

Reports of CDM/JI Feasibility Studies: FY2009 Summary

Title

Programmatic CDM Feasibility Study for Biomass (*Gliricidia*) Utilisation for Thermal Energy to Be Used at Industrial Facilities

Organization

EX Corporation

Framework of the Study Implementation

- Hokkaido Electric Power Co., Inc. : Investigation regarding purchase of credits, PDD preparation support
- E2 Engineering Corporation : Technical investigation on gasification plants, Introduction of boilers etc, Analysis of the technology to be introduced and environmental loads related to pre existing boilers
- Nanpo Shokai.Ltd : Support to surveys in Sri Lanka, Support to technological analysis of biomass collection, PDD preparation support
- Sri Lanka Bioenergy Association of Sri Lanka (BEASL) : Analysis of Programmatic CDM promotion policy with the Coordinating/Managing Entity (CME), Logistics
- Ener Fab (Pvt)Ltd. : Coordination with prospective sites, Analysis of gasification and boiler technologies, Calculation and basic design, Analysis of environmental loads of the technologies under consideration
- Mahatma Gandhi Centre (MGC) : Investigation of procurement methods of *Gliricidia* around the prospective sites, Support to dissemination of information to the public, Support to the collection of local information, Logistics

1 . Project outline

Sri Lanka is a fossil fuel importing country whose energy demand is on the rise resulting in a large pressure to the financial state of the country. This project aims to use collected wood chips of *Gliricidia* (*Gliricidia sepium*), a fast growing tree, and use it as a source of industrial heat under the framework of Programmatic CDM as an alternate to fossil fuel (furnace oil, diesel) and in addition to reduction of GHG and co benefits resulting from the prevention of atmospheric pollution, contribute to self reliance in terms of energy and development of rural villages and areas in Sri Lanka.

The total amount of reduction of CO₂ from three (3) projects (Lion Brewery, Premium Exports Ceylon, and Ceylon Cold Stores) chosen for the first phase in this study is expected to be 13,882tCO₂/y and a total of 138,820tCO₂ in the ten year period of 2011 to 2020. After second phase onwards, in sites with annual usage of

furnace oil of about 300kL, the reduction amount is expected to be about 800-900tCO₂/y per site and as about 2,000 big and small scale heat using enterprises are expected within the country, the applicability of the project is expected to be high.

Regarding the implementation schedule, the framework of PoA needs to be agreed to by the stakeholders after the completion of this study. Further, along with negotiations between three (3) companies chosen as CPA for the first phase and Ener Fab (Pvt)Ltd regarding towards signing a business contract, actions to start the validation for the registration of PoA should be initiated as soon as possible.

Table 1. The Expected Amount of Emission Reduction from the Three Projects
Targeted for the Preparation of PDD

	Lion Brewery Ceylon Limited.	Premium Exports Ceylon Limited.	Ceylon Cold Stored PLC	Total
Fossil fuel to be replaced	Furnace oil	Furnace oil	Diesel	-
Facility to be installed	Boiler (Gasifier is also considered)	Boiler	Gasifier	-
Annual emission reduction	5,443tCO ₂ /y	7,273 tCO ₂ /y	1,166tCO ₂ /y	13,882 tCO ₂ /y
Emission reduction in 10years	54,430tCO ₂	72,730tCO ₂	11,660 tCO ₂	138,820 tCO ₂

Methodology applied

The methodology to be applied is small scale methodology I.C. (Ver.16).

2. Content

(1) Challenges

The challenges encountered during the course of this study are described below.

i) Selection of the most appropriate site

In Sri Lanka, heat using facilities using fossil fuel are mostly of small scale and it is not easy for Japanese companies to invest or to procure CERs from these single entities. Further, there is variation in the level of knowledge of CDM among companies and many companies do not have sufficient knowledge regarding CDM or Programmatic CDM. In order to form a smooth and effective CDM business, selection of possible sites for CDM projects was carried out.

ii) Investigation of logistics related to the procurement of Gliricidia fuel

According to an estimation by Ener Fab (Pvt)Ltd, supplies for already known demands of Gliricidia chips has been accounted for. However, in future when the Programmatic CDM starts and the demand for Gliricidia increases, the supply from chips collected from pre-planted trees will not be sufficient and there is a chance that the transportation cost can significantly increase. In this study, the logistics of the supply of Gliricidia was investigated and the policies for increasing its cultivation was also analysed.

iii) Framework of CME and implementation of structure of PoA

Factors like the PoA framework including the distribution of CER, role of the CME etc are important parameters for agreement between the stakeholders and hence discussions with stakeholders was carried out to determine the implementation structure of the PoA.

iv) Analysis of environmental impacts and co-benefit evaluation

Regarding measures to counter pollution, for air pollutants to be released from the factories, a quantitative technical evaluation of co-benefit effects through the implementation of the projects was carried out by referring to the co-benefit quantification manual.

v) Evaluation of biomass usage technologies (gasification plants, boilers)

In addition to the comparison of technologies applicable to usage of biomass fuel, technical evaluation of environmental impacts from gasification facilities and boilers expected to be used in this project and their alleviation / improvement methods was carried out. The specification of the plants to be installed in the proposed projects was also investigated.

vi) Investigation of fund procurement for the implementation of the project

Information was collected on the present state and challenges to fund procurement for investments to biomass fuel conversion projects, possibilities of fund procurement and low interest E-Friends Loans etc supplied by commercial banks and Japan International Cooperation Agency (JICA). Possibility of their usage to this project was also investigated.

(2) Content of the study

During the course of this study, site visit to Sri Lanka was conducted six (6) times. Details are presented below.

Table 2. Outline of Survey in Sri Lanka

Duration	Tasks
First visit 2009.8.11to 15	Coordination with local counterparts and stakeholders of Sri Lanka. Collection of basic information. <ul style="list-style-type: none">• Lion Brewery, the largest site from the prospective sites short listed as object for the CPA , decided as the site for the preparation of PDD• Questionnaires sent through sub contractors to three (3) companies to select other additional CPA sites in addition to Lion Brewery.• Based on information collected by MGC, Wategadara village chosen as site where a detailed investigation of cultivation possibilities and Gliricidia chip collection from the view point of the producers is to be carried out. A search investigation into the potential sites for the usage of chips in an area of radius 30km around the village was also started.
Second visit 2009.10.11to 19	Information collection and discussion with stakeholders regarding potential sites. <ul style="list-style-type: none">• Discussion was carried out with stakeholders regarding the collection and content of the questionnaires sent out during the site visit of August regarding potential sites in Sri Lanka, and consensus building. A common understanding was reached on the challenges being faced and future measures.• Site visit of S.A.Silva Son Private Limited, manufacturers of coconut products (located near Wategadara village), who have already introduced biomass boilers, was carried out

	<p>and an interview was conducted to understand the present state of the procurement of biomass resource and challenges faced.</p> <ul style="list-style-type: none"> • Ener Fab started the investigation for the options of biomass resource procurement. An interview to understand the present operation of Ener Fab was also carried out.
Third visit 2009.11.5 to14	<p>Checking the status of sub contracted work, visit of facilities, Visit of prospective sites for Gliricidia Procurement and other potential project sites, Collection of local information regarding fund procurement.</p> <ul style="list-style-type: none"> • Confirmation of the operation outline of Ener Fab and analysis of wood biomass resource procurement. • Regarding the visit of pre-existing facilities, two (2) sites of clients (one (1) hotel, one (1) food producer) of Ener Fab were visited. • Update on the collection of questionnaires by the counterpart and visit of the potential site. • Information collection on initial investment by commercial banks and, PMU (Project Management Unit) of the Ministry of Enterprise Development & Investment Promotion (local counterpart of JICA for E-Friends loan). • Regarding the implementation structure of the project, discussion with BEASL who are the potential organization to undertake the role of CME. • Arrangements for the seminar to be held in February.
Fourth visit 2009.12.10 to20	<p>Start of the survey on local storage amount for the procurement of Gliricidia fuel. Coordination between stakeholders regarding business implementation structure. Site visit for co-benefit quantitative survey and assignment of analysis to a local entity.</p> <ul style="list-style-type: none"> • It was understood through an investigation by Ener Fab on procurement of Gliricidia that no national statistics exist for the storage amount of Gliricidia. Hence the possibility of an ad-hoc estimate was considered (interview was carried out around Puttