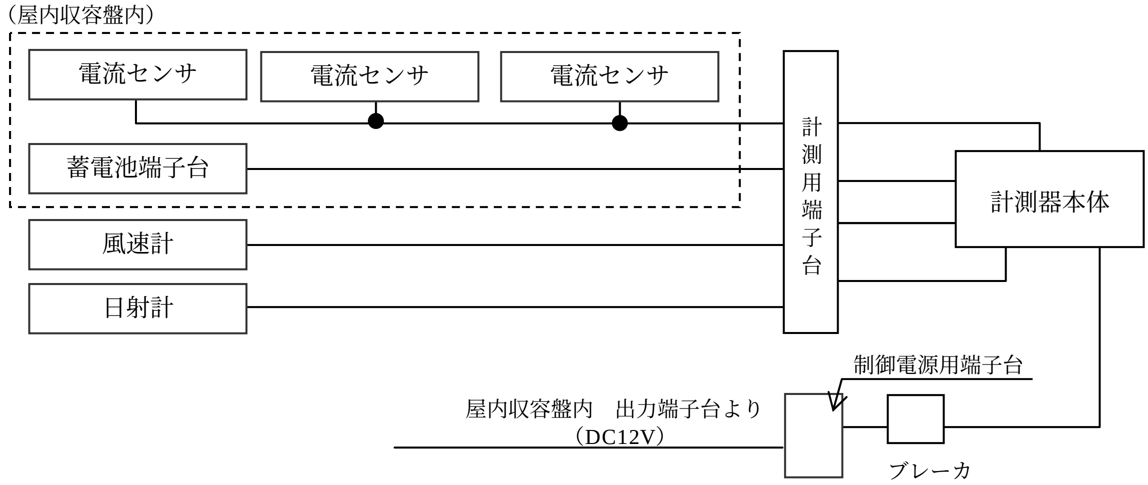


図 2-1　システムブロック図

表 2-1　主要構成装置

構成装置	数量	概　　要
直流電流センサ	3 台	風車、太陽電池、負荷装置の電流値計測
風速計	1 台	風速値を計測
日射計	1 台	日射値を計測
端子台	1 式	―
配線用遮断器（ブレーカ）	1 台	制御電源の投入、遮断
アッテネータユニット	1 台	電圧調整器
計測器本体	1 台	各計測データを蓄積する。
収容箱	1 台	端子台、ブレーカ、計測器本体を収容する。
CompactFlash メモリカード	2 台	収集データ回収用

３．構成機器

（1）直流電流センサ

・型　　式：HCS-AP
・入 出 力：0-20A 入力/DC0-4V 出力/DC0-1V 出力
・電　　源：DC12V
・記　　事：風車出力電流、太陽電池出力電流、負荷電流を計測

（2）風速計

・型　　式：014A 型
・入 出 力：0-60m/s 入力/0-74.464Hz 出力/0-1V 出力
・電　　源：DC12V
・記　　事：精度±1.5%FS

（３）日射計

・型　　式：PCM-01(L)
・入 出 力：0-2kW/m^{2}入力/DC0-10mV出力/0-1V出力
・記　　事：波長範囲 305～2800nm

（４）計測器本体

・型　　式：Ｄ１風向風速Ｂプラス（LGD1-008B-PLUS）
・入力ＣＨ数：7 チャンネル
・測定性能：電圧 0～±2.0000V（分解能 100μV）、風速 0～1V（分解能 1/10000）
・データ記憶容量 390,176 データ（7CH、10 分インターバルで約 12.9 ヶ月のデータ）
・データ回収：コンパクトフラッシュカード（本体カードソケットにカード挿入することにより、自動回収）
・電　　源：DC12V（50mA 以内）
・動作温度：-20℃～+70℃（結露しないこと）
・寸　　法：W210×H134×D79 ㎜（収納ケース）

４．機能概要

（1）モニタリング機能

①表 4-1 に示す項目を計測して蓄積します。

②計測データは 5 秒毎にサンプリングし、10 分間隔で記録します。この際の処理は瞬間最大風速値を除き、5 秒毎のサンプリングデータの平均値となります。

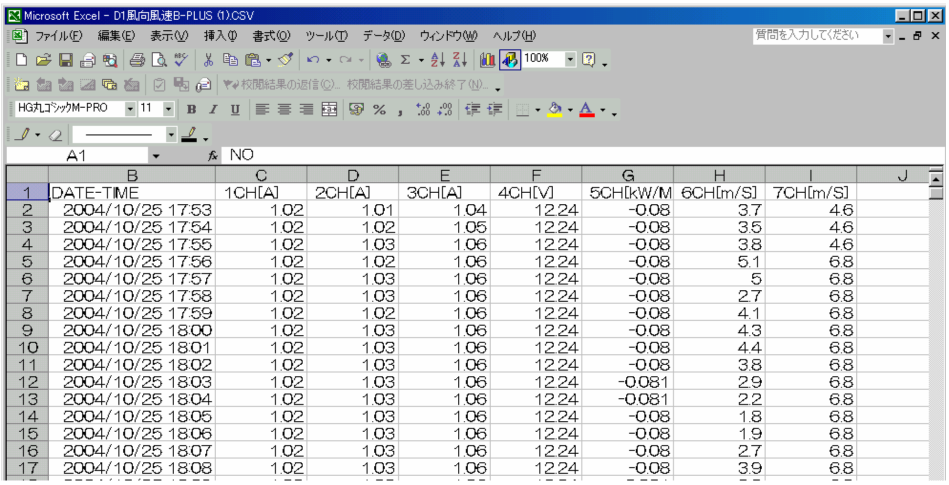
表 4-1.計測項目

CH 番号	計測項目	単位	入力信号	記　事
1	風車出力電流	A	0-1V	0～20A
2	太陽電池出力電流	A	0-1V	0～20A
3	負荷消費電流	A	0-1V	0～20A
4	蓄電池電圧	V	0-1V	0～20V
5	日射	kW/m^2	0-1V	0～2.0kW/m^2
6	風速	m/s	0-1V	0～60m/s
7	瞬間最大風速	m/s	0-1V	0～60m/s

（2）データ回収機能

①計測器本体に蓄積されたデータは、コンパクトフラッシュカードにより回収可能です。回収後、新規のデータが蓄積されます。なお、回収データは CSV ファイル形式で、マイクロソフト Excel にて参照可能です。（図 4-1）

②データ蓄積期間は約 1 年です。約 1 年を超えてデータ回収を実施しない場合、古いデータから上書きされます。



	B	C	D	E	F	G	H	I	J
1	DATE-TIME	1CH[A]	2CH[A]	3CH[A]	4CH[V]	5CH[kW/M	6CH[m/S]	7CH[m/S]	
2	2004/10/25 17:53	1.02	1.01	1.04	12.24	-0.08	3.7	4.6	
3	2004/10/25 17:54	1.02	1.02	1.05	12.24	-0.08	3.5	4.6	
4	2004/10/25 17:55	1.02	1.03	1.06	12.24	-0.08	3.8	4.6	
5	2004/10/25 17:56	1.02	1.02	1.06	12.24	-0.08	5.1	6.8	
6	2004/10/25 17:57	1.02	1.03	1.06	12.24	-0.08	5	6.8	
7	2004/10/25 17:58	1.02	1.03	1.06	12.24	-0.08	2.7	6.8	
8	2004/10/25 17:59	1.02	1.02	1.06	12.24	-0.08	4.1	6.8	
9	2004/10/25 18:00	1.02	1.03	1.06	12.24	-0.08	4.3	6.8	
10	2004/10/25 18:01	1.02	1.03	1.06	12.24	-0.08	4.4	6.8	
11	2004/10/25 18:02	1.02	1.03	1.06	12.24	-0.08	3.8	6.8	
12	2004/10/25 18:03	1.02	1.03	1.06	12.24	-0.081	2.9	6.8	
13	2004/10/25 18:04	1.02	1.03	1.06	12.24	-0.081	2.2	6.8	
14	2004/10/25 18:05	1.02	1.03	1.06	12.24	-0.08	1.8	6.8	
15	2004/10/25 18:06	1.02	1.03	1.06	12.24	-0.08	1.9	6.8	
16	2004/10/25 18:07	1.02	1.03	1.06	12.24	-0.08	2.7	6.8	
17	2004/10/25 18:08	1.02	1.03	1.06	12.24	-0.08	3.9	6.8	

図 4-1.回収データ参照画面

想定されるケースに対するIRR計算のシミュレーション結果

想定ケース			内部収益率 IRR
設備補助	1/3	CER収入あり	7.35%
		CER収入なし	5.00%
	1/2	CER収入あり	12.63%
		CER収入なし	9.87%
バッテリー交換補助	あり	CER収入あり	3.38%
	なし	CER収入なし	-0.71%
CER収入	あり		1.25%
	なし		-0.71%

注：1）税金は考慮していない。
　　2）必要資金は、100%資本金として調達。

Draft-04
Jan. 25, 2005

Project Design Document

for

Small-Scale CDM Activity

Wind Power Project
in Mondul Kiri Province, Cambodia

March 2005

Marubeni Corporation

CONTENTS

A. General description of project activity

A.1 Title of the project activity:

Wind Power Project in Mondul Kiri Province, Cambodia (the Project).

A.2 Description of the project activity:

A.2.1 Outline of the project activity:

The Project is for renewable energy development using wind and solar power in the highlands of Mondul Kiri Province (the Province), Cambodia.

The Project will comprise 115 small, hybrid power systems with a total capacity of 1.4 MW. These wind power generators will be constructed in 21 communes and 90 villages in Mondul Kiri Province and will be operated 24 hours/day for a total of 8,760 hours/year.

The electricity generated from renewable energy by the Project will replace electricity generated from diesel-powered mini-grids. The reduction in CO_2 emissions is estimated at 2,759 t CO_2 per year for the duration of the Project. Over the entire crediting period (21 years) the Project is expected to reduce emissions by 57,939 t CO_2, generating the equivalent amount of Certified Emission Reductions (CERs).

Electricity generated by the Project will be supplied to the villagers at lower rates (US$0.10/kWh) in return for their assistance in observing and monitoring the project facilities.

A.2.2 Purpose of the project activity:

Cambodia has made efforts to implement a sustainable energy efficiency program aimed at meeting its domestic energy needs[1]. However the national power system is encountering problems with low electrification rates, efficiency, institutional structure and environmental impacts.
In order to help the government achieve these goals and to improve the well-being of local residents, the Project will supply electricity produced from clean energy to isolated villages with little or no access to electricity.

A.2.3 CDM project under sustainable development policy in Cambodia

Cambodia ratified the UNFCCC in December 1995 and the Ministry of Environment (MoE) has coordinated preparations for participation in CDM (MoE, 2002). An initial national communication under the UNFCCC was published in August 2002 that provided a national greenhouse gas inventory for 1994 and described Cambodia's ability to respond to the effects of climate change. In mid 2003 the Cambodian Climate Change Office (CCCO) at MoE was appointed as the interim DNA (Designated National Authority) for CDM in Cambodia. CCCO is currently working to finalize sustainable development criteria for assessing proposed CDM projects. These criteria are based on Cambodia's existing government development plants, policies, regulations and laws.

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[1] Source: "Renewable Energy and Energy Efficiency (2004)", Ministry of Industry, Mines and Energy, Cambodia.

In Cambodia, capacity building activities are being conducted with a range of stakeholders, including relevant government ministries, private developers, non-government organizations, foreign investors and donor organizations[2]. Under these projects, the government aims to raise awareness about CDM at the national and provincial levels, strengthen CDM capacity for policy makers, public and private sectors, prepare sustainable development criteria for assessing proposed CDM projects, establish the final DNA and assessment process for proposed CDM projects, develop a pipeline of potential CDM projects, and promote these projects among developers and investors[3].

A.2.4 Contribution to the sustainable development of the host country:

The Project will contribute to the sustainable development of the region and the country in the following ways:

a. Socially sustainable development

There is no industrial development in the area surrounding the Project site at Sen Monorom, Mondul Kiri Province, and therefore the residents currently rely on home-generated electricity from small diesel generators. This causes great inconvenience to the local people in their daily lives. The local government is not able to use computers continuously and the region has no light after 10 pm due to the undeveloped electricity supply system. There is a high demand for electricity for schools and for the use of home television and radio as an information source. By meeting these demands for electricity the well-being of the residents in the community will be improved.

Considering the socioeconomic circumstances of the region, it would be difficult for them to improve the electricity supply system by themselves. The Project will introduce new, state of the art hybrid power system technology and know-how for the manufacture of propellers and batteries, enabling the local residents to produce them on their own.

The Project also has the potential to act as a business model for local companies to establish their own renewable energy projects and electricity companies. This will increase job opportunities and provide income for the local residents, helping to provide stability and improve their quality of life.

b. Economically sustainable development

The local production of the hybrid generation systems and the new electricity companies will invigorate and help support the local economy by creating new jobs for the residents. Because the electricity supplied by the Project will enable local people to work at night under lighting, the economic and social activities will also be promoted.

Furthermore, the technology is expected to be adopted not only in neighboring provinces but also in other countries such as Laos and Myanmar. The sustainable development in Cambodia could thus bring development and stability to the economy of the whole region.

c. Environmentally sustainable development

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[2] Source: “Sustainable Energy in Cambodia; Status and Assessment of the Potential for Clean Development Mechanism Projects (2004)”, The Cambodian Research Center for Development

[3] Source: “Climate Change and the Clean Development Mechanism (2004)”, The Cambodian Research Center for Development

Up to now, the development of the Cambodian energy sector has been based mainly on heavy fuel or diesel generators which are conventional, GHG-emission intensive and often out-of-date technologies[4]. In addition, due to the population hike in Sen Monorom in recent years, the demand for electricity is also likely to increase and lead to the further expansion of unplanned diesel-fuelled electricity generation which, in turn, could have an adverse effect on the valuable natural environment. The Project will provide access to technologies that can generate clean energy as an alternative to diesel fuel and thus protects the rich natural environment of Mondul Kiri Province while improving the well-being of the region.

A.2.5 Financial Scheme of the project activity:

The initial cost of the Project is estimated at approximately US$2.73 million (JPY300 million). This includes costs relating to the procurement and construction of equipment. Subsequently, running costs of approximately JPY?, annually, will be required for the maintenance.

Out of the total initial investment cost for the Project, it is assumed that 40% will be contributed by the capital fund while the remaining 60% will be financed on loan from banks.

A.3 Project participants:

Cambodia and Japan are the Parties to the proposed activity. At the moment the project participants, as defined by the CDM glossary, are as follows:

- **Marubeni Corporation (Marubeni)** – Project Promoter/Official Contact
- **General Environmental Technos Co., Ltd. (KANSO)** – CDM Advisor

Contact information is provided in Annex I. Investors to the Project will eventually be added to the above list of the Project participants.

A.4 Technical description of the project activity:

A.4.1 Location of the project activity:

A.4.1.1 Host country Party(ies):

Kingdom of Cambodia

A.4.1.2 Region/State/Province etc.:

Mondul Kiri Province

A.4.1.3 City/Town/Community etc:

Sen Monorom

[4] Source: "Climate Change and the Clean Development Mechanism (2004)", The Cambodian Research Center for Development

A.4.1.4 Detailed description of the physical location, including information allowing the unique identification of this project activity:

The planned site is located in Mondul Kiri Province, Cambodia (see Fig. 1 - Location of the project site in Cambodia).

Mondul Kiri Province is located 390 km from Phnom Penh and nestles along Cambodia's eastern border with Vietnam. Its land area of about 14,682km comprises 8.11% of the total land area of Cambodia (181,035km) and 76% of the Province consists of forest. The total population is approximately 40,000 with an annual growth rate of 2.49%[5]. The Province comprises five districts, which include 21 communes and 90 villages.

The Province comprises mostly highlands and lies between 600 and 800 m above sea level. It has favorable wind conditions with a wind velocity of 15.2 m/s[6].

Figure 2 shows the planned site for the installation of the hybrid power system.

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[5] Source: Ministry of Agriculture, Forestry and Fisheries, Cambodia (http://www.fadinap.org/cambodia/)

[6] Source: Ministry of Agriculture, Forestry and Fisheries, Cambodia (http://www.fadinap.org/cambodia/)

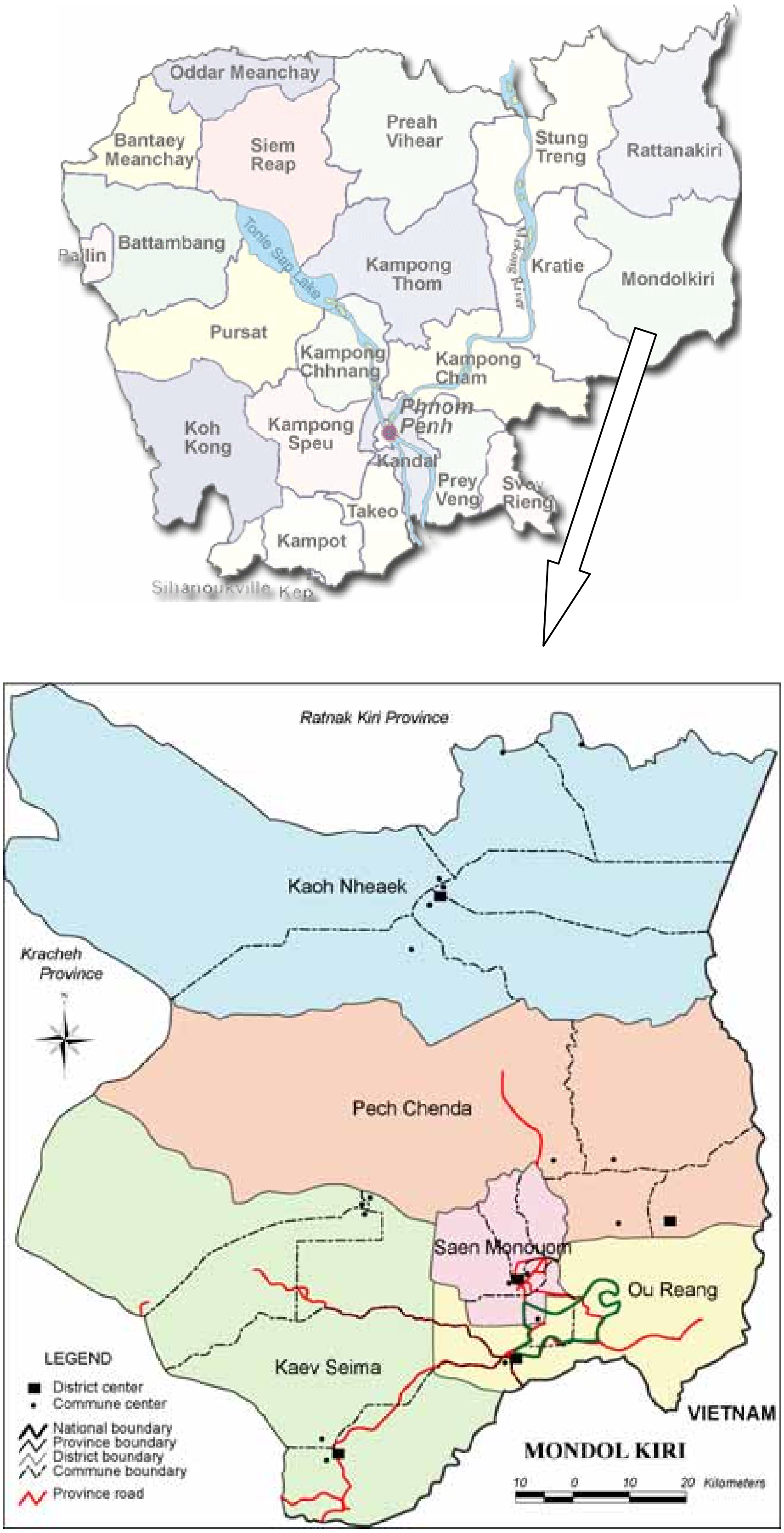


Figure 1. Location of the project site in Cambodia

Figure 2. Planned site for the installation of the hybrid power system

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

A.4.2.1 Type and category(ies) of project activity:

The Project activities are of the following type and category:

Type: I – RENEWABLE ENERGY PROJECTS
Category: A －Electricity generation by the user

The Project conforms to the project type and category selected because it uses renewable wind and solar power technologies that produce electricity to be used on-site by the user. Furthermore, the proposed units, with a generating capacity of 1.4 MW, will replace existing diesel electricity generation.

A.4.2.2 Technology to be transferred:

The key technology to be employed in the Project is a hybrid system comprising a vertical-sail-axle-type windmill generator and a photovoltaic generator (Fig. 3). This hybrid system utilizes renewable energy from both wind and/or sunlight as its power source and generates electricity during both day and night.

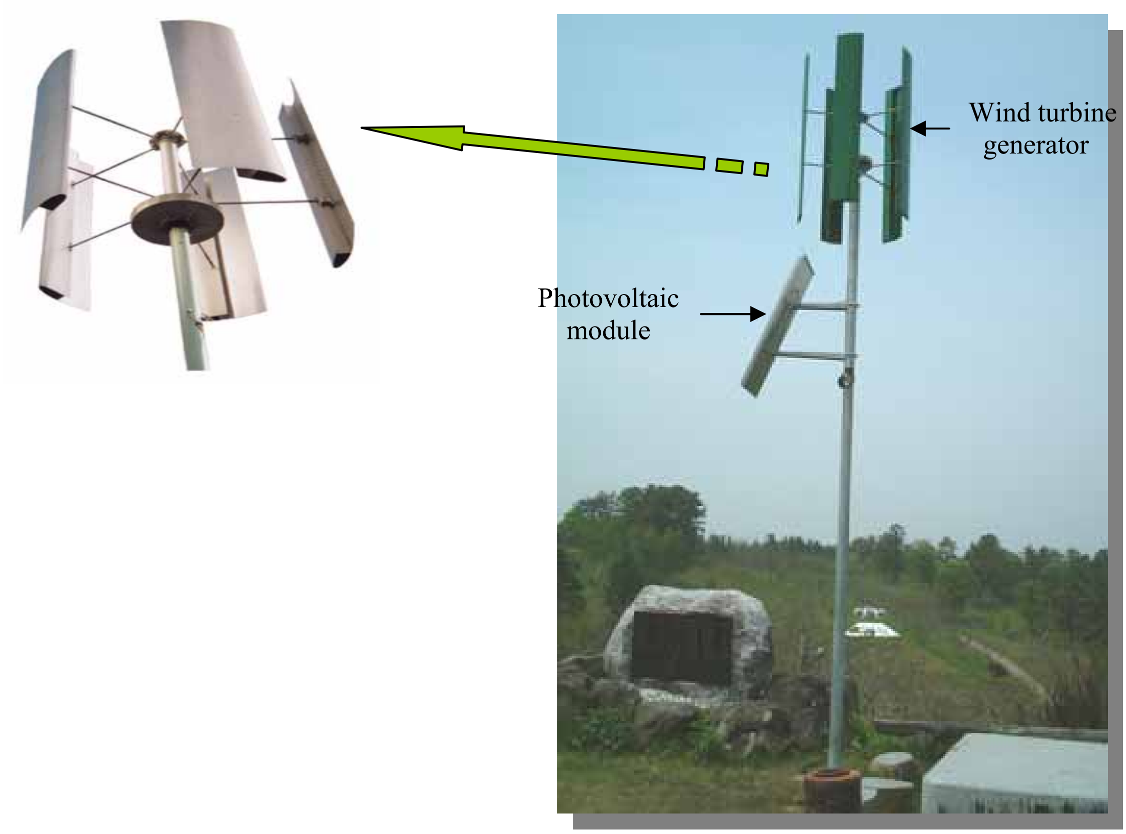
The Cygnus Mill wind turbine was designed as an environmentally friendly wind power generator. One of the most remarkable features of the Cygnus Mill is that, in contrast to the conventional propeller-type windmill with a horizontal axle, the Cygnus Mill can efficiently convert even relatively weak wind power (1-12 m/s) into electricity. The Cygnus Mill has the following advantages:

- ✓ rotates regardless of wind direction
- ✓ starts rotating at wind velocity of ca. 1m/s
- ✓ has high running torque in low winds
- ✓ has a simple engine system
- ✓ has a light and simple structure
- ✓ produces little noise and vibration
- ✓ is easy to set up

This new, state of the art technology introduced by the Project will thus lead to a transfer of knowledge within the country.

●Cygnus Mill

●Example of installation



●Basic system configuration

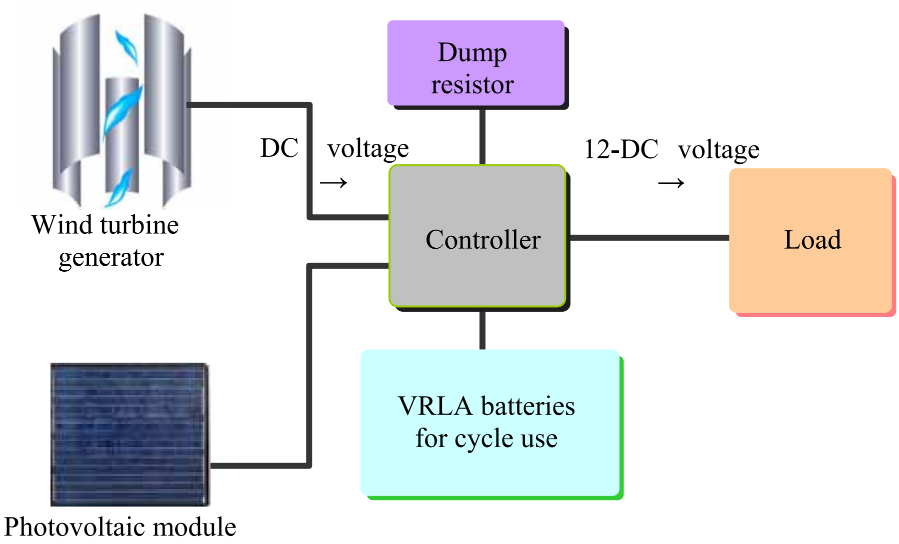


Figure 3. Hybrid power system with a wind turbine generator and a photovoltaic module

A.4.3 Brief statement on how anthropogenic emissions of greenhouse gases (GHGs) by sources are to be reduced by the proposed CDM project activity:

The Project is expected to reduce anthropogenic GHG emissions by displacing diesel-fuelled electricity generation with clean energy (zero GHG emissions) generated by wind and/or sunlight. As stated in section B, the proposed project activity is estimated to reduce emissions by 2,759 t CO_2 annually, totalling approximately 57,939 t CO_2 over the entire crediting period (21 years).

A.4.4 Public funding of the project activity:

The financial plans for the Project do not involve public funding from Annex I countries.

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

This particular project was originally initiated and developed by project participants who have not previously conducted other CDM projects. According to paragraph 2 of Appendix C of the simplified M&P for small-scale CDM project activities, the Project is not part of a larger project activity.

B. Baseline methodology

B.1 Title and reference of the project category applicable to the project activity:

Project category: Type I.A. Renewable Energy Projects, Electricity generation by the user

Reference: Appendix B of the simplified M&P for small-scale CDM project activities (UNFCCC, 2003)

B.2 Project category applicable to the project activity:

According to article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, category I.A. comprises *"renewable technologies that supply individual households or users with a small amount of electricity. These technologies include solar power, hydropower, wind power, and other technologies that produce electricity, all of which is used on-site by the user, such as solar home systems, and wind battery chargers."*

The proposed small-scale CDM project comprises wind and solar power generators that supply electricity to individual households and thus qualifies for project category I.A.

B.3 Description of how the anthropogenic GHG emissions by sources are reduced below those that would have occurred in the absence of the proposed CDM project activity (i.e. explanation of how and why this project is additional and therefore not identical with the baseline scenario)

B.3.1 Justification of using simplified methodologies:

As per article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, the capacity of renewable energy generators shall not exceed 15 MW in order to qualify as a small-scale CDM project. In the Project, the capacity of the facility is 1.4 MW ($\leqq$15 MW). Hence, the Project qualifies as a small-scale CDM.

B.3.2 Assessment of additionality:

Cambodia's power supply facilities were heavily damaged by war. Currently, only around 13% of the population[7] has continuous access to electricity via a reliable public grid and most are in Phnom Penh. Besides this "grid-quality" power, today electricity is provided by a number of different organizations using many different systems, standards and levels of quality, such as rural electricity enterprises (REEs), battery charging services, private stand-by diesel generation, etc.

It has been estimated that there are 600 REEs operating diesel-powered mini-grids in rural areas to sell power to around 60,000 households[8]. Batteries are also widely used in village homes and by some isolated communities. Through this combination of supplies, 19% of the richest quintiles in rural areas have electric lighting, but only 0.6% of the poorest quintile. Around 85% of rural dwellers still rely on

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[7] Source: "National Policy on Renewable Energy-based Rural electrification (2003)", The Royal Government of Cambodia

[8] Source: SME Cambodia (http://www.smecambodia.org)

kerosene lamps rather than electricity for lighting for electricity supplies[9]. In addition, it is noteworthy that Cambodia has the highest electricity costs of any ASEAN country[10]. The average tariff charged by REEs is estimated at US$0.53/kWh[11], and estimated 8,000 battery charging businesses provide services at more than US$1.00/kWh[12]. This is due to the reliance on small, isolated generation grids and the resulting lack of economies of scale, low efficiency in generation and distribution of electricity, and high capital and fuel costs[13].

Supply requirements are projected to increase by an average 12.1% per year and the peak demand is expected to reach 1,216 MW in 2020. In response, the Royal Government of Cambodia has set the goal of raising the access rate to reliable, grid quality electricity services to 70% of the rural population by the year 2030[14].

To that end, the government of Cambodia formulated its "Energy Sector Development Plan" in 1994 with the following objectives:
- To provide an adequate supply of energy throughout Cambodia at a reasonable and affordable price,
- To ensure a reliable, secure electricity supply at prices which facilitate investment in Cambodia and the development of the national economy,
- To encourage the adoption and environmentally and socially acceptable development of energy resources needed to supply all sectors of the Cambodian economy,
- To encourage the efficient use of energy and to minimize detrimental environmental effects resulting from energy supply and use.

Following this plan, in 1999 the government then formulated the "Cambodian Power Sector Strategy" to develop an adequate and reliable source of electric power over the next 20 years. This strategy establishes the sector's policy and action plan for:
- Investment in the power sector,
- Priorities for generation and transmission,
- Establishment of the power sector's Regulatory Framework,
- Commercialization of Electricity du Cambodia[15],
- Private sector participation,
- Provincial and rural electrification

Particular importance is placed on rural electrification since electricity is very important for both the improvement of living standards and the important infrastructure required for agricultural and small-scale industrial development in rural areas.
Furthermore, sustainable energy can play a vital role to achieve the country's targets for poverty reduction by enhancing energy security and providing local economic benefits through job creation and reducing imports of fossil fuels. The benefits of distributed generation from renewable sources are

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[9] Source: "Country Report for 17th ASEAN Ministers on Energy Meeting Bangkok (1999)", Ministry of Industry, Mines and Energy, Cambodia

[10] Source: ASEAN Center for Energy, 2004

[11] Source: "Renewable Electricity Action Plan (2003)", World Bank, Hundley

[12] Source: "Final Report on RE Strategy & Program for the Rural Electrification Strategy and Implementation Program for the World Bank (2001)", Metritec Ltd.

[13] Source: "Cambodia Power Sector Strategy (1999)", The Seventeenth ASEAN Ministers on Energy Meeting

[14] Source: "Strategy for Renewable Energy-based Rural Electrification in Cambodia (2003)", The Royal Government of Cambodia

[15] Electricity du Cambodia (EDC): a government owned power utility responsible for the generation, transmission and distribution of power in nine areas of the country.

especially valuable in Cambodia where there is the challenge of providing energy services to a rural population with minimal existing infrastructure.

Despite the above priorities, the following circumstances are noted as potential barriers to the Project:

- **Investment Barriers**

The Cambodian banking system is relatively fragile, operates mostly over the short-term and has a high interest rate. Several micro-finance institutions (MFI) operating in the rural areas provide credit for short periods with interest rates ranging from 40-60% per annum. Under these conditions there has, up till now, been little incentive for either wind power generation or investment in such business[16] despite the fact that sustainable development has been an important priority for the Cambodian government.

Furthermore, without the revenue from carbon credits (CERs), the internal rate of return (IRR) for the Project over the first 15 years, or the effective life of the hybrid system, is estimated at only 0.13%. When the Project is CDM registered and CERs are issued at the rate of US$10/t CO_2 for the Project over 15 years, this, coupled with the revenue from electricity sales (US$0.10/kWh), will lift the IRR to 1.78%, making the Project profitable.

The CDM presents a clear opportunity for Cambodia to develop sustainable energy solutions, rather than only those with the lowest initial capital cost.

- **Technological Barriers**

The Project will be the first of its kind in Cambodia to utilize wind and/or solar power for electricity generation. The capacity to design and manufacture such technology does not currently exist in Cambodia and there are no projects or technologies readily available for wind and/or solar power generation because:

- Technical know-how and maintenance skills are in short supply
- Lack of experience in operation, maintenance and management
- Limited training possibilities
- Low volume of renewable energy installations

These technological barriers will lead to higher risks and costs when the Project first attempts to introduce its unique operating systems to the country.

B.4 Description of the project boundary for the project activity:

Appendix B of the simplified M&P for small-scale CDM project activities defines the project boundary as "*the physical, geographical site of the generating unit and the equipment that uses the electricity produced delineates the project boundary*."

According to this definition, the Project boundary can be described as "homes that use electricity produced by the newly introduced hybrid power system."

[16] Source: "Strategy for Renewable Energy-based Rural Electrification in Cambodia" (2003), The Royal Government of Cambodia

B.5 Details of the baseline and its development:

B.5.1 Specify the baseline for the proposed project activity using a methodology specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities:

Article 4 in Appendix B of the simplified M&P defines the baseline as "*the fuel consumption of the technology in use or that would have been used in the absence of the project activity*."

B.5.1.1 Energy baseline

The annual energy baseline in the Project is developed in accordance with option (b) in article 4 in Appendix B of the simplified M&P.

The formula is described as follows:

$$\text{Annual energy baseline (kWh/y)} = \sum_i \text{Estimated annual energy output by the } i\text{th technology (kWh/y)} \div (1 - \text{Distribution loss})$$

Where $\sum_i$ denotes the sum over the group of "*i*" renewable energy technologies implemented as part of the project.

In the Project,

1) The sum over the group of "*i*" renewable energy technologies means the sum over all the implemented hybrid generation systems of one kind (i=1).

2) Estimated annual energy output = total installed capacity × operation hours × load factors.
As described earlier in section A, the total installed capacity of the generation systems (115 units) in the Project is 1.4 MW. These systems will be operated for 8,760 hours annually with a load factor of 20%, on average.

Therefore,

$$\text{Estimated annual energy output (kWh/y)} = \text{Total output (kW)} \times \text{Total operation hours (h/y)} \times \text{Load factor (\%)}$$

$$= 1{,}400 \text{ (kW)} \times 8{,}760 \text{ (h/y)} \times 20\%$$

$$= 2{,}452{,}800 \text{ kWh/y}$$

3) Distribution loss = 20% (default value)[17].

According to the above formula, the energy baseline which will be replaced by the Project activity is calculated at 3,066,000 kWh/y.

B.5.1.1 Baseline emission

The baseline emission is computed in accordance with paragraph 6 of Appendix B of the simplified M&P which stipulates "The emissions baseline is the energy baseline calculated in accordance with paragraph 4 above times the CO_2 emission coefficient for the fuel displaced. IPCC default values for emission coefficients may be used. A default value 0.9 kg CO_2equ/kWh, which is derived from diesel generation units, may be used."

The formula is as follows:

Baseline CO_2 emissions ($t\ CO_2/y$)	=	Annual energy baseline (kWh/y)	×	CO_2 emission coefficients for diesel powered generator (CO_2e/kWh)
	=	3,066,000 (kWh/y)	×	0.9 (CO_2e/kWh)
	=	2,759 t CO_2/y		

B.5.2 Date of completing the final draft of this baseline section:

06/01/2005

B.5.3 Name of person/entity determining the baseline:

Kyoto Mechanisms Business Office
Environmental Assessment Department
General Environmental Technos Co., Ltd.
1-3-5 Azuchimachi, Chuo-ku, Osaka, Japan 541-0052
Tel: +81-6-6263-7407
Fax: +81-6-6263-7309

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[17] Source: Footnote 3 of Appendix B of simplified M&P for small-scale CDM project activities.

C. Duration of the project activity and crediting period

C.1 Duration of the project activity:

C.1.1 Starting date of the project activity:

April 1, 2006 (Starting date of the hybrid power system operation)

C.1.2 Expected operational lifetime of the project activity:

30 years

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

C.2.1 Renewable crediting period *(at most seven (7) years per crediting period)*

C.2.1.1 Starting date of the first crediting period:

01/04/2006

C.2.1.2 Length of the first crediting period:

7 years

C.2.2 Fixed crediting period *(at most ten (10) years)*:

C.2.2.1 Starting date:

C.2.2.2 Length (max 10 years):

D. Monitoring methodology and plan

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

The Project monitoring methodology is as defined in paragraph 8 (b) for project type I.A. in Appendix B of the simplified M&P. This methodology consists of "metering the electricity generated by all systems of a sample."

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

The Project comprises the renewable technology of wind and solar power generation supplying individual households or users with a small amount of electricity. As per article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, the capacity of renewable energy generators shall not exceed 15 MW in order to qualify as a small-scale CDM project. The planned generation capacity of 1.4 MW is less than this 15 MW threshold and therefore qualifies as a small-scale CDM.

The monitoring methodology to be used by the Project is identical with that prescribed for type I.A. projects, i.e., "metering the electricity generated by all systems of a sample."

D.3 Data to be monitored:

As part of the Project activity, data on power generation are electronically recorded and then manually retrieved by the project participants on a quarterly basis in order to measure the actual amount of electricity generated by all the hybrid generation systems.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
D.3.1	Quantita-tive	Electricity generated by the hybrid systems	kWh	m	Quarterly	100%	Electronic	Min. of 2 yrs after last CER issuance	Data of each unit are retrieved in a memory card and then collected at routine check-up.

D.4 Name of person/entity determining the monitoring methodology:

Kyoto Mechanisms Business Office
Environmental Assessment Department
General Environmental Technos Co., Ltd.
1-3-5 Azuchimachi, Chuo-ku, Osaka, Japan 541-0052
Tel: +81-6-6263-7407
Fax: +81-6-6263-7309

E. Calculation of GHG emission reductions by sources

E.1 Formulae used:

E.1.1 Selected formulae as provided in appendix B:

In accordance with paragraph 6 of Appendix B of the simplified M&P, the baseline emission is calculated by multiplying the annual energy baseline by the CO_2 emission coefficient for the fuel displaced.

The formula is as follows:

$$\text{Baseline } CO_2 \text{ emission } (t\ CO_2/y) = \text{Annual energy baseline } (kWh/y) \times CO_2 \text{ emission coefficients for diesel } (CO_2e/kWh)$$

E.1.1.1 Annual energy baseline

As mentioned earlier in B.5, the annual energy baseline is calculated as follows:

$$\text{Annual energy baseline } (kWh/y) = \sum_i \text{Estimated annual energy output by the } i^{th} \text{ technology } (kWh/y) \div (1 - \text{Distribution loss})$$

$$= 3{,}066{,}000 \text{ kWh/y}$$

E.1.1.2 CO_2 emission factor

As stipulated in paragraph 6 of Appendix B of the simplified M&P, an IPCC default value 0.9 kg CO_2e/kWh (derived from diesel generation units) can be used.

E.1.1.3 Baseline CO_2 emission

Using the above data, the baseline CO_2 emission is calculated as follows:

$$\text{Baseline } CO_2 \text{ emission } (t\ CO_2/y) = \text{Annual energy baseline } (kWh/y) \times CO_2 \text{ emission coefficients for diesel } (CO_2e/kWh)$$

$$= 3{,}066{,}000\ (kWh/y) \times 0.9\ (CO_2e/kWh)$$

$$= 2{,}759\ t\ CO_2/y$$

The total reduction in emissions over the crediting period of 21 years is estimated at 57,939 tCO_2.

E.1.1.4 CO_2 emission due to the Project activity within the Project boundary (Project emission)

There will be no CO_2 emission due to the Project activity since wind and solar power are clean energies emitting no GHGs.

E.1.1.5 Leakage due to the Project activity

Article 7 in Appendix B of the simplified M&P states that "*if the renewable energy technology is equipment transferred from another activity, a leakage calculation is required.*" The equipment for wind and solar energy generation to be used in the Project will be newly constructed so there is no need to consider leakage in accordance with the Project.

E.1.1.4 CO_2 emission reductions due to the Project

The CO_2 emission reductions are calculated as follows:

CO_2 Emission Reductions = Baseline Emission – (Project Emission + Leakage)

= 2,759 t CO_2/y – (0 + 0)

= 2,759 t CO_2/y

Since there is no CO_2 emission or leakage due to the implementation of the Project, the reduction in CO_2 emissions realized by the Project is estimated at 2,759 t CO_2/y.

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

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

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

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

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

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

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

Table 2 summarizes the values of the parameters that are required in estimating CO_2 emission reductions.

Table 2. Values of the parameters for estimation of CO_2 emission reductions by the Project

<table>
<tr><th colspan="2">Item</th><th>Term / Parameter</th><th>Value</th><th>Remarks</th></tr>
<tr><td rowspan="5">Specification of hybrid systems</td><td>A</td><td>Number of hybrid systems</td><td>115 generators</td><td>Refer to Section A</td></tr>
<tr><td>B</td><td>Total installed capacity of hybrid systems</td><td>1.4 MW</td><td>Refer to Section A</td></tr>
<tr><td>C</td><td>Annual average load factor of hybrid systems</td><td>20%</td><td>Refer to Section A</td></tr>
<tr><td>D</td><td>Total operating hours</td><td>8,760 h</td><td>Refer to Section A</td></tr>
<tr><td>E</td><td>Annual power generation of the Project</td><td>2,452,800 kWh</td><td>B×C × D</td></tr>
<tr><td rowspan="3">Annual energy baseline</td><td>F</td><td>No. of the kinds of renewable energy technologies</td><td>1</td><td>Hybrid system</td></tr>
<tr><td>G</td><td>Default value for distribution loss</td><td>20%</td><td>Footnote 3 of Appendix B of simplified M&P</td></tr>
<tr><td>H</td><td>Energy baseline</td><td>3,066,000 kWh</td><td>F ×E÷(1 – G)</td></tr>
<tr><td rowspan="2">Baseline CO_2 emission</td><td>I</td><td>Emission coefficient</td><td>0.9</td><td>IPCC default value for diesel generation units</td></tr>
<tr><td>J</td><td>Baseline CO_2 emission</td><td>2,759 t CO_2/y</td><td>H×I</td></tr>
<tr><td rowspan="2">CO_2 emission by the Project</td><td>K</td><td>CO_2 emission due to the Project activity</td><td>0 t CO_2/y</td><td>Refer to E.1.1.4</td></tr>
<tr><td>L</td><td>Leakage due to the Project activity</td><td>0 t CO_2/y</td><td>Refer to E.1.1.5</td></tr>
<tr><td rowspan="2">CO_2 emission reduction by the Project</td><td>M</td><td>Annual CO_2 emission reductions</td><td>2,759 t CO_2/y</td><td>J－K－L</td></tr>
<tr><td>N</td><td>Total CO_2 emission reduction during the crediting period (21 years: 2006-2026)</td><td>57,939 t CO_2</td><td>M × 21 years</td></tr>
</table>

F. Environmental impacts

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

Cambodia complies with the "Laws on Environmental Protection and Natural Resource Management (1996)" and "Environmental Impact Assessment (EIA) (1999)" which prescribe criteria for all environmental activities.

However, the natural resources used for the Project, namely wind and solar power, are completely clean energy sources which neither pollute nor impact on the environment and thus the above mentioned EIA law does not provide relevant criteria.

The only possible concern associated with the Project could be the handling of batteries after their use with the windmills. As the batteries contain poisonous liquid lead they need to be disposed of with caution to prevent the lead from melting into ground water and thereby into the local drinking water. As a precaution, the Project proposes that a new recycling business for used lead be established by local companies.

G. Stakeholders comments

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

A Project hearing was held with the local residents, central and state government organizations etc.

Several meetings and seminars were held in the capital, Phnom Penh, and in Sen Monorom to inform stakeholders of the Project activity and to canvas opinions on social, environmental, economical and technical issues. (Meetings/seminars were held on Sep. 1, 3 and Nov. 12, 2004).

Local stakeholders from Pu Tru village, the proposed Project site, and interested persons from Sen Monorom hospital were invited to the seminars in order to voice their concerns about the current situation and their needs and to comment on the Project activity. Meetings were also held with the Ministry of Industry, Mines and Energy and the Japan International Cooperation Agency to obtain their views on the national electrification plan and their opinions on the Project.

G.2 Summary of the comments received:

The only concern raised by the local residents concerned the electricity fee. The comment made was that it would be very difficult for them to find jobs to pay the planned US$0.10/kWh.

All other comments received from the stakeholders were positive and encouraging. The Project was welcomed by all concerned because it is environmentally safe, improves social welfare by providing lighting to schools and residences, and reduces poverty by developing the rural area. The government of Cambodia greatly appreciates the establishment of the Project since it makes a substantial contribution to the nation's sustainable development and to the government's "Power Sector Strategy" which aims to provide electrification throughout the nation by 2020.

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

Concerns regarding the payment of the electricity fee will be resolved by providing opportunities to work in the rubber tree plantation site near Pu Tru village. The rubber tree plantation project will hire approximately 3,000 workers, giving priority to local residents. Upon receipt of this proposal, the local residents showed their willingness to work and appreciation for the new job opportunity.

No further modifications to the Project design are necessary since all the other comments received from the meetings/seminars supported the Project.

Annex 1

CONTACT INFORMATION FOR PARTICIPANTS IN THE PROJECT ACTIVITY

Project Promoter/Official Contact

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Country:	Japan
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FAX:	+81 3 3282 3407
E-Mail:	
URL:	http://www.marubeni.com
Represented by:	
Title:	Assistant General Manager
Salutation:	Mr.
Last Name:	Ikejima
Middle Name:	
First Name:	Norio
Department:	Environmental Machinery Dept.
Mobile:	
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CDM Advisor

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Country:	Japan
Telephone:	+81 6 6263 7300
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URL:	http://www.kanso.co.jp
Represented by:	
Title:	Chief Manager
Salutation:	Mr.
Last Name:	Takahashi
Middle Name:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The financial plans for the Project do not involve public funding from Annex I countries.

Draft-04
Jan. 25, 2005

Project Design Document

for

Small-Scale CDM Activity

Wind Power Project
in Mondul Kiri Province, Cambodia

March 2005

Marubeni Corporation

CONTENTS

Annexes

A. General description of project activity

A.1 Title of the project activity:

Wind Power Project in Mondul Kiri Province, Cambodia (the Project).

A.2 Description of the project activity:

A.2.1 Outline of the project activity:

The Project is for renewable energy development using wind and solar power in the highlands of Mondul Kiri Province (the Province), Cambodia.

The Project will comprise 115 small, hybrid power systems with a total capacity of 1.4 MW. These wind power generators will be constructed in 21 communes and 90 villages in Mondul Kiri Province and will be operated 24 hours/day for a total of 8,760 hours/year.

The electricity generated from renewable energy by the Project will replace electricity generated from diesel-powered mini-grids. The reduction in CO_2 emissions is estimated at 2,759 t CO_2 per year for the duration of the Project. Over the entire crediting period (21 years) the Project is expected to reduce emissions by 57,939 t CO_2, generating the equivalent amount of Certified Emission Reductions (CERs).

Electricity generated by the Project will be supplied to the villagers at lower rates (US$0.10/kWh) in return for their assistance in observing and monitoring the project facilities.

A.2.2 Purpose of the project activity:

Cambodia has made efforts to implement a sustainable energy efficiency program aimed at meeting its domestic energy needs[1]. However the national power system is encountering problems with low electrification rates, efficiency, institutional structure and environmental impacts.
In order to help the government achieve these goals and to improve the well-being of local residents, the Project will supply electricity produced from clean energy to isolated villages with little or no access to electricity.

A.2.3 CDM project under sustainable development policy in Cambodia

Cambodia ratified the UNFCCC in December 1995 and the Ministry of Environment (MoE) has coordinated preparations for participation in CDM (MoE, 2002). An initial national communication under the UNFCCC was published in August 2002 that provided a national greenhouse gas inventory for 1994 and described Cambodia's ability to respond to the effects of climate change. In mid 2003 the Cambodian Climate Change Office (CCCO) at MoE was appointed as the interim DNA (Designated National Authority) for CDM in Cambodia. CCCO is currently working to finalize sustainable development criteria for assessing proposed CDM projects. These criteria are based on Cambodia's existing government development plants, policies, regulations and laws.

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[1] Source: "Renewable Energy and Energy Efficiency (2004)", Ministry of Industry, Mines and Energy, Cambodia.

In Cambodia, capacity building activities are being conducted with a range of stakeholders, including relevant government ministries, private developers, non-government organizations, foreign investors and donor organizations[2]. Under these projects, the government aims to raise awareness about CDM at the national and provincial levels, strengthen CDM capacity for policy makers, public and private sectors, prepare sustainable development criteria for assessing proposed CDM projects, establish the final DNA and assessment process for proposed CDM projects, develop a pipeline of potential CDM projects, and promote these projects among developers and investors[3].

A.2.4 Contribution to the sustainable development of the host country:

The Project will contribute to the sustainable development of the region and the country in the following ways:

a. Socially sustainable development

There is no industrial development in the area surrounding the Project site at Sen Monorom, Mondul Kiri Province, and therefore the residents currently rely on home-generated electricity from small diesel generators. This causes great inconvenience to the local people in their daily lives. The local government is not able to use computers continuously and the region has no light after 10 pm due to the undeveloped electricity supply system. There is a high demand for electricity for schools and for the use of home television and radio as an information source. By meeting these demands for electricity the well-being of the residents in the community will be improved.

Considering the socioeconomic circumstances of the region, it would be difficult for them to improve the electricity supply system by themselves. The Project will introduce new, state of the art hybrid power system technology and know-how for the manufacture of propellers and batteries, enabling the local residents to produce them on their own.

The Project also has the potential to act as a business model for local companies to establish their own renewable energy projects and electricity companies. This will increase job opportunities and provide income for the local residents, helping to provide stability and improve their quality of life.

b. Economically sustainable development

The local production of the hybrid generation systems and the new electricity companies will invigorate and help support the local economy by creating new jobs for the residents. Because the electricity supplied by the Project will enable local people to work at night under lighting, the economic and social activities will also be promoted.

Furthermore, the technology is expected to be adopted not only in neighboring provinces but also in other countries such as Laos and Myanmar. The sustainable development in Cambodia could thus bring development and stability to the economy of the whole region.

c. Environmentally sustainable development

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[2] Source: "Sustainable Energy in Cambodia; Status and Assessment of the Potential for Clean Development Mechanism Projects (2004)", The Cambodian Research Center for Development

[3] Source: "Climate Change and the Clean Development Mechanism (2004)", The Cambodian Research Center for Development

Up to now, the development of the Cambodian energy sector has been based mainly on heavy fuel or diesel generators which are conventional, GHG-emission intensive and often out-of-date technologies[4]. In addition, due to the population hike in Sen Monorom in recent years, the demand for electricity is also likely to increase and lead to the further expansion of unplanned diesel-fuelled electricity generation which, in turn, could have an adverse effect on the valuable natural environment. The Project will provide access to technologies that can generate clean energy as an alternative to diesel fuel and thus protects the rich natural environment of Mondul Kiri Province while improving the well-being of the region.

A.2.5 Financial Scheme of the project activity:

The initial cost of the Project is estimated at approximately US$2.73 million (JPY300 million). This includes costs relating to the procurement and construction of equipment. Subsequently, running costs of approximately JPY?, annually, will be required for the maintenance.

Out of the total initial investment cost for the Project, it is assumed that 40% will be contributed by the capital fund while the remaining 60% will be financed on loan from banks.

A.3 Project participants:

Cambodia and Japan are the Parties to the proposed activity. At the moment the project participants, as defined by the CDM glossary, are as follows:

- **Marubeni Corporation (Marubeni)** – Project Promoter/Official Contact
- **General Environmental Technos Co., Ltd. (KANSO)** – CDM Advisor

Contact information is provided in Annex I. Investors to the Project will eventually be added to the above list of the Project participants.

A.4 Technical description of the project activity:

A.4.1 Location of the project activity:

A.4.1.1 Host country Party(ies):

Kingdom of Cambodia

A.4.1.2 Region/State/Province etc.:

Mondul Kiri Province

A.4.1.3 City/Town/Community etc:

Sen Monorom

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[4] Source: "Climate Change and the Clean Development Mechanism (2004)", The Cambodian Research Center for Development

A.4.1.4 Detailed description of the physical location, including information allowing the unique identification of this project activity:

The planned site is located in Mondul Kiri Province, Cambodia (see Fig. 1 - Location of the project site in Cambodia).

Mondul Kiri Province is located 390 km from Phnom Penh and nestles along Cambodia's eastern border with Vietnam. Its land area of about 14,682km comprises 8.11% of the total land area of Cambodia (181,035km) and 76% of the Province consists of forest. The total population is approximately 40,000 with an annual growth rate of 2.49%[5]. The Province comprises five districts, which include 21 communes and 90 villages.

The Province comprises mostly highlands and lies between 600 and 800 m above sea level. It has favorable wind conditions with a wind velocity of 15.2 m/s[6].

Figure 2 shows the planned site for the installation of the hybrid power system.

[5] Source: Ministry of Agriculture, Forestry and Fisheries, Cambodia (http://www.fadinap.org/cambodia/)

[6] Source: Ministry of Agriculture, Forestry and Fisheries, Cambodia (http://www.fadinap.org/cambodia/)

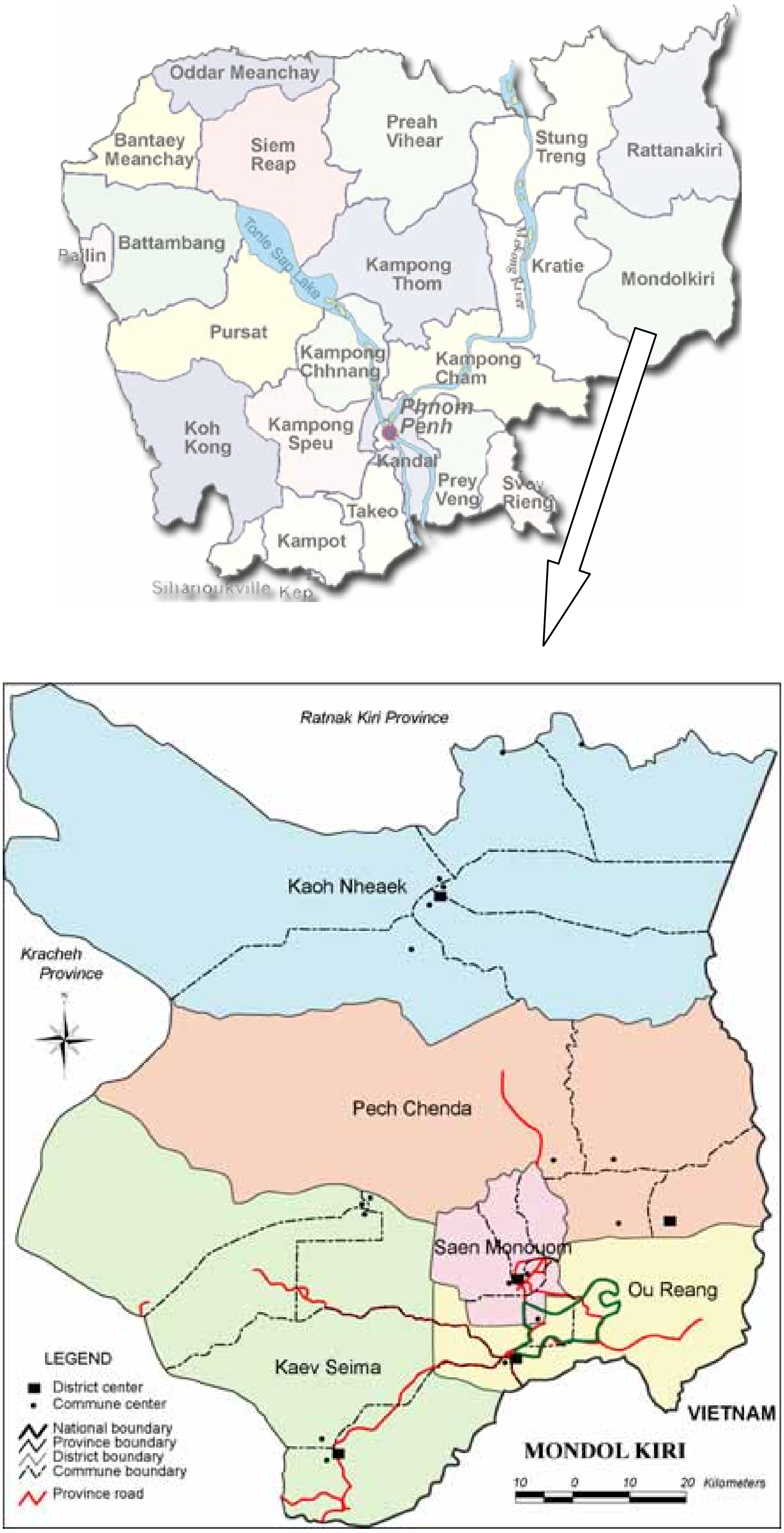


Figure 1. Location of the project site in Cambodia

Figure 2. Planned site for the installation of the hybrid power system

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

A.4.2.1 Type and category(ies) of project activity:

The Project activities are of the following type and category:

Type: I – RENEWABLE ENERGY PROJECTS
Category: A －Electricity generation by the user

The Project conforms to the project type and category selected because it uses renewable wind and solar power technologies that produce electricity to be used on-site by the user. Furthermore, the proposed units, with a generating capacity of 1.4 MW, will replace existing diesel electricity generation.

A.4.2.2 Technology to be transferred:

The key technology to be employed in the Project is a hybrid system comprising a vertical-sail-axle-type windmill generator and a photovoltaic generator (Fig. 3). This hybrid system utilizes renewable energy from both wind and/or sunlight as its power source and generates electricity during both day and night.

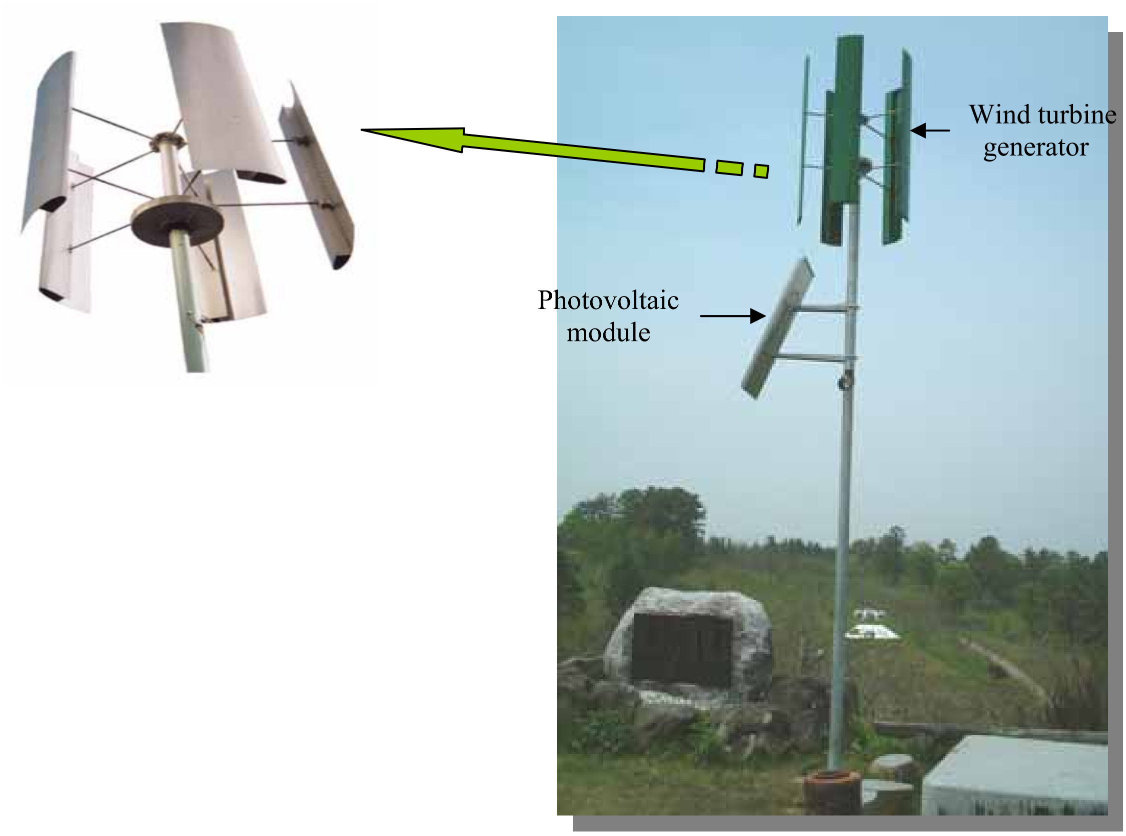
The Cygnus Mill wind turbine was designed as an environmentally friendly wind power generator. One of the most remarkable features of the Cygnus Mill is that, in contrast to the conventional propeller-type windmill with a horizontal axle, the Cygnus Mill can efficiently convert even relatively weak wind power (1-12 m/s) into electricity. The Cygnus Mill has the following advantages:

- ✓ rotates regardless of wind direction
- ✓ starts rotating at wind velocity of ca. 1m/s
- ✓ has high running torque in low winds
- ✓ has a simple engine system
- ✓ has a light and simple structure
- ✓ produces little noise and vibration
- ✓ is easy to set up

This new, state of the art technology introduced by the Project will thus lead to a transfer of knowledge within the country.

●Cygnus Mill

●Example of installation



●Basic system configuration

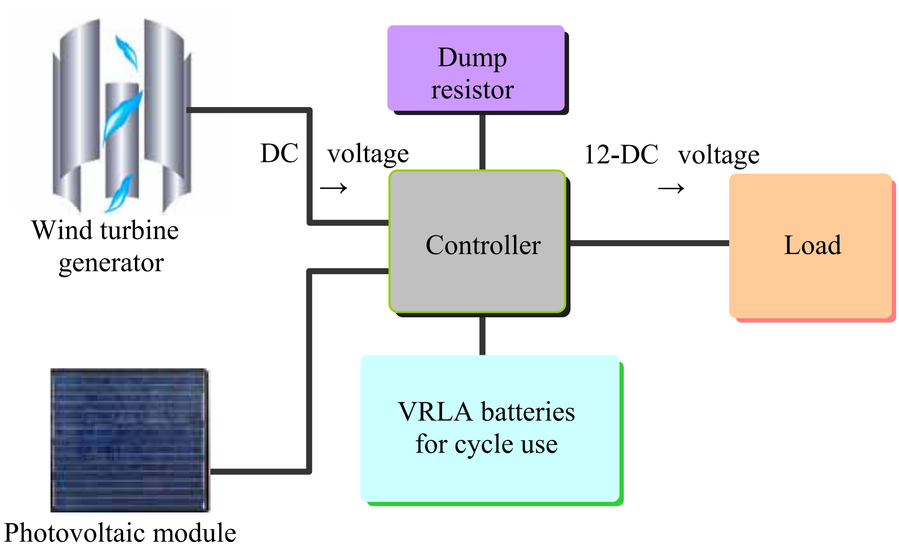


Figure 3. Hybrid power system with a wind turbine generator and a photovoltaic module

A.4.3 Brief statement on how anthropogenic emissions of greenhouse gases (GHGs) by sources are to be reduced by the proposed CDM project activity:

The Project is expected to reduce anthropogenic GHG emissions by displacing diesel-fuelled electricity generation with clean energy (zero GHG emissions) generated by wind and/or sunlight. As stated in section B, the proposed project activity is estimated to reduce emissions by 2,759 t CO_2 annually, totalling approximately 57,939 t CO_2 over the entire crediting period (21 years).

A.4.4 Public funding of the project activity:

The financial plans for the Project do not involve public funding from Annex I countries.

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

This particular project was originally initiated and developed by project participants who have not previously conducted other CDM projects. According to paragraph 2 of Appendix C of the simplified M&P for small-scale CDM project activities, the Project is not part of a larger project activity.

B. Baseline methodology

B.1 Title and reference of the project category applicable to the project activity:

Project category: Type I.A. Renewable Energy Projects, Electricity generation by the user

Reference: Appendix B of the simplified M&P for small-scale CDM project activities (UNFCCC, 2003)

B.2 Project category applicable to the project activity:

According to article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, category I.A. comprises *"renewable technologies that supply individual households or users with a small amount of electricity. These technologies include solar power, hydropower, wind power, and other technologies that produce electricity, all of which is used on-site by the user, such as solar home systems, and wind battery chargers."*

The proposed small-scale CDM project comprises wind and solar power generators that supply electricity to individual households and thus qualifies for project category I.A.

B.3 Description of how the anthropogenic GHG emissions by sources are reduced below those that would have occurred in the absence of the proposed CDM project activity (i.e. explanation of how and why this project is additional and therefore not identical with the baseline scenario)

B.3.1 Justification of using simplified methodologies:

As per article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, the capacity of renewable energy generators shall not exceed 15 MW in order to qualify as a small-scale CDM project. In the Project, the capacity of the facility is 1.4 MW ($\leqq$15 MW). Hence, the Project qualifies as a small-scale CDM.

B.3.2 Assessment of additionality:

Cambodia's power supply facilities were heavily damaged by war. Currently, only around 13% of the population[7] has continuous access to electricity via a reliable public grid and most are in Phnom Penh. Besides this "grid-quality" power, today electricity is provided by a number of different organizations using many different systems, standards and levels of quality, such as rural electricity enterprises (REEs), battery charging services, private stand-by diesel generation, etc.

It has been estimated that there are 600 REEs operating diesel-powered mini-grids in rural areas to sell power to around 60,000 households[8]. Batteries are also widely used in village homes and by some isolated communities. Through this combination of supplies, 19% of the richest quintiles in rural areas have electric lighting, but only 0.6% of the poorest quintile. Around 85% of rural dwellers still rely on

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[7] Source: "National Policy on Renewable Energy-based Rural electrification (2003)", The Royal Government of Cambodia

[8] Source: SME Cambodia (http://www.smecambodia.org)

kerosene lamps rather than electricity for lighting for electricity supplies[9]. In addition, it is noteworthy that Cambodia has the highest electricity costs of any ASEAN country[10]. The average tariff charged by REEs is estimated at US$0.53/kWh[11], and estimated 8,000 battery charging businesses provide services at more than US$1.00/kWh[12]. This is due to the reliance on small, isolated generation grids and the resulting lack of economies of scale, low efficiency in generation and distribution of electricity, and high capital and fuel costs[13].

Supply requirements are projected to increase by an average 12.1% per year and the peak demand is expected to reach 1,216 MW in 2020. In response, the Royal Government of Cambodia has set the goal of raising the access rate to reliable, grid quality electricity services to 70% of the rural population by the year 2030[14].

To that end, the government of Cambodia formulated its "Energy Sector Development Plan" in 1994 with the following objectives:
- To provide an adequate supply of energy throughout Cambodia at a reasonable and affordable price,
- To ensure a reliable, secure electricity supply at prices which facilitate investment in Cambodia and the development of the national economy,
- To encourage the adoption and environmentally and socially acceptable development of energy resources needed to supply all sectors of the Cambodian economy,
- To encourage the efficient use of energy and to minimize detrimental environmental effects resulting from energy supply and use.

Following this plan, in 1999 the government then formulated the "Cambodian Power Sector Strategy" to develop an adequate and reliable source of electric power over the next 20 years. This strategy establishes the sector's policy and action plan for:
- Investment in the power sector,
- Priorities for generation and transmission,
- Establishment of the power sector's Regulatory Framework,
- Commercialization of Electricity du Cambodia[15],
- Private sector participation,
- Provincial and rural electrification

Particular importance is placed on rural electrification since electricity is very important for both the improvement of living standards and the important infrastructure required for agricultural and small-scale industrial development in rural areas.
Furthermore, sustainable energy can play a vital role to achieve the country's targets for poverty reduction by enhancing energy security and providing local economic benefits through job creation and reducing imports of fossil fuels. The benefits of distributed generation from renewable sources are

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[9] Source: "Country Report for 17th ASEAN Ministers on Energy Meeting Bangkok (1999)", Ministry of Industry, Mines and Energy, Cambodia

[10] Source: ASEAN Center for Energy, 2004

[11] Source: "Renewable Electricity Action Plan (2003)", World Bank, Hundley

[12] Source: "Final Report on RE Strategy & Program for the Rural Electrification Strategy and Implementation Program for the World Bank (2001)", Metritec Ltd.

[13] Source: "Cambodia Power Sector Strategy (1999)", The Seventeenth ASEAN Ministers on Energy Meeting

[14] Source: "Strategy for Renewable Energy-based Rural Electrification in Cambodia (2003)", The Royal Government of Cambodia

[15] Electricity du Cambodia (EDC): a government owned power utility responsible for the generation, transmission and distribution of power in nine areas of the country.

especially valuable in Cambodia where there is the challenge of providing energy services to a rural population with minimal existing infrastructure.

Despite the above priorities, the following circumstances are noted as potential barriers to the Project:

- **Investment Barriers**

The Cambodian banking system is relatively fragile, operates mostly over the short-term and has a high interest rate. Several micro-finance institutions (MFI) operating in the rural areas provide credit for short periods with interest rates ranging from 40-60% per annum. Under these conditions there has, up till now, been little incentive for either wind power generation or investment in such business[16] despite the fact that sustainable development has been an important priority for the Cambodian government.

Furthermore, without the revenue from carbon credits (CERs), the internal rate of return (IRR) for the Project over the first 15 years, or the effective life of the hybrid system, is estimated at only 0.13%. When the Project is CDM registered and CERs are issued at the rate of US$10/t CO_2 for the Project over 15 years, this, coupled with the revenue from electricity sales (US$0.10/kWh), will lift the IRR to 1.78%, making the Project profitable.

The CDM presents a clear opportunity for Cambodia to develop sustainable energy solutions, rather than only those with the lowest initial capital cost.

- **Technological Barriers**

The Project will be the first of its kind in Cambodia to utilize wind and/or solar power for electricity generation. The capacity to design and manufacture such technology does not currently exist in Cambodia and there are no projects or technologies readily available for wind and/or solar power generation because:

- Technical know-how and maintenance skills are in short supply
- Lack of experience in operation, maintenance and management
- Limited training possibilities
- Low volume of renewable energy installations

These technological barriers will lead to higher risks and costs when the Project first attempts to introduce its unique operating systems to the country.

B.4 Description of the project boundary for the project activity:

Appendix B of the simplified M&P for small-scale CDM project activities defines the project boundary as "*the physical, geographical site of the generating unit and the equipment that uses the electricity produced delineates the project boundary*."

According to this definition, the Project boundary can be described as "homes that use electricity produced by the newly introduced hybrid power system."

[16] Source: "Strategy for Renewable Energy-based Rural Electrification in Cambodia" (2003), The Royal Government of Cambodia

B.5 Details of the baseline and its development:

B.5.1 Specify the baseline for the proposed project activity using a methodology specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities:

Article 4 in Appendix B of the simplified M&P defines the baseline as "*the fuel consumption of the technology in use or that would have been used in the absence of the project activity*."

B.5.1.1 Energy baseline

The annual energy baseline in the Project is developed in accordance with option (b) in article 4 in Appendix B of the simplified M&P.

The formula is described as follows:

$$\text{Annual energy baseline (kWh/y)} = \sum_i \text{Estimated annual energy output by the } i\text{th technology (kWh/y)} \div (1 - \text{Distribution loss})$$

Where $\sum_i$ denotes the sum over the group of "*i*" renewable energy technologies implemented as part of the project.

In the Project,

1) The sum over the group of "*i*" renewable energy technologies means the sum over all the implemented hybrid generation systems of one kind (*i*=1).

2) Estimated annual energy output = total installed capacity × operation hours × load factors.
As described earlier in section A, the total installed capacity of the generation systems (115 units) in the Project is 1.4 MW. These systems will be operated for 8,760 hours annually with a load factor of 20%, on average.

Therefore,

$$\text{Estimated annual energy output (kWh/y)} = \text{Total output (kW)} \times \text{Total operation hours (h/y)} \times \text{Load factor (\%)}$$

$$= 1{,}400\ (\text{kW}) \times 8{,}760\ (\text{h/y}) \times 20\%$$

$$= 2{,}452{,}800\ \text{kWh/y}$$

3) Distribution loss = 20% (default value)[17].

According to the above formula, the energy baseline which will be replaced by the Project activity is calculated at 3,066,000 kWh/y.

B.5.1.1 Baseline emission

The baseline emission is computed in accordance with paragraph 6 of Appendix B of the simplified M&P which stipulates "The emissions baseline is the energy baseline calculated in accordance with paragraph 4 above times the CO_2 emission coefficient for the fuel displaced. IPCC default values for emission coefficients may be used. A default value 0.9 kg CO_2equ/kWh, which is derived from diesel generation units, may be used."

The formula is as follows:

Baseline CO_2 emissions (t CO_2/y)	=	Annual energy baseline (kWh/y)	×	CO_2 emission coefficients for diesel powered generator (CO_2e/kWh)
	=	3,066,000 (kWh/y)	×	0.9 (CO_2e/kWh)
	=	2,759 t CO_2/y		

B.5.2 Date of completing the final draft of this baseline section:

06/01/2005

B.5.3 Name of person/entity determining the baseline:

Kyoto Mechanisms Business Office
Environmental Assessment Department
General Environmental Technos Co., Ltd.
1-3-5 Azuchimachi, Chuo-ku, Osaka, Japan 541-0052
Tel: +81-6-6263-7407
Fax: +81-6-6263-7309

[17] Source: Footnote 3 of Appendix B of simplified M&P for small-scale CDM project activities.

C. Duration of the project activity and crediting period

C.1 Duration of the project activity:

C.1.1 Starting date of the project activity:

April 1, 2006 (Starting date of the hybrid power system operation)

C.1.2 Expected operational lifetime of the project activity:

30 years

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

C.2.1 Renewable crediting period *(at most seven (7) years per crediting period)*

C.2.1.1 Starting date of the first crediting period:

01/04/2006

C.2.1.2 Length of the first crediting period:

7 years

C.2.2 Fixed crediting period *(at most ten (10) years)*:

C.2.2.1 Starting date:

C.2.2.2 Length (max 10 years):

D. Monitoring methodology and plan

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

The Project monitoring methodology is as defined in paragraph 8 (b) for project type I.A. in Appendix B of the simplified M&P. This methodology consists of "metering the electricity generated by all systems of a sample."

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

The Project comprises the renewable technology of wind and solar power generation supplying individual households or users with a small amount of electricity. As per article 1 in Appendix B of the simplified M&P for small-scale CDM project activities, the capacity of renewable energy generators shall not exceed 15 MW in order to qualify as a small-scale CDM project. The planned generation capacity of 1.4 MW is less than this 15 MW threshold and therefore qualifies as a small-scale CDM.

The monitoring methodology to be used by the Project is identical with that prescribed for type I.A. projects, i.e., "metering the electricity generated by all systems of a sample."

D.3 Data to be monitored:

As part of the Project activity, data on power generation are electronically recorded and then manually retrieved by the project participants on a quarterly basis in order to measure the actual amount of electricity generated by all the hybrid generation systems.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
D.3.1	Quantita-tive	Electricity generated by the hybrid systems	kWh	m	Quarterly	100%	Electronic	Min. of 2 yrs after last CER issuance	Data of each unit are retrieved in a memory card and then collected at routine check-up.

D.4 Name of person/entity determining the monitoring methodology:

Kyoto Mechanisms Business Office
Environmental Assessment Department
General Environmental Technos Co., Ltd.
1-3-5 Azuchimachi, Chuo-ku, Osaka, Japan 541-0052
Tel: +81-6-6263-7407
Fax: +81-6-6263-7309

E. Calculation of GHG emission reductions by sources

E.1 Formulae used:

E.1.1 Selected formulae as provided in appendix B:

In accordance with paragraph 6 of Appendix B of the simplified M&P, the baseline emission is calculated by multiplying the annual energy baseline by the CO_2 emission coefficient for the fuel displaced.

The formula is as follows:

$$\text{Baseline } CO_2 \text{ emission } (t\ CO_2/y) = \text{Annual energy baseline } (kWh/y) \times CO_2 \text{ emission coefficients for diesel } (CO_2e/kWh)$$

E.1.1.1 Annual energy baseline

As mentioned earlier in B.5, the annual energy baseline is calculated as follows:

$$\text{Annual energy baseline } (kWh/y) = \sum_i \text{Estimated annual energy output by the } i^{th} \text{ technology } (kWh/y) \div (1 - \text{Distribution loss})$$

$$= 3{,}066{,}000 \text{ kWh/y}$$

E.1.1.2 CO_2 emission factor

As stipulated in paragraph 6 of Appendix B of the simplified M&P, an IPCC default value 0.9 kg CO_2e/kWh (derived from diesel generation units) can be used.

E.1.1.3 Baseline CO_2 emission

Using the above data, the baseline CO_2 emission is calculated as follows:

$$\text{Baseline } CO_2 \text{ emission } (t\ CO_2/y) = \text{Annual energy baseline } (kWh/y) \times CO_2 \text{ emission coefficients for diesel } (CO_2e/kWh)$$

$$= 3{,}066{,}000\ (kWh/y) \times 0.9\ (CO_2e/kWh)$$

$$= 2{,}759 \text{ t } CO_2/y$$

The total reduction in emissions over the crediting period of 21 years is estimated at 57,939 tCO_2.

E.1.1.4 CO_2 emission due to the Project activity within the Project boundary (Project emission)

There will be no CO_2 emission due to the Project activity since wind and solar power are clean energies emitting no GHGs.

E.1.1.5 Leakage due to the Project activity

Article 7 in Appendix B of the simplified M&P states that "*if the renewable energy technology is equipment transferred from another activity, a leakage calculation is required.*" The equipment for wind and solar energy generation to be used in the Project will be newly constructed so there is no need to consider leakage in accordance with the Project.

E.1.1.4 CO_2 emission reductions due to the Project

The CO_2 emission reductions are calculated as follows:

CO_2 Emission Reductions = Baseline Emission – (Project Emission + Leakage)

= 2,759 t CO_2/y – (0 + 0)

= 2,759 t CO_2/y

Since there is no CO_2 emission or leakage due to the implementation of the Project, the reduction in CO_2 emissions realized by the Project is estimated at 2,759 t CO_2/y.

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

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

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

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

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

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

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

Table 2 summarizes the values of the parameters that are required in estimating CO_2 emission reductions.

Table 2. Values of the parameters for estimation of CO_2 emission reductions by the Project

Item		Term / Parameter	Value	Remarks
Specification of hybrid systems	A	Number of hybrid systems	115 generators	Refer to Section A
	B	Total installed capacity of hybrid systems	1.4 MW	Refer to Section A
	C	Annual average load factor of hybrid systems	20%	Refer to Section A
	D	Total operating hours	8,760 h	Refer to Section A
	E	Annual power generation of the Project	2,452,800 kWh	B×C × D
Annual energy baseline	F	No. of the kinds of renewable energy technologies	1	Hybrid system
	G	Default value for distribution loss	20%	Footnote 3 of Appendix B of simplified M&P
	H	Energy baseline	3,066,000 kWh	F ×E÷(1 – G)
Baseline CO_2 emission	I	Emission coefficient	0.9	IPCC default value for diesel generation units
	J	Baseline CO_2 emission	2,759 t CO_2/y	H×I
CO_2 emission by the Project	K	CO_2 emission due to the Project activity	0 t CO_2/y	Refer to E.1.1.4
	L	Leakage due to the Project activity	0 t CO_2/y	Refer to E.1.1.5
CO_2 emission reduction by the Project	**M**	**Annual CO_2 emission reductions**	**2,759 t CO_2/y**	**J－K－L**
	N	**Total CO_2 emission reduction during the crediting period (21 years: 2006-2026)**	**57,939 t CO_2**	**M × 21 years**

F. Environmental impacts

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

Cambodia complies with the “Laws on Environmental Protection and Natural Resource Management (1996)” and “Environmental Impact Assessment (EIA) (1999)” which prescribe criteria for all environmental activities.

However, the natural resources used for the Project, namely wind and solar power, are completely clean energy sources which neither pollute nor impact on the environment and thus the above mentioned EIA law does not provide relevant criteria.

The only possible concern associated with the Project could be the handling of batteries after their use with the windmills. As the batteries contain poisonous liquid lead they need to be disposed of with caution to prevent the lead from melting into ground water and thereby into the local drinking water. As a precaution, the Project proposes that a new recycling business for used lead be established by local companies.

G. Stakeholders comments

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

A Project hearing was held with the local residents, central and state government organizations etc.

Several meetings and seminars were held in the capital, Phnom Penh, and in Sen Monorom to inform stakeholders of the Project activity and to canvas opinions on social, environmental, economical and technical issues. (Meetings/seminars were held on Sep. 1, 3 and Nov. 12, 2004).

Local stakeholders from Pu Tru village, the proposed Project site, and interested persons from Sen Monorom hospital were invited to the seminars in order to voice their concerns about the current situation and their needs and to comment on the Project activity. Meetings were also held with the Ministry of Industry, Mines and Energy and the Japan International Cooperation Agency to obtain their views on the national electrification plan and their opinions on the Project.

G.2 Summary of the comments received:

The only concern raised by the local residents concerned the electricity fee. The comment made was that it would be very difficult for them to find jobs to pay the planned US$0.10/kWh.

All other comments received from the stakeholders were positive and encouraging. The Project was welcomed by all concerned because it is environmentally safe, improves social welfare by providing lighting to schools and residences, and reduces poverty by developing the rural area. The government of Cambodia greatly appreciates the establishment of the Project since it makes a substantial contribution to the nation's sustainable development and to the government's "Power Sector Strategy" which aims to provide electrification throughout the nation by 2020.

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

Concerns regarding the payment of the electricity fee will be resolved by providing opportunities to work in the rubber tree plantation site near Pu Tru village. The rubber tree plantation project will hire approximately 3,000 workers, giving priority to local residents. Upon receipt of this proposal, the local residents showed their willingness to work and appreciation for the new job opportunity.

No further modifications to the Project design are necessary since all the other comments received from the meetings/seminars supported the Project.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The financial plans for the Project do not involve public funding from Annex I countries.