CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

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"Coconut shell charcoaling and power generation at Badalgama, Sri Lanka"

Version 05,

Date: 16/10/2007

A.2. Description of the small-scale project activity:

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Charcoal used for producing activated carbon is manufactured in open pits, at several locations in North Western province of Sri Lanka which has the highest density of coconut plantations. This process of charcoal manufacturing releases methane and wide range of organic vapours and gases. Approximately 185,000 tonnne per annum (TPA) of coconut shell is converted to 55,000 TPA charcoal by pit charcoal manufacturers in open pits in Sri Lanka. The following diagram shows various stages of operation in the manufacturing of coconut shell charcoal in open pits.

Empty open pit

Open pit with coconut shell

Pyrolysis stage

End of pyrolysis

Purpose of the Project

The project activity involves construction of a mechanized charcoaling plant for converting coconut shells to charcoal using gasification cum pyrolysis process and utilization of the energy of released gases to generate electricity.

Mechanized Charcoaling Plant

The project activity would be implemented in phased manner. The charcoal production and the electricity generation capacity would increase with the implementation of each phase. The project activity would be using approximately 77,442 tonnes of coconut shells per year to produce approximately 26,400 tonnes of charcoal and subsequently generate 5.8 MW of electricity at the end of Phase -IV. The description of the project activity after implementation of each phase is as follows:

Phase	Date of commissio-ning[1]	Coconut Shell Consumption (DRY) (tonnes/yr)	Kilns in operation	Charcoal Production (tonnes/yr)	Generation Capacity (MW)
I	Currently in Operation	9678	1	3,300	0.27
II	01/09/2007	29043	3	9,900	1.21
III	01/01/2009	58077	6	19,800	4.81
IV	01/04/2009	77442	8	26,400	5.80

Methane, other gases and vapours released in the process would be fully combusted to generate energy for producing steam, which would be further used to generate electricity. The electricity generated would be sold to the Ceylon Electricity Board (CEB) through a Power Purchase Agreement (PPA).

In the absence of the project activity the methane released in manufacturing of charcoal from coconut shell in open pits would have caused GHG emissions. Also, electricity equivalent to that exported to CEB by the project activity would have generated in the fossil fuel based power plants connected to CEB causing GHG emissions.

In order to counter the loss of income of current charcoal manufacturers, due to project activity, Recogen would purchase the coconut shells from same pit charcoal suppliers at reasonable prices. Therefore the project activity would not create additional demand for coconut shells but substitute the open pit charcoal manufacturing process.

Hence the implementation of project activity would help to reduce GHG emissions in following two ways:

[1] These are tentative dates of commissioning based on design reports and may change on actual implementation.

1. Avoidance of methane emissions that would have occurred in the open pit charcoal manufacturing process to produce equivalent amount of charcoal.
2. Supply of clean power from renewable sources to CEB thereby reducing GHG emissions that would have occurred to produce equivalent amount of energy in the grid.

Approved Small Scale Methodology - **AMS III.K. (Ver 01, 23 December 2006)** has been used for estimation of GHG reduction due to avoidance of methane by the project activity and **AMS I.D. (Ver 10, 23 December 2006)** to estimate the GHG reductions due to export of electricity to CEB.

Projects Contribution to Sustainable Development

Recogen Limited, which is the owner of the project activity, believes that the project activity has the potential to positively shape the economic, environmental and social aspects of the region.

Social well being:

- The project activity would result in the generation of employment for the local people during both the construction and the operation phase of the project activity.
- It would also help to enhance the skills of the labour in the area by dissemination of knowledge and experience in different technical areas.

Economic well being:

The project activity would contribute to overall economic well being in the country by:

- Creating business opportunities for local stakeholders such as suppliers, manufacturers, contractors etc.
- Reducing the demand-supply gap in the power deficit grid.

Environmental well being

- Since, the project activity would use waste gases emitted from charcoal manufacturing process for power generation; it would prevent release of these gases in the environment.
- The power generation by project activity would prevent exploitation and depletion of natural, finite and non-renewable resource like coal/gas.

A.3. Project participants:

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Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants(as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
1. Sri Lanka (Host)	Recogen Limited	No
2. Japan	Japan Carbon Finance, Ltd.	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

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A.4.1.1. Host Party(ies):

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Sri Lanka

A.4.1.2. Region/State/Province etc.:

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North Western Province

A.4.1.3. City/Town/Community etc:

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Badalgama

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

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The project is located in North Western province of Sri Lanka at Beatrice Estate, km 19 on Negambo-Katana Road, Badalgama. The project site is easily accessible by road and nearest airport is at Colombo. Also the materials required for construction of the plant are easily available from the nearby area. The project activity is located at $7^0$17’20” N Latitude and $79^0$58’34” E Longitude. The geographical location of the project activity is shown in the map below.

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

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The categories for the project activity according to the "Appendix B - Indicative Simplified Baseline and monitoring Methodologies for Selected Small Scale CDM Project Activities" are as follows:

1. For Avoidance of methane - Type III.K (reference AMS III.K, ver 01, 23 December 2006) – "Avoidance of Methane release from charcoal production by shifting from pit method to mechanised charcoaling process"
2. For Electricity Generation – Type I.D (reference AMS I.D, ver 10, 23 December 2006) – "Renewable electricity generation for the grid"

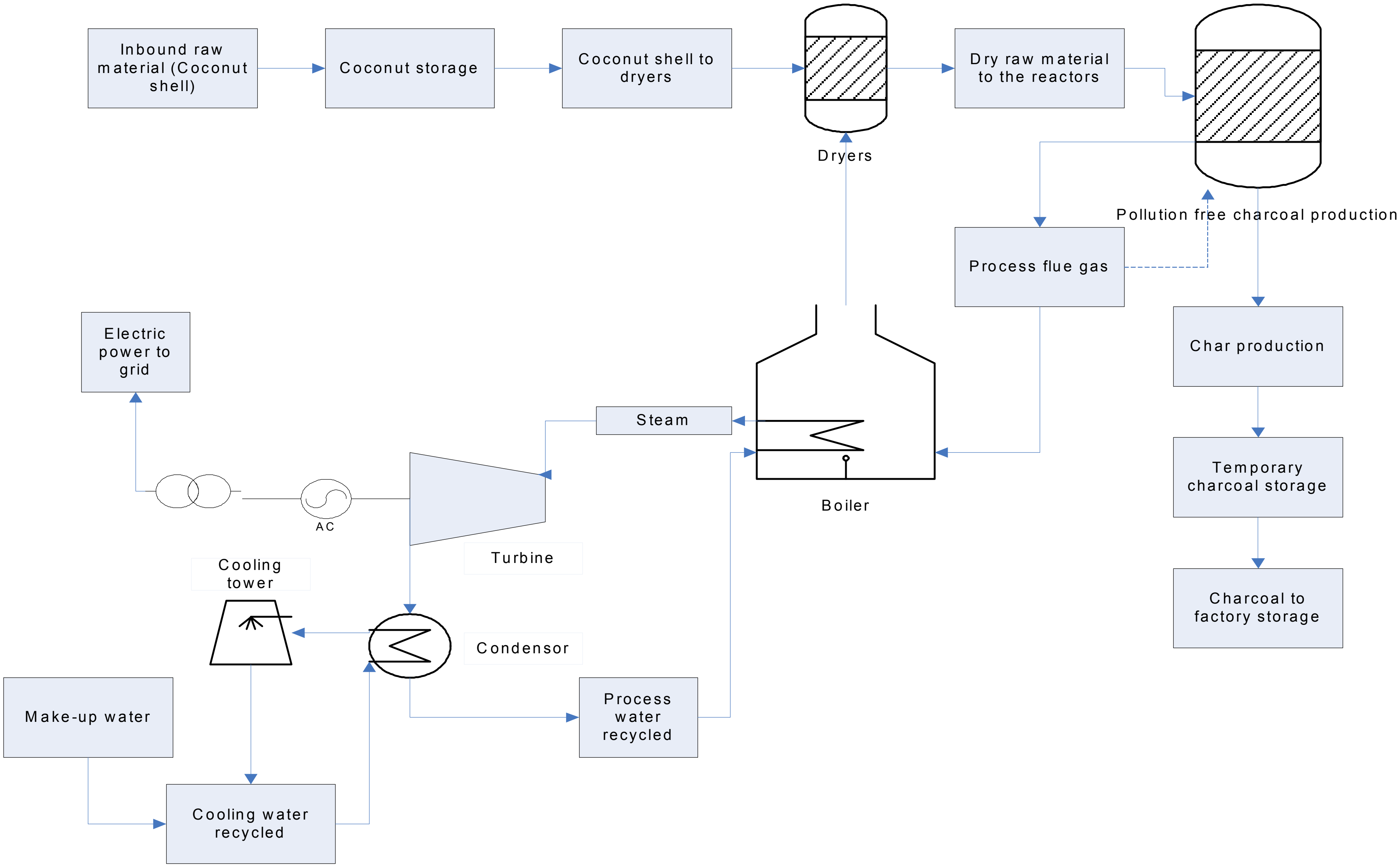
Technology of project activity

The technology used has been developed indigenously and is environmentally safe and sound. The project process involves crushing raw coconut shells in crushers, followed by separation of the shell undersize and pith. The raw coconut shell is then fed to shell dryer that uses waste heat of flue gases to dry coconut shells to reduce the moisture content of the coconut shells. Thereafter, dry shells are fed to the processing kilns. In the kiln, combination of gasification and pyrolysis

converts the shell to charcoal at temperature of approximately 500^{0}C over period exceeding 2 hours. The charcoal is discharged from the kilns through water sealed screw conveyor. The gases generated in the kilns are combusted in combustion chamber situated downstream of the kiln. The sensible heat of flue gases from combustion chamber is used in boilers to generate steam, which is further used to generate electricity through steam turbines. The wet steam from turbine is condensed and used again in the boiler. The capacity of power generation will be enhanced phase wise by addition of new turbine in the Phase III as follows.

Phase	Installed capacity of turbine (MW)	Generation Capacity (MW)	Boilers' configuration	Comments
I	1X1.25	0.27	1X10 Tonnes per hour(TPH), 17 Kg/Cm^2 @ 350^{0}C	The turbine would be running at low PLF thereby generating only 0.27 MW
II	1X1.25	1.21	1X10 TPH, 17 Kg/Cm^2 @ 350^{0}C	No new turbine would be installed. The turbine installed in phase I would run at full load in phase II
III	1X5.0	4.81	1X25 TPH, 64 Kg/Cm^2 @ 450^{0}C	A new turbine of 5.0 MW would be installed in phase III, the 1.25 MW turbine would not be used for power generation during the Phase III
IV	1X5.0 + 1X1.25	5.80	1X10 TPH, 17 Kg/Cm^2 @ 350^{0}C; 1X25 TPH, 64 Kg/Cm^2 @ 450^{0}C	Both the turbines would be used in phase IV onwards to generate 5.8 MW

The Systematic diagram of the mechanised charcoaling process as explained above is given below.


Inbound raw material (Coconut shell)
Coconut storage
Coconut shell to dryers
Dryers
Dry raw material to the reactors
Pollution free charcoal production
Process flue gas
Char production
Temporary charcoal storage
Charcoal to factory storage
Electric power to grid
Steam
AC
Turbine
Boiler
Cooling tower
Condensor
Process water recycled
Make-up water
Cooling water recycled

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

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Years	Annual estimation of emission reductions in t CO_2 e
2007-2008	13698
2008-2009	44193
2009-2010	46656
2010-2011	46656
2011-2012	46656
2012-2013	46656
2013-2014	46656
2014-2015	46656
2015-2016	46656
2016-2017	46656
Total estimated reductions (tonnes of CO_2 e)	**431139**
otal number of crediting years	**10**
Annual average over the crediting period of estimated reductions ((tonnes of CO_2 e)	**43113**

A.4.4. Public funding of the small-scale project activity:

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No public funding as part of project financing from parties included in Annex I of the convention is involved in the project activity.

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

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According to Appendix C of Simplified Modalities & Procedures for small scale CDM project activities, 'Debundling' is defined as the fragmentation of a large project activity into smaller parts. A small-scale project activity that is part of a large project activity is not eligible to use the simplified modalities and procedures for small-scale CDM project activities. Paragraph 2 of the aforesaid document states that a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- By the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

Project participant has not registered any small scale CDM project in the same category and technology/measure whose project boundary is within 1 km of this project activity. Hence, the project activity is not a debundled component of a large scale project activity.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

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- For Avoidance of methane - Type **III.K** (reference AMS III.K, ver 01, 23 December 2006) – "Avoidance of Methane release from charcoal production by shifting from pit method to mechanised charcoaling process"
- For Electricity Generation – Type **I.D** (reference AMS I.D, ver 10, 23 December 2006) – "Renewable electricity generation for the grid"

Reference: "Appendix B- Indicative Simplified Baseline and monitoring Methodologies for Selected Small Scale CDM Project Activities"

B.2 Justification of the choice of the project category:

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The category III.K. is applicable under one of the following conditions;

(a) This category is applicable to project activities that avoid release of methane from pit charcoal production by producing charcoal in new facility(ies) equipped with recovery and flaring/combustion of methane generated in the production process.

(b) The category is applicable under one of the following condition;

I. *Local regulations do not require controlling methane emissions in charcoal production;*

II. *There is a widespread non compliance1 of the local regulation evidenced by:*

(i) Annually collected data from control groups set up by the project activity, or

(ii) Annually collected data on legal action and enforcement mechanisms implemented under the prevailing regulation, or

(iii) Official reports (e.g. annual reports of regulatory bodies for pollution control).

(c) No relevant changes in greenhouse gas emissions other than methane occur as a consequence of the project activity and/or need to be accounted, except for the possibilities of leakage.

(d) The implementation of the project activity shall not result in changes in the type and source of biomass raw material used for production of charcoal (e.g. if in the baseline charcoal was produced from coconut shells, the project activity will only produce charcoal from coconut shells).

(e) Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually

The project activity qualifies for the project activity category III.K as it satisfies the above mentioned applicability criteria in the following manner:

(a) The project activity involves converting coconut shells to charcoal using mechanized charcoaling process. The project activity avoids methane release by utilization of the methane released in the process to generate electricity.

(b) There is no legal regulation in the region that requires controlling methane emissions in charcoal production.

(c) There is no change in the GHG emissions other than methane as a consequence of the project activity.

(d) The implementation of the project activity will not result in any change in the type and source of biomass raw material used for production of charcoal.

(e) It will not result in emission reduction more than 60 kt CO2 equivalent annually over the crediting period. The estimated average project activity emission reductions due to avoidance of methane release from charcoal production by shifting from pit method to mechanised charcoaling process amounts to 21,632 tCO2/year, less than the above mentioned emission reduction limit for this category.

The Applicability conditions as per the category I.D. are as follows:

(a) This category comprises renewable energy generation units, such as photovoltaics, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit.

(b) If the unit added has both renewable and non-renewable components (e.g.. a wind/diesel unit), the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15MW.

(c) Biomass combined heat and power (co-generation) systems that supply electricity to and/or displace electricity from a grid are included in this category. To qualify under this category, the sum of all forms of energy output shall not exceed 45 MWthermal e.g. for a biomass based co-generating system the rating for all the boilers combined shall not exceed 45 $MW_{thermal}$.

(d) In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct1 from the existing units.

The project activity qualifies for the project activity category I.D. as it satisfies the above mentioned applicability criteria in the following manner:

(a) The project activity comprises renewable energy generation units thru mechanized charcoaling process using flue gases generated by renewable biomass (coconut shells). The project activity displaces electricity from the Sri Lankan grid which is a fossil fuel based.

(b) After successful implementation of all the phases the total capacity of the project would be only 5.8 MW for generating electricity and will not exceed

the eligibility limit of 15 MW for a small scale project activity during the entire crediting period.

(c) This is not applicable as the project activity does not comprise of cogeneration unit.

(d) This is not applicable as there is no existing renewable power generation facility.

B.3. Description of the project boundary:

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As per the Appendix B for small scale project activities:

- The project boundary for I.D (reference AMS I.D. ver 10, 23 December 2006, para 6) encompasses the physical, geographical site of renewable generation.

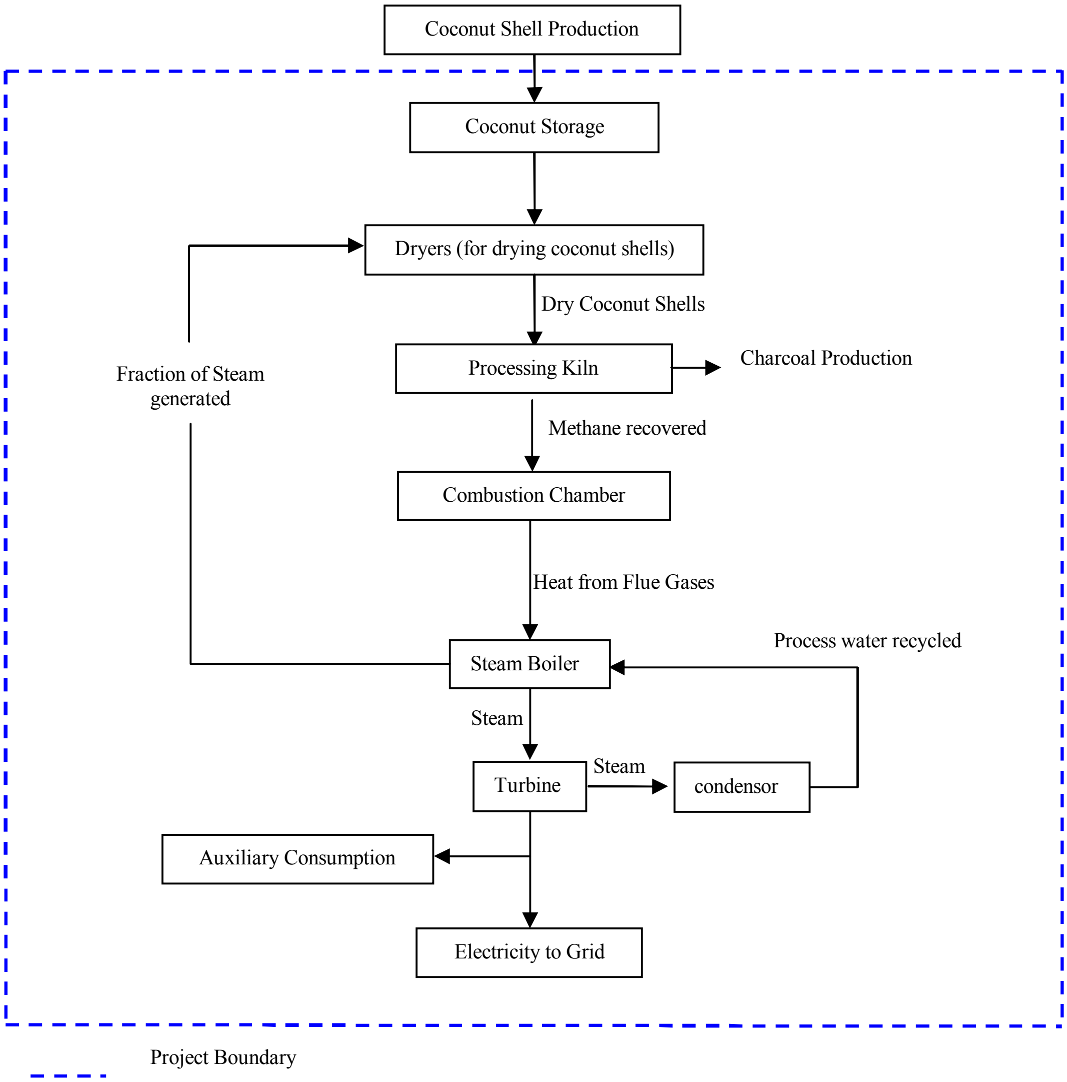
- The project boundary for III.K (reference AMS III.K. ver 01, 23 December 2006, para 7) encompasses the physical, geographical site where,

  (a) Where the charcoal is manufactured in open pits and the avoided methane emission occurs in absence of the proposed project activity;

  (b) Where the charcoal manufacturing with recovery and flaring/combustion of methane takes place;

  (c) And in the itineraries between them, where the transportation of raw material for charcoal manufacturing occurs.

Thus the project boundary includes the coconut shell storage yard to the point of power supply to nearest substation encompassing the physical and geographical site of the mechanised charcoal manufacturing unit. Thus, boundary covers storage yard, crushers, dryers, conveyor belt system for transporting raw material to the processing kilns, processing kilns, combustion chamber, boiler, turbine and all other accessory equipments. For the purpose of calculation of baseline emissions, national grid is also included in the system boundary. The project boundary is shown in the following diagram.



B.4. Description of baseline and its development:

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Determination of the baseline

For avoidance of Methane release from charcoal production by shifting from pit method to mechanised charcoaling process, realistic and credible baseline scenarios may include:

1. Manufacturing of charcoal from coconut shells in open pits (current practice)
2. The proposed project not undertaken as a CDM project activity.
3. Installation of the mechanised charcoaling manufacturing facility with no provision for methane capturing.

Alternative 1: "Manufacturing of charcoal from coconut shells in open pit" does not face any barriers and can be a credible baseline scenario. In the absence of the project activity open pits would have been used for manufacturing charcoal.

Alternative 2: "The proposed project activity not undertaken as a CDM project activity" cannot be a baseline scenario as it faces associated barriers as given in subsequent section B.5

Alternative 3: "Installation of the mechanised charcoaling manufacturing facility with no provision for methane capturing" cannot be a credible baseline scenario as it is economically unattractive. Methane has a high energy generating potential and is a significant renewable energy source with associated price value.

Thus, the appropriate baseline scenario for project activity category **III.K (ver 01, 23 December 2006)** is as follows:

In the baseline scenario the charcoal would have been produced in open pits within the project boundary and methane would be emitted to the atmosphere. The baseline emissions therefore is the amount of methane that would have been produced from open pits to process the equivalent quantity of raw material used in the project activity to produce charcoal. The key parameters for determining the baseline emissions, as per the paragraph 9 of the project activity are as follows:

Key variables used for determining the Baseline Emissions
$\mathbf{Q_{y,raw}}$ - Quantity of raw material used in the new facility in the year "y" (tonnes)
$\mathbf{M_{y,b}}$ - Methane emission factor for open pit charcoal manufacturing process (tonnes of CH_4/tonne raw material used)
$\mathbf{M_{y,d}}$ - Factor to account for any legal requirement for capture and flare of methane in open pit charcoal production (tonne of CH_4/tonne of raw material)
$\mathbf{GWP_{CH4}}$ - Global Warming Potential of Methane (CH_4)

The appropriate baseline scenario for project activity under category **I.D (ver 10, 23 December 2006),** would be equivalent amount of electricity generation in fossil fuel based power plants connected to CEB resulting in GHG emissions. The project activity by utilizing the renewable source of energy to generate electricity reduces equivalent amount of CO_2 emissions in the grid. The baseline is the GWh generated by the renewable generation unit multiplied by the emission coefficient factor for the Sri Lankan grid.

The key parameters and assumptions for determining the baseline emissions as per the paragraph 9(a) are as follows:

Key variables used for determining the Baseline Emissions
Generation of power of all the power plants for the year 2004, 2005, 2006 – statistical digest 2004, statistical digest 2005, statistical digest 2006 – www.ceb.lk
EF_y - Baseline Emission factor (tCO_2/GWh)
EG_y - Renewable Electricity Generation (GWh)

Dispatch data analysis is not selected because of the unavailability of the dispatch data for electricity generation.

Date of completing the baseline section is 16/10/2007

Recogen Ltd. has determined the baseline and they are project participant as listed in Annex 1 of this document.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

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The implementation of the project activity is a voluntary step undertaken by Recogen Ltd. with no direct or indirect mandate by law. The project proponent was aware of the various barriers associated to project implementation. However, it was felt that the availability of carbon financing against a sale consideration of carbon credits generated due to project activity would help to overcome these barriers. The barriers faced by the project activity are discussed below:

Prevailing practice barrier

The prevailing and the common practice to manufacture coconut shell charcoal in Sri Lanka is through open pits. This process of charcoal manufacturing releases methane and wide range of organic vapours and gases.

The project activity is first of its kind in the country which involves application of sophisticated technology to manufacture charcoal in controlled conditions using gasification cum pyrolysis process. The gases generated in the kiln are totally combusted in combustion chamber situated downstream of the kiln, thereby avoiding release of methane ito atmosphere. Further the sensible heat of flue gases from combustion chamber are used in boiler to generate steam which is further used to generate electricity through a steam turbine

In absence of any promotional policies by the government to encourage the implementation of the project activity, equivalent amount of GHG emissions would have occurred due to release of

methane generated during pyrolysis process in open pits and generation of equivalent amount of electricity at the Sri Lankan grid.

Technological barrier

Optimization of the amount of energy generated by the charcoal manufacturing plant was a daunting task. Attempts were made to analyze the composition of the vapours released to estimate the potential for power generation. This proved to be a challenge as Sri Lanka did not have the necessary expertise and equipment to reliably perform this analysis. Attempts to send a sample to Singapore for this purpose failed as the vapour was considered a dangerous cargo which was not accepted by the air lines and it was considered that a delay in the analysis could lead to erroneous results. As such an expert was brought down from Singapore with the necessary equipment to perform the analysis without delay at site. It was found that the identification of all the components in the mixture of gases which constitute the vapour could not be done completely. However, the information gathered provided adequate information to estimate the energy value of the vapors and thus estimate the power generation potential. Data were collected to design and evaluate the viability of a commercial scale project. The sale of the power generated was expected to offset the very high cost of conversion of coconut shells to charcoal in a highly sophisticated and expensive plant, as compared to the primitive pit charcoaling methods.

In this scenario the governing factor, which would have severely affected the project was the amount of energy and the price paid by the state monopoly utility, the Ceylon Electricity Board for the power exported to the grid. The prevailing regulations prevented the power being sold to any other party. This level of tariff determined solely by the utility was very low and was disputed by all those who supplied power to the grid including the small hydro power developers. During the years of experimentation the cost of materials and labour were rising.

At this stage the potential of obtaining revenue by the sale of the carbon credits from the project was considered to carry ahead the project. The project activity obtained approval from Govt. of Sri Lanka in year January 2002 for participation in CERUPT tender of Netherlands Government. It was then decided that the charcoal manufacturing process needed to be tested out in a commercial scale operation including the power generation. Single kiln of 3300 TPA capacity and a small steam turbine system matching the expected out put of power was selected for this stage of development.

Immediate problems were encountered in finding sources for the equipment particularly the blowers and heat exchangers, which could with stand the extremes of high temperature and corrosive atmospheres. Only a few manufacturers were ready to make offers for the blowers required. None could be found for the supply of the heat exchangers. Therefore the heat exchangers were designed and built in Sri Lanka. The assistance of the faculty of Engineering of the University of Peradeniya was obtained to try to perform stress analysis of the components of the heat exchangers under the expected operating conditions. With all these constraints kiln and turbine were ready for commissioning by 2004. Problems were encountered from beginning due to blowers not being able to withstand extreme conditions, particularly leakage of air through shaft seals created inflammable conditions which exacerbated the problems. Similar problems were encountered in heat exchanger as well. Efforts were continued for almost a year with modifications and improvements to equipment to overcome the problems encountered.

During this period, Recogen was on constant search for a reputed consultant, which could develop PDD for the project activity to be registered as CDM project activity and project participant from Annex I country which could provide advance against purchase of CER.

In July 2005, Recogen entered into Emission Reduction Purchase Agreement (ERPA) with Japan Carbon Fund (JCF) for sale of carbon credits generated by project activity.

Benefits obtained against sale of CERs would be used for constant development and successful operation of the power generation plant. Further, these benefits would also be used to employ highly skilled man-power and impart them essential training to run the system efficiently.

In spite of above discussed barriers, Recogen Ltd. was one such entrepreneur to initiate this GHG abatement project under Clean Development Mechanism. Recogen Limited's success would depend on securing the proposed carbon finance and it would definitely encourage other organisations to come up with similar project activities contributing further towards GHG emission reductions.

B.6. Emission reductions:

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B.6.1. Explanation of methodological choices:

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The following procedures have been applied as per **AMS III.K (ver 01, 23 December 2006)** to calculate project emissions, baseline emissions, leakage emissions and emission reductions attributable to the avoidance of the methane released in the charcoaling process in open pits.

Project Activity Emissions

Project activity emissions include:

1. Incremental CO_2 emissions due to incremental distances between the charcoal manufacturing facility(ies) to the consumption points in comparison to the baseline case;
2. Incremental CO_2 emissions due to incremental distances between the raw material collection points to the new charcoal manufacturing facility(ies) in comparison to the baseline case;
3. CO_2 emissions related to the power used by the project activity facilities, including the equipments for air pollution control required by regulations. If the project activity consumes grid electricity, the corresponding emissions are calculated as described in category I.D;
4. Fugitive emissions of methane due to capture and flare inefficiencies

$$\mathbf{PEy = PE_{y,transp1} + PE_{y,transp2} + PE_{y,power} + PE_{y,fugitive}}$$

Where:

PE_y: project activity direct emissions in the year "y" (tCO_2e)

$PE_{y,transp1}$: emissions from incremental transportation from raw material collection points in the year "y" (tCO_2e)

$PE_{y,transp2}$: emissions from incremental transportation to consumption points in the year "y" (tCO_2e)

$PE_{y,power}$: emissions from electricity or diesel consumption in the year "y"(tCO_2e)

$PE_{y,fugitive}$: fugitive emissions from capture and flare inefficiencies in the project charcoal manufacturing plant in the year "y" (t CO_2e)

When trucks are used for transportation, emissions from incremental distances for transportations shall be estimated as follows.

$$\mathbf{PE_{y,transp1} = (Q_{y,raw}/CT_{y1}) * DAF_{w1} * EF_{CO2}}$$

Where:

$Q_{y,raw}$: quantity of raw material used in the year "y" (tonnes)

CT_{y1}: average truck capacity for raw material transportation (tonnes/truck)

DAF_{w1} : average incremental distance for raw material transportation (km/truck)

$EFCO_2$: CO_2 emission factor for the fuel used (tCO_2/km)

Local values or IPCC default values can be used.

$$PE_{y,transp\ 2} = (Q_{y,prod}/CT_{y\ 2}) * DAF_{w\ 2} * EF_{CO2}$$

Where:

$Q_{y,prod}$: quantity of charcoal produced in the year "y" (tonnes)

CT_{y2}: average truck capacity for charcoal transportation (tonnes/truck)

DAF_{w2}: average incremental distance for charcoal transportation (km/truck)

The Project emissions due to the electricity consumption / diesel consumption by the project activity are as follows:

$$PE_{y,power} = PE_{y,power,E} + PE_{y,power,D}$$

Where,

$PE_{y,power,E}$ Project emissions due to electricity consumption (tCO_2)

$PE_{y,power,D}$ Project emissions due to diesel consumption (tCO_2)

The CO_2 emissions related to the power used by the project activity facilities are as follows:

$$PE_{y,power,E} = EF_y * EC_y$$

Where,

EF_y: Emission factor (tCO_2/GWh) in year y

EC_y: Electricity Consumption by charcoal manufacturing facilities (GWh) in year y

The CO_2 emissions related to the diesel consumption by the project activity facilities are as follows:

$$PE_{y,power,D} = EF_{Diesel} * Q_{y,HSD}$$

EF_{Diesel}: Emission factor of the diesel (tCO_2/TJ)

$Q_{y,HSD}$: Diesel Consumption during start ups by project charcoal manufacturing facilities (tonnes) in year y

Fugitive emissions due to capture and flare inefficiencies shall be estimated as follows:

$$PE_{y,fugitive} = (1 - CFE_{project}) * ME_{y,project} * GWP\_CH4$$

Where:

$CFE_{project}$: capture and flare efficiency of the methane recovery and combustion equipment in the project charcoal manufacturing plant (a default value of 0.9 shall be used, given no other appropriate value)

$ME_{y,project}$: methane emission potential of the project charcoal manufacturing process in the year "y" (tonnes)

$ME_{y,project}$ shall be estimated ex-ante and reported, amount of methane generated by the project activity in each year will be assessed ex-post through direct measurement.

Baseline Emission

In the absence of the project activity, charcoal would have been produced in open pits within the project boundary and methane emissions would have occurred. Baseline emissions are the amount of methane that would have been produced from open pits to process the equivalent quantity of raw material used in the project activity to produce charcoal. Only dry weights of the biomass raw material shall be considered for the calculations.

The baseline emissions shall be estimated using the relation below:

$$BE_y = Q_{y,raw} * (M_{y,b} - M_{y,d}) * GWP_{CH4}$$

Where:

BE_y: baseline emissions (tCO_2e)

$Q_{y,raw}$: quantity of raw material used in the new facility in the year "y" on a dry basis (tonnes)

$M_{y,b}$: methane emission factor for open pit charcoal manufacturing process (tonnes of CH_4/tonne raw material used)

$M_{y,d}$: factor to account for any legal requirement for capture and flare of methane in open pit charcoal production (tonne of CH4/tonne of raw material)

GWP_{CH4}: Global Warming Potential of CH_4 (a value of 21)

$M_{y,b}$ has been determined from laboratory experiments and field trials and using relevant statistical methods. The details of the same are enclosed in Annex 3.

Leakage Emisions

As per the methodology, if the charcoal manufacturing technology is equipment transferred from another activity or if the existing pit charcoaling equipment is transferred to another activity, leakage effects are to be considered. As the proposed project activity does not includes any

transfer of equipment from or to any other activity the leakage emissions calculations are not required.

Emission Reduction

The emission reduction achieved by the project activity due to the avoidance of methane release will be measured as the difference between the baseline emissions and the sum of the project emissions and the leakage.

$$\mathbf{ER_{y,M} = BE_y - (PE_y + Leakage_y)}$$

Where:

$ER_{y,M}$: Emission reduction in the year "y" (tCO_2e) due to avoidance of methane release from charcoal production by shifting from pit method to mechanised charcoaling process.

The following procedures have been applied as per **AMS I.D (ver 10, 23 December 2006)** to calculate project emissions, baseline emissions, leakage emissions and emission reductions attributable to the avoidance of the methane released in the charcoaling process in open pits.

As per AMS I.D. (version 10, 23 December 2006),

For all other systems, the baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO2e/kWh) calculated in a transparent and conservative manner as:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM0002. Any of the four procedures to calculate the operating margin can be chosen, but the restrictions to use the Simple OM and the Average OM calculations must be considered

OR

(b) The weighted average emissions (in kg CO2e/kWh) of the current generation mix. The data of the year in which project generation occurs must be used.

The emission coefficient has been determined using the option (a) of the methodology as specified above. The emission factor has been calculated ex-ante as per ACM0002. Simple Operating Margin has been used for calculation of Combined Margin as the low-cost/must run resources

constitute less than 50%[2] of total grid generation in average of the five most recent years (2001-2005).

The step-by-step calculation of base line emission is as follows:

STEP 1. Calculation of Operating Margin emission factor (EF_{OM})

$$EF_{OM,y} = \sum_{i,j} F_{i,j} \times COEF_{i,j} / \sum_{j} GEN_{j}$$

Where,

$COEF_{i,j}$: the CO_2 emission coefficient of fuel i (t CO2 / mass or volume unit of the fuel),

GEN_j: the electricity (GWh) delivered to the grid by source j

$F_{i,j}$: the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j, calculated as given below

j: the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants

The CO_2 emission coefficient $COEF_i$ is estimated as

$$COEF_i = NCV_i \times EF_{CO_2,i} \times OXID_i$$

Where,

NCV_i: the net calorific value (energy content) per mass or volume unit of a fuel i

$EFCO_{2,i}$: the CO_2 emission factor per unit of energy of the fuel i

$OXID_i$: the oxidation factor of the fuel

The OM emission factor ($EF_{OM,y}$) has been calculated ex-ante, separately for the most recent three years (2003-2004, 2004-2005 and 2005-2006) and an average value has been considered as the OM emission factor for the baseline ($EF_{OM,y}$).

$$EF_{OM} = \sum EF_{OM,y} / 3$$

Where y represents the year

STEP 2. Calculation of the Build Margin emission factor (EF_{BM})

---

[2] Refer Annexure 3

It is calculated as the generation-weighted average emission factor (t CO_2/GWh) of a sample of power plants m of grid, as follows:

$$EF_{BM} = \sum_{i,m} F_{i,m} \times COEF_{i,m} / \sum_{m} GEN_{m}$$

Where

$F_{i,m}$, $COEF_{i,m}$ and GEN_m - are analogous to the variables described in OM method above for plants $_m$.

The Build Margin emission factor EF_{BM} has been calculated as ex-ante based on the most recent information available on plants already built at the time of PDD submission. Further, none of the power plant in the sample group has been registered as CDM project activities.

STEP 3. Calculation of the electricity baseline emission factor (EF_y)

It is calculated as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_y = W_{OM} \times EF_{OM} + W_{BM} \times EF_{BM}$$

where the weights **W_{OM}** and **W_{BM}**, by default, are 50% (i.e., $W_{OM} = W_{BM} = 0.5$), and EF_{OM}, and EF_{BM} are calculated as described in Steps 1 and 2 above and are expressed in t CO_2/GWh.

$$BE_y = EF_y \times EG_y$$

Where

BE_y: Baseline emissions due to displacement of electricity during the year y (tCO_2)

EG_y: Net quantity of electricity generated by the project activity during the year y (GWh)

EF_y: CO_2 baseline emission factor for the electricity displaced due to the project activity (tCO_2/GWh)

Leakage Emissions

As per the Paragraph 12 of the methodology, If the energy generating equipment is transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered. As the proposed project activity does not includes any transfer of equipment from or to any other activity the leakage emissions calculations are not required.

Emission Reduction

The emission reduction achieved by the project activity due to sale of electricity to the grid will be measured as the difference between the baseline emissions and the sum of the project emissions and the leakage.

$$ER_{y,P} = BE_y - (PE_y + Leakage_y)$$

Where:

$ER_{y,P}$: Emission reduction in the year "y" (tCO_2e) due to export of electricity to the CEB

Total Emission Reductions

The total reductions achieved by the project activity is given as the sum of $ER_{y,M}$ and $ER_{y,P}$ as follows:

$$ER_{y,T} = ER_{y,M} + ER_{y,P}$$

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	NCV_{LFO}
Data unit:	TJ/tonne
Description:	Net Calorific Value for Lanka furnace Oil
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.2, pg 1.18
Value applied:	0.0430
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	EF_{LFO}
Data unit:	tCO_2e/TJ
Description:	CO_2 Emission factor for Lanka Furnace Oil
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.

Any comment:	

Data / Parameter:	**OF_{LFO}**
Data unit:	--
Description:	Oxidation factor for Lanka Furnace Oil
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**$NCV_{Naphtha}$**
Data unit:	TJ/tonne
Description:	Net Calorific Value for Naphtha
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.2, pg 1.18
Value applied:	0.0445
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**$EF_{Naphtha}$**
Data unit:	tCO_2e/TJ
Description:	CO_2 Emission factor for Naphtha
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	73.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	$OF_{Naphtha}$
Data unit:	--
Description:	Oxidation factor for Naphtha
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	NCV_{LAD}
Data unit:	TJ/tonne
Description:	Net Calorific Value for Lanka Auto diesel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.2, pg 1.18
Value applied:	0.0430
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	EF_{LAD}
Data unit:	tCO_2e/TJ
Description:	CO_2 Emission factor for Lanka Auto diesel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	OF_{LAD}
Data unit:	--

Description:	Oxidation factor for Lanka Auto diesel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**NCV_{LHF}**
Data unit:	TJ/tonne
Description:	Net Calorific Value for Lanka Heavy fuel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.2, pg 1.18
Value applied:	0.0430
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**EF_{LHF}**
Data unit:	tCO_2e/TJ
Description:	CO_2 Emission factor for Lanka Heavy Fuel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**OF_{LHF}**
Data unit:	--
Description:	Oxidation factor for Lanka Heavy Fuel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories

	Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	The plant specific / national data is unavailable hence, IPCC value has been taken.
Any comment:	

Data / Parameter:	**$M_{y,b}$**
Data unit:	tCH_4/tonne of raw material used
Description:	methane emission factor for open pit charcoal manufacturing process
Source of data used:	laboratory records and field tests
Value applied:	0.01461
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data has been taken from the lab study conducted as per annex 1 of AMS III.K (ver 01, 23 December 2006), detailed in Annex 3 of the PDD
Any comment:	

Data / Parameter:	**$M_{y,d}$**
Data unit:	factor to account for any legal requirement for capture and flare of methane in open pit charcoal production
Description:	(tCH_4/tonne of raw material)
Source of data used:	
Value applied:	0.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	There are no legal requirements present for capture and flare of methane in open pit charcoal production.
Any comment:	

Data / Parameter:	**$PE_{y,transp1}$**
Data unit:	tCO_2
Description:	Incremental CO_2 emission due to incremental transportation from raw material collection points in the year 'y'
Source of data used:	Plant data
Value applied:	0.0
Justification of the	Due to the project activity there has been actually a reduction in the

choice of data or description of measurement methods and procedures actually applied :	Transportation distance from raw material collection points to the charcoal manufacturing facility. Thus, the project emissions because of incremental transportation from raw material collection points in the year 'y' need not be accounted.
Any comment:	

Data / Parameter:	**$PE_{y,transp2}$**
Data unit:	tCO_2
Description:	Incremental CO_2 emission due to incremental transportation to consumption points in the year 'y'
Source of data used:	Plant data
Value applied:	0.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	Due to the project activity there has been actually a reduction in the Transportation distance from charcoal manufacturing facility to the consumption points. Thus, the project emissions because of incremental transportation to consumption points in the year 'y' need not be accounted.
Any comment:	

Data / Parameter:	**$PE_{y,fugitive}$**
Data unit:	tCO_2
Description:	Fugitive emissions due to capture and flare inefficiencies
Source of data used:	Plant Records
Value applied:	0.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project activity involves capturing of methane generated during charcoal production process in a closed system which shall be combusted under controlled conditions and not flared. Hence, no fugitive methane emissions are expected due to capture and flare inefficiencies.
Any comment:	

Data / Parameter:	**EF_{Diesel}**
Data unit:	tCO_2e/TJ
Description:	CO_2 Emission factor for Diesel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.4, pg 1.23-1.24
Value applied:	74.1
Justification of the choice of data or description of measurement	The plant specific / national data is unavailable hence, IPCC value has been taken.

methods and procedures actually applied :	
Any comment:	The data would be used to calculate project emissions die to power consumption or diesel consumption in a year y of the crediting period.

Data / Parameter:	**EF_{CEB}**
Data unit:	t CO_2 / GWh
Description:	CO_2 emission factor for Ceylon electricity board
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Table 1.2, pg 1.18,
Value applied:	615.13
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

The calculations of emission reduction attributable to avoidance of methane release as per **AMS III.K (ver 01, 23 December 2006)** are as follows:

Baseline Emissions:

For 2007 - 2008

BE_y	=	**$Q_{y,raw}$**	*	**$(M_{y,b} - M_{y,d})$**	*	**GWP_{CH4}**
tCO2		tonnes		tCO_2/tonne of raw material		--
8,911	=	**29,043**	*	**(0.01461-0.0)**	*	**21**

For 2008 - 2009

BE_y	=	**$Q_{y,raw}$**	*	**$(M_{y,b} - M_{y,d})$**	*	**GWP_{CH4}**
tCO2		tonnes		tCO_2/tonne of raw material		--
22,275	=	**72,601**	*	**(0.01461-0.0)**	*	**21**

Annual baseline emissions from 2009

BE_y	=	**$Q_{y,raw}$**	*	**$(M_{y,b} - M_{y,d})$**	*	**GWP_{CH4}**

tCO2		Tonnes		tCO_2/tonne of raw material		--
23,760	=	**77,442**	*	**(0.01461-0.0)**	*	**21**

Project Emissions

1. Due to incremental distances for transportation of raw material:
   Since there is no increase in the distance between raw material procurement and charcoal manufacturing site, emissions due to incremental distances for transportation of raw material would be zero.
2. Due to incremental distances for transportation of charcoal:
   Since there is no increase in the distance between charcoal manufacturing site and consumption points, emissions due to incremental distances for transportation of charcoal would be zero
3. Due to consumption of power by the charcoal manufacturing facilities:
   The project activity would not cause any CO_2 emissions related to the power used by the project activity facilities, including the equipments for air pollution control required by regulations. The power requirement for these equipments would be met by the electricity that would be generated by the project activity itself running on a renewable source. However, the emissions due to use of diesel during startup periods would be monitored and recorded as mentioned in section B.7.1 and would be used to calculate the associated project emissions.
4. Due to capture and flare inefficiencies:
   The project activity involves capturing of methane generated during charcoal production process in a closed system which shall be combusted under controlled conditions and not flared. Hence, no fugitive methane emissions are expected due to capture and flare inefficiencies.

Emission reduction due to Methane release avoidance

For 2007 - 2008

$ER_{y,M}$	=	BE_y	-	PE_y	-	Leakage
tCO2		tCO_2		tCO_2		tCO_2
8,911	=	**8,911**	-	**0.0**	-	**0.0**

For 2008 - 2009

$ER_{y,M}$	=	BE_y	-	PE_y	-	Leakage
tCO2		tCO_2		tCO_2		tCO_2
22,275	=	**22,275**	-	**0.0**	-	**0.0**

Annual emission reduction from 2009

$ER_{y,M}$	=	BE_y	-	PE_y	-	Leakage
tCO2		tCO_2		tCO_2		tCO_2
23,760	=	**23,760**	-	**0.0**	-	**0.0**

The project activity will therefore result in reduction of 221,266 t CO_2 over the crediting period due to methane release avoidance.

The calculations of emission reduction attributable to export of electricity to grid as per **AMS I.D (ver 10, 23 December 2006)** are as follows:

Baseline Emissions:

For 2007 - 2008

BE_y	=	EG_y	*	EF_y
tCO2		GWh		tCO_2/GWh
4,787	=	**7.78**	*	**615.13**

For 2008 - 2009

BE_y	=	EG_y	*	EF_y
tCO2		GWh		tCO_2/GWh
21,918	=	**35.63**	*	**615.13**

Annual baseline emissions from 2009

BE_y	=	EG_y	*	EF_y
tCO2		GWh		tCO_2/GWh
22,896	=	**37.22**	*	**615.13**

Emission reduction due to export of electricity to CEB

For 2007 – 2008

$ER_{y,P}$		BE_y		PE_y		Leakage
tCO2	=	tCO_2	-	tCO_2	-	tCO_2
4,787	=	**4,787**	-	**0**	-	**0**

For 2008 – 2009

$ER_{y,P}$		BE_y		PE_y		Leakage
tCO2	=	tCO_2	-	tCO_2	-	tCO_2
21,918	=	**21,918**	-	**0**	-	**0**

Annual emission reductions from 2009

$ER_{y,P}$		BE_y		PE_y		Leakage
tCO2	=	tCO_2	-	tCO_2	-	tCO_2
22,896	=	**22,896**	-	**0**	-	**0**

The project activity will therefore result in reduction of 209,873 t CO_2 over the crediting period due to export of electricity to the grid.

Total Emission reductions

For 2007-2008

$ER_{y,T}$		$ER_{y,M}$		$ER_{y,P}$
tCO2	=	tCO_2	+	tCO_2
13,698	=	**8,911**	+	**4,787**

For 2008-2009

$ER_{y,T}$		$ER_{y,M}$		$ER_{y,P}$
tCO2	=	tCO_2	+	tCO_2
44,193	=	**22,275**	+	**21,918**

Total annual emission reductions from 2009

$ER_{y,T}$	=	$ER_{y,M}$	+	$ER_{y,P}$
tCO_2		tCO_2		tCO_2
46,656	=	**23,760**	+	**22,896**

The project activity will therefore result in total reduction of 431,139 t CO_2 over the crediting period due to export of electricity to the grid.

B.6.4 Summary of the ex-ante estimation of emission reductions:

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The Emission reduction, due to methane release avoidance, as per **AMS III.K (ver 01, 23 December 2006)** is as follows

Year	Project activity emissions (tCO_2e)	Baseline emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
2007-08	0	8911	0	8911
2008-09	0	22275	0	22275
2009-10	0	23760	0	23760
2010-11	0	23760	0	23760
2011-12	0	23760	0	23760
2012-13	0	23760	0	23760
2013-14	0	23760	0	23760
2014-15	0	23760	0	23760
2015-16	0	23760	0	23760
2016-17	0	23760	0	23760
Total (t CO_2e)	**0**	**221266**	**0**	**221266**

The Emission reduction, due to export of electricity to the CEB, as per **AMS I.D (ver 10, 23 December 2006)** is as follows

Year	Project activity emissions (tCO_2e)	Baseline emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
2007-08	0	4787	0	4787

2008-09	0	21918	0	21918
2009-10	0	22896	0	22896
2010-11	0	22896	0	22896
2011-12	0	22896	0	22896
2012-13	0	22896	0	22896
2013-14	0	22896	0	22896
2014-15	0	22896	0	22896
2015-16	0	22896	0	22896
2016-17	0	22896	0	22896
Total (tCO_2e)	**0**	**209873**	**0**	**209873**

Therefore, total emission reduction by the project activity is as follows

Year	Project activity emissions (tCO_2e)	Baseline emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
2007-08	0	**13698**	**0**	**13698**
2008-09	0	**44193**	**0**	**44193**
2009-10	0	**46656**	**0**	**46656**
2010-11	0	**46656**	**0**	**46656**
2011-12	0	**46656**	**0**	**46656**
2012-13	0	**46656**	**0**	**46656**
2013-14	0	**46656**	**0**	**46656**
2014-15	0	**46656**	**0**	**46656**
2015-16	0	**46656**	**0**	**46656**
2016-17	0	**46656**	**0**	**46656**
Total (tCO_2e)	**0**	**431139**	**0**	**431139**

Thus the project activity will result in emission total reductions of 431,139 tCO_2 over the crediting period.

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Parameter:	**EG_{GEN}**
Unit:	GWh/yr
Description:	Total electricity generated by the project activity
Source of data:	Onsite instrumentation
Value of data:	2007-08: 8.65; 2008-09: 39.59; 2009 onwards: 41.36
Brief description of measurement methods and procedures to be applied:	Monitoring location: Energy meters at plant will measure the data. The data will be recorded in the factory log books by the supervisor (electrical)
QA/QC procedures to be applied (if any):	The data recorded can be cross-checked with the individual consumption of the different load centres. The calibrated equipments can be checked by the verifier. The calibration of the equipments for measurement of power will be done once a year.
Any comment:	Manager In-charge would be responsible for regular calibration of the meter, which would be carried out annually.

2007-08	2008-09	2009 onwards
8.65	39.59	41.36

Parameter:	**EG_{AUX}**
Unit:	GWh/yr
Description:	Auxiliary Electricity
Source of data:	Onsite instrumentation
Value of data:	2007-08: 0.86; 2008-09: 3.96; 2009 onwards: 4.14
Brief description of measurement methods and procedures to be applied:	Monitoring location: meters at plant will measure the data. The data will be recorded in the factory log books by the supervisor (electrical)
QA/QC procedures to be applied (if any):	This data will be used for the calculation of project net electricity generation.
Any comment:	Manager In-charge would be responsible for regular calibration of the meter, which would be carried out annually.

2007-08	2008-09	2009 onwards
0.86	3.96	4.14

Parameter:	**$Q_{y,raw}$**
Unit:	Tonnes/year
Description:	Quantity of raw material used
Source of data:	Plant records and log books
Value of data:	2007-08: 29,043; 2008-09: 72,601; 2009 onwards: 77,442
Brief description of	The total quantity of raw material (coconut shells) shall be weighed using

2007-08	2008-09	2009 onwards
29,043	72,601	77,442

measurement methods and procedures to be applied:	a weigh bridge and recorded in the factory log books by the supervisor (raw material), moisture content shall also be monitored through and deducted from this quantity so as to arrive at $\mathbf{Q_{y,raw}}$
QA/QC procedures to be applied (if any):	The amount of raw material used can be cross checked by the purchase orders and stock inventory for the raw material
Any comment:	

Parameter:	$\mathbf{Q_{y,prod}}$
Unit:	Tonnes/year
Description:	Quantity of charcoal produced
Source of data:	Plant records and log books
Value of data:	2007-08: 9903; 2008-09: 24750; 2009onwards: 26400
Brief description of measurement methods and procedures to be applied:	The quantity of charcoal produced can be measured using a weigh bridge and recorded in the factory log books by the supervisor (charcoal production)
QA/QC procedures to be applied (if any):	The amount of raw material produced can be cross checked by the sale receipts and the stock inventory for the charcoal manufactured.
Any comment:	

2007-08	2008-09	2009onwards
9903	24750	26400

Parameter:	$\mathbf{MC_{raw}}$
Unit:	%
Description:	Moisture content of raw material(undried)
Source of data:	Plant records and log books
Value of data:	12
Brief description of measurement methods and procedures to be applied:	The moisture content of raw material would be measured through representative sampling and would be recorded in the log books by the supervisor (raw material)
QA/QC procedures to be applied (if any):	
Any comment:	The moisture content of raw material should be measured at least once annually.

Parameter:	$\mathbf{MC_{charcoal}}$
Unit:	%
Description:	Moisture content of charcoal
Source of data:	Plant records and log books
Value of data:	This will be monitored ex-post

Brief description of measurement methods and procedures to be applied:	The moisture content of charcoal would be measured through representative sampling and would be recorded in the log books by supervisor (charcoal production)
QA/QC procedures to be applied (if any):	
Any comment:	The moisture content of charcoal should be measured at least once annually.

Parameter:	$\mathbf{Q_{y,\ HSD}}$
Unit:	tCO_2
Description:	Quantity of HSD consumed in year y
Source of data used:	Plant HSD stock inventory
alue of data:	This shall be monitored ex-post.
Brief description of measurement methods and procedures to be applied:	The amount of HSD consumed by the project activity would be monitored through a HSD stock inventory where the monthly stock would be maintained.
QA/QC procedures to be applied (if any):	The HSD stock inventory would be maintained monthly and would be signed by the supervisor (electrical) every month after review.
Any comment:	

Parameter:	**Annual Demonstration**
Unit:	--
Description:	--
Source of data used:	Published data, field surveys, market surveys.
Value of data:	--
Brief description of measurement methods and procedures to be applied:	The annual demonstration that in absence of the project activity, pit charcoaling would have been used to produce charcoal shall be demonstrated as **a > b** where, **a** : Total amount of charcoal produced in the country in year y (through pit charcoaling and mechanised charcoaling) **b**: total amount of charcoal produced in the country in year y by all mechanised charcoaling plants in the region.
QA/QC procedures to be applied (if any):	
Any comment:	The parameter has to be evaluated and demonstrated annually and would be archived till 2 years after the end of the crediting period.

Parameter:	$\mathbf{CT_{y1}}$
Unit:	Tonnes/truck

Description:	Average truck capacity for raw material transportation
Source of data:	Plant records and log books
Value of data:	This will be monitored ex-post
Brief description of measurement methods and procedures to be applied:	The number of trucks bringing the raw material (coconut shells) would be monitored and recorded in the factory log books. The average truck capacity for raw material transportation would be calculated using the number of trucks and the purchase receipts of the coconut shells bought by the project activity over the corresponding period.
QA/QC procedures to be applied (if any):	Manager in charge shall review the reports prepared by monitoring team and cross check with log books in order to ensure quality in data reporting.
Any comment:	The data shall be stored for two years after the crediting period.

Parameter:	**CT_{y2}**
Unit:	Tonnes/truck
Description:	Average truck capacity for charcoal transportation
Source of data:	Plant records and log books
Value of data:	This will be monitored ex-post
Brief description of measurement methods and procedures to be applied:	The number of trucks transporting charcoal, if any, would be monitored and recorded in the factory log books. The average truck capacity for charcoal transportation would be calculated using the number of trucks and the sale receipts of charcoal produced by the project activity over the corresponding period.
QA/QC procedures to be applied (if any):	Manager in charge shall review the reports prepared by monitoring team and cross check the data with log books in order to ensure quality in data reporting
Any comment:	

Parameter:	**DAF_{w1}**
Unit:	Km/truck
Description:	Average incremental distance for raw material transportation
Source of data:	Plant records and log books
Value of data:	This will be monitored ex post
Brief description of measurement methods and procedures to be applied:	The distance of coconut shells mills from where the shell would be purchased to the project activity site would be monitored to find out the average raw material transportation distance per tonne of charcoal produced. This value would be used to calculate the average incremental raw material transportation distance over the baseline case.
QA/QC procedures to be applied (if any):	Manager in charge shall review the reports prepared by monitoring team and cross check with log books in order to ensure quality in data reporting
Any comment:	

Parameter:	**DAF_{w2}**
Unit:	Km/truck
Description:	Average incremental distance for charcoal transportation

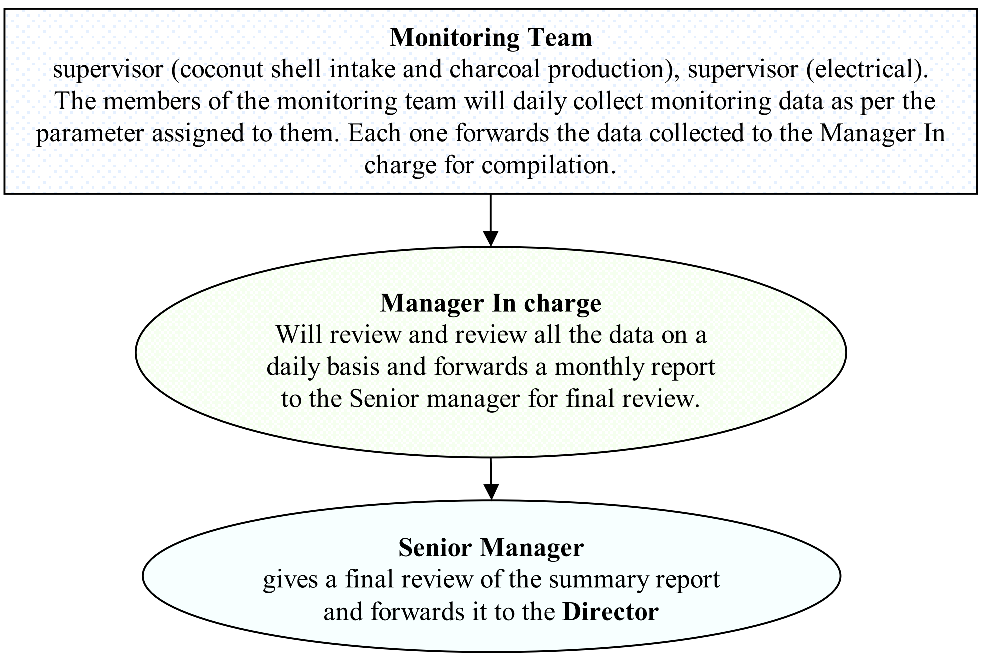
Source of data:	Plant records and log books
Value of data:	This will be monitored ex post
Brief description of measurement methods and procedures to be applied:	The distance of charcoal consumption points to which charcoal would be transported, if any from the project activity site would be monitored to find out the average charcoal transportation distance per tonne of charcoal produced. This value would be used to calculate the average incremental charcoal transportation distance over the baseline case.
QA/QC procedures to be applied (if any):	Manager in charge shall review the reports prepared by monitoring team and cross check with log books in order to ensure quality in data reporting
Any comment:	

B.7.2 Description of the monitoring plan:

>>

The following operational and management structure would be implemented for the project activity:

The monitoring team at the floor level consisting of monitoring supervisors would be assigned the responsibility of monitoring and recording of parameters for their corresponding shifts. At the end of each day the recorded data would be compiled by the Manager in charge. In case of any irregularity observed, necessary action would be taken immediately. On monthly basis, the reports would be prepared and forwarded to the senior manager for final review after which he will forward the same to the Director, Recogen Limited. The following organisation structure would be present to operate the project activity:



B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

Date of completion of baseline and monitoring methodology:

16/10/2007

Recogen Limited has determined the monitoring methodology and they are project participant as listed in Annex 1 of this document.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>

01/12/2005

C.1.2. Expected operational lifetime of the project activity:

>>

25y-0m

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

>>

A fixed crediting period of 10 years has been selected for the project activity.

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>>

Not applicable

C.2.1.2. Length of the first crediting period:

>>

Not Applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

05/01/2008,

The crediting period shall start only after the registration of the project activity.

C.2.2.2. Length:

>>

10y-0m

SECTION D. Environmental impacts

>>

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

>>

Environmental recommendation for establishing charcoal manufacturing plant from Central Environmental Authority has been obtained. A comprehensive environmental impact assessment study was carried out to ascertain the environmental impacts caused by the project activity. The impacts on various parameters were taken into consideration and are summarised below:

Impact on Water Quality:

The project activity would not have any significant adverse impact on the water quality in the area.

Impact on Air Quality

During the construction phase, the cutting and filling of earthwork, construction operations and the handling of construction material will generate dust resulting in increased SPM levels in surrounding area. To overcome this, water would be sprinkled at the site as and when required. Further due to deployment of various mechanical equipment and vehicles enhanced SO_2 and NO_x levels are expected which would affect the quality of air marginally. However, the impact on the air quality would be temporary and reversible in nature.

There would not be any significant adverse impacts on air quality due to the project activity during the operation phase as well. The waste gases from the boiler would be vented out after meeting the statutory regulations, using an electrostatic precipitator.

Impact on Topography and drainage

No major change in topography is likely on account of proposed project except for leveling of land. No negative impact is likely on topography or drainage as no natural drain passes through project area and no mitigation measures would be required. Temporary topography change is anticipated due to storage of raw materials.

Impact on Soil Quality

No significant adverse impact on the soil quality is anticipated, due to the implementation of the project activity.

Impact on Noise levels

The source of noise generation during construction and operation phase are the equipments such as earth moving machines, dumpers, trucks, concrete mixers, etc. The operation of these equipments will generate noise. The adverse impact of noise will be limited to working area only. Ear plugs and Ear muffs would be provided to those working in the zones of high levels of noise.

Impact on Traffic

During construction and operation phase, use of trucks, light vehicles, etc., will add to present traffic density. But the additional traffic will not have any significant impact on public. No extra mitigation measures are needed to regulate the additional burden on traffic.

Impact on Ecology

There are no wildlife sanctuaries or fragile ecosystems within the study area. Hence, adverse impact on biological environment will be negligible. During construction phase there will hardly be any negative impact on terrestrial eco-system. On the contrary, with progressive growth of greenery, terrestrial micro-habitats will develop in the long run. Hence no adverse impact of proposed project is anticipated on the faunal diversity in the area surrounding the proposed project.

Impact on Socio-Economics

During construction phase and the operation phase employment opportunities would be generated for the local residents. All semi skilled and unskilled workers will be drawn from local nearby villages.

Impact on Economy

With the commencement of plant, there will be substantial improvement of the overall economy of the local people in the form of additional income through employment, development of infrastructure in surrounding areas such as transport facility, shops etc.

Impact on Places of religious, historical, archaeological importance

No such place exists within the proposed plant area or within vicinity. Therefore, no adverse impact is anticipated.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

There are no significant adverse impacts associated with the project activity as described above.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

Stakeholders of this project activity mainly include local population. Letters were distributed requesting the representatives of local population to participate in the stakeholders' meetings and communicate their suggestions/objections regarding the project activity. Meetings were therefore, held at the factory premises of Recogen. The representatives of Recogen Ltd. presented the salient features of the company and the project activity to the stakeholders and requested their suggestions/objections. The opinions expressed by the stakeholders were answered and subsequently recorded.

E.2. Summary of the comments received:

>>

Representatives of the local population appreciated Recogen's decision to implement the project activity. However, few queries were also raised during the stakeholders' consultation meetings on benefits of the project activity to the local population and if the flue gases released by the project activity would cause any health related problems to the people living in the project vicinity.

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

>>

The comments raised by various stakeholders in the meetings were answered satisfactorily by the representatives of Recogen Limited. The representatives of Recogen explained to the stakeholders present that the project activity would benefit the local population by generation of employment. The flue gases from the project activity conform to the emission standards and an environmental licence for the same has been issued by the concerned authority. No other significant adverse concerns were raised during the consultation with stakeholders.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Recogen Limited
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State/Region:	North Western province
Postfix/ZIP:	10
Country:	Sri Lanka
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FAX:	94 11 2699630, 2699299
E-Mail:	-
URL:	-
Represented by:	
Title:	Director
Salutation:	Mr.
Last Name:	Jayasinghe
Middle Name:	PARAKRAMA
First Name:	LIYANARACHCHIGE
Department:	-
Mobile:	-
Direct FAX:	-
Direct tel:	-
Personal E-Mail:	lpj@haycarb.com

Organization:	Japan Carbon Finance, Ltd.
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City:	Chiyoda-ku
State/Region:	Tokyo
Postfix/ZIP:	102-0073
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Telephone:	+81-3-5212-8870
FAX:	+81-3-5212-8886
E-Mail:	jcf@jcarbon.co.jp
URL:	http://www.jcarbon.co.jp
Represented by:	
Title:	Deal Manager
Salutation:	Mr.
Last Name:	Watanabe
Middle Name:	
First Name:	S
Department:	Carbon Finance Department
Mobile:	-
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Direct tel:	+81-3-5212-8878
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding as part of project financing from parties included in Annex I of the convention is involved in the project activity.

Annex 3

BASELINE INFORMATION

- **DETERMINATION OF $M_{y,b}$**

During the carbonization of coconut shells, volatiles amounting to 70% of the mass of coconut shells on dry weight basis, are released to the atmosphere, yielding 30% of coconut shell mass as charcoal, if the carbonization is conducted in absence of air at 500 ^{0}C. However, the yield obtained by traditional manufacturers has not been higher than 27%, thus suggesting that either the charcoaling temperature is in excess of 500^{0}C or some amount of carbon is converted to CO_2 due to the presence of unwanted oxygen in the process.

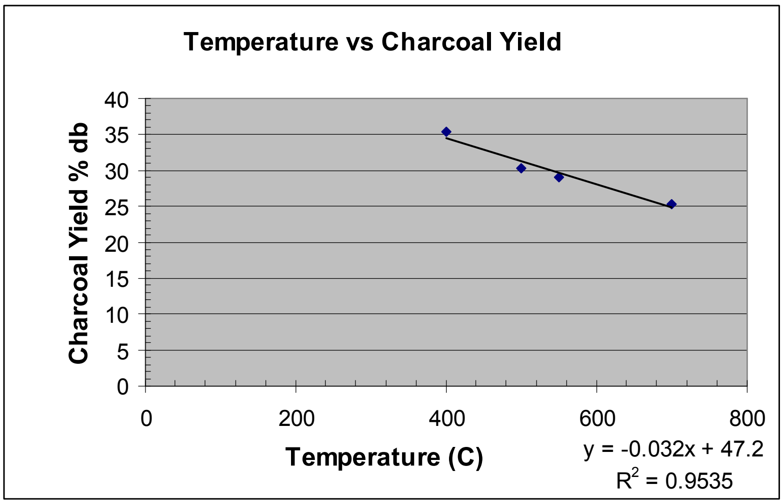
Laboratory experiments carried out by Recogen reveal that the charcoaling yield is inversely proportional to the temperature of carbonization, and the release of methane is directly proportional to the charcoaling temperature. Therefore, it would be reasonable to use the temperature of the pit charcoaling process to ascertain the amount of methane released to the atmosphere during the traditional process. Thus, it would not be necessary to perform actual measurements of methane released in the pit charcoaling process, thereby simplifying the data acquisition to a mere case of collecting pit charcoaling temperature.

Methodology adopted in laboratory trials.

1. Laboratory Rotary type kiln was used for the generation of lab-scale data. A crushed and dried, 100g sample of coconut shell was subjected to charcoaling at different temperatures ranging from 400 to 700 ^{0}C at different time intervals, varying from 1 to 10 hours of carbonization.
2. The resulting solid masses were measured and analyzed for their properties. The volatiles released were collected into gas sample bags and their volumes and gas compositions were measured.
3. Using SHIMADZU MODEL GC-8A Gas Chromatograph with Shimadzu Carboxin 1000 column, the Methane percentage in the collected volatile gas samples was measured. Thermal Conductivity Detector maintained at an oven temperature of 30 ^{0}C with the carrier gas Helium was employed in this process.
4. The quantity of methane in the volatile gas was computed as a percentage on volume basis. This percentage was used to compute the total weight of methane released when processing 1MT of coconut shell.

Results:

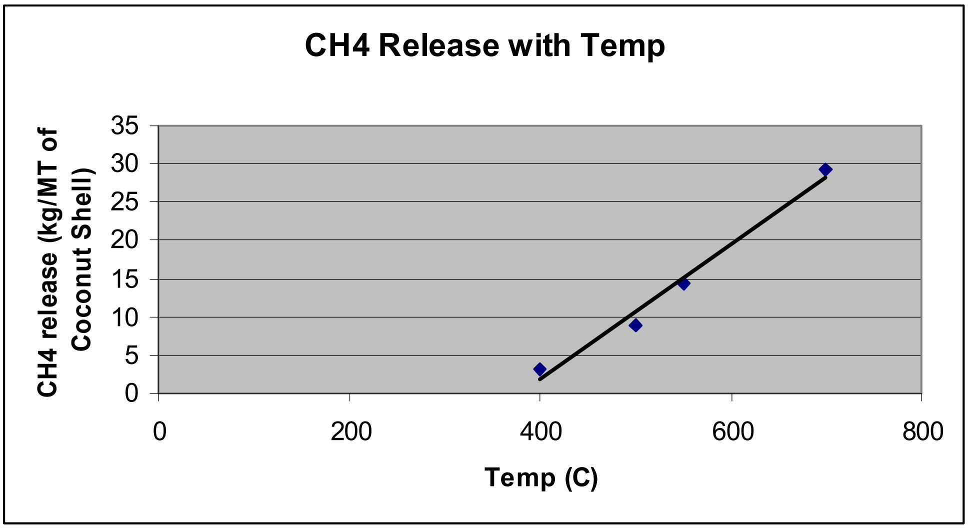
Relationship of charcoal yield to temperature in Coconut Shell Charcoaling



This clearly indicates that the yield of charcoal is linearly proportional to the charcoaling temperature and it follows the relationship given below:

[Yield % $_{(Charcoal)}$ = - 0.032 x Temperature + 47.2]

Relationship of Methane production to Temperature in Coconut Shell Charcoaling



This clearly indicates that the quantity of methane released is linearly proportional to the charcoaling temperature and it follows the relationship given below:

CH_4 (kg/MT Coconut Shell used) = 0.0887 x Temperature (^{0}C) – 33.9030

Conclusion

According to the results it can be concluded that 10 – 15 kg of methane is released when processing 1 MT of coconut shell if the charcoaling temperature is in the range 500 to 550 ^{0}C. Also the quantity of methane released is not affected by the duration of the process of charcoaling at a given temperature.

Therefore, it would be reasonable to use the relationships established above, with the actual charcoaling temperatures in the field, to ascertain the total quantity of methane released per unit weight of coconut shell used.

Methodology adopted in field trials.

The Pit charcoaling cycle consists of four stages

(a) Pyrolysis phase over 12 hours when gases are released

(b) Pacification phase of 12 hours when the pit is closed and hence no gases are released

(c) Cooling phase of 12 hours

(d) Unloading of the charcoal and loading of the fresh shells for the next cycle

1) Charcoaling temperature and yield were measured in selected pits. Temperature measurements were done throughout the pyrolysis phase at one hour intervals in the selected pits

2) The projected methane release from the pits was calculated based on the temperature of the charcoaling zone using the co-relation graphs prepared using the laboratory testing.

Experimental Results:

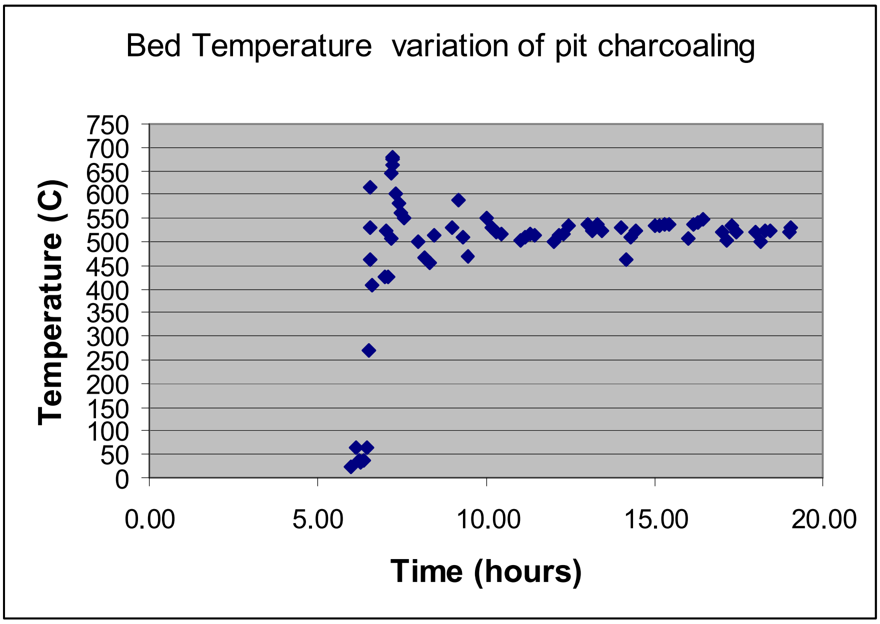
The temperature measurements of pit charcoaling have been done for selected pits and it has been evidenced that the temperature is naturally maintained in the range of 500 ^{0}C – 560 ^{0}C during the pyrolysis phase. Charcoal produced at this condition has average 12% volatile matter and the yield is average 29%.

Temperature measured at pit locations in the Coconut Triangle

Location	Temperature (^{0}C)		
	Top layer	Pyrolysis zone	Bottom layer
1. Kakapalliya	195	538	230
2. Sembukattiya	190	560	235
3. Kadhawala	196	610	236

4. Lihiriyagama	258	568	235
5. Mirigama	235	547	203
6. Kuliyapitiya	230	580	240
7. Kandhanegedara	218	543	212
8. Medagama	252	562	220
9. Kokawela	220	548	190
10. Battuluoya	248	578	236
11. Uraliya	252	578	248
12. Dummalasoriya	280	572	313
13. Kotadeniyawa	230	588	312
Mean charcoaling Temperature (^{0}C)	**567**		
Standard deviation	**20.4**		

Bed temperature variation in the Pyrolysis phase of coconut shell pit charcoaling:



Conclusion:

Since the laboratory charcoaling temperatures and yield are falling in the same range as pit charcoaling, laboratory charcoaling has direct relationship with the traditional pit charcoaling method in SriLanka. The selected pits were representative of the industry by way of geographical

location, raw material, size of pits and duration of charcoaling. The measured temperature values are the average of four measurements covering the cross section of the pit.

Formula:

CH_4 (kg/MT Coconut Shell used) = 0.0887 x Temperature (^{0}C) –33.9030

Accordingly the methane release at a conservative charcoaling temperature of 547 ^{0}C is **14.61** kg/MT of coconut shell used.

- **DETRMINATION OF EF_y**

Power generation Mix of CEB for recent five years

Low Cost / Must Run					Thermal Generation					Total Gener	% of low-cost/must run
(Gwh)	CEB Hydro	CEB Wind	SPP Hydro	Total	CEB	IPP	SPP	Hired	Total		
2001	3,044.87	3.4	64	3,113.04	1,895.50	1,057.78	0.05	471.09	3,424.42	6,537.46	**47.6**
2002	2,588.62	3.6	103	2,695.72	1,952.62	1,243.32	0.39	939.25	4,135.58	6,831.30	**39.5**
2003	3,190.00	3.4	120	3,313.40	2,193.00	1,711.00	1.16	394	4,299.16	7,612.56	**43.5**
2004	2,755.00	2.7	206	2,963.70	2,507.00	2,064.00	1.42	509	5,081.42	8,045.12	**36.8**
2005	3,173.00	2.4	280	3,455.40	2,162.00	3,152.00	--	--	5,314.00	8,769.40	**39.4**
Total	14,751.49	15.6	774	15,541.26	10,710.12	9,228.10	2.97	2,313.34	22,254.58	37,795.84	**41.1**

As the average percentage contribution of low cost /must run resources for last five years is less than 50% of the total generation, hence Operating margin has been calculated as Simple Operating Margin

Calculation of Operating Margin Emission Factor

The following table gives the Simple Operating Margin emission factor[3] for CEB for the most recent 3 years at the time of PDD submission

CALCULATION OF BASELINE EMISSION FACTORS-SRILANKAN GRID			
	2004	**2005**	**2006**
Simple Operating Margin, tCO_2/GWh	**669.34**	**652.67**	**578.74**
Average Simple Operating Margin over three year period, tCO_2/GWh		**633.58**	

Built Margin Emission Factor[4]:

Build Margin Factor , tCO_2/GWh	**596.67**

Therefore the combined margin and the emission factor for the CEB are:

Combined Margin Factor (Avg of OM & BM)	**615.13**
Baseline Emissions Factor (tCO_2/GWh)	**615.13**

[3] Detailed calculations of OM are provided to DOE for validation of data.

[4] Detailed calculations of BM are provided to DOE for validation of data

Annex 4

MONITORING INFORMATION

The methodology requires the project-monitoring plan to consist of monitoring the electricity generated by the project activity and the quantity of raw material used.

Energy meters would be used for monitoring the energy generated by all the units. All energy meters used would be electronic meters of desired accuracy. The energy meters would be maintained in accordance with electrical standards in Sri Lanka. Each meter would be inspected and sealed and shall not be interfered with by anyone. All the energy meters would be tested for accuracy and compliance every half year by accredited independent agency. If during half yearly test check, meters are found to be beyond permissible limits of error, they would be calibrated immediately.

Total quantity of raw material (coconut shells) fired in the project plant and the total quantity of the charcoal produced would be measured on a weigh belt and a weigh bridge respectively. The weigh belt and the weigh bridge would be tested for accuracy every year by an accredited independent agency. If during yearly test check, Weigh Bridge or the weigh belt is found to be beyond permissible limits of error it would be calibrated immediately.

The monitoring team formed by Recogen Limited comprising of a special group of supervisors who will be assigned the responsibility of monitoring of different parameters and record keeping. On a monthly basis, the monitoring reports would be checked and discussed by the senior team members/managers. On monthly basis, these reports would be forwarded at the senior management level.

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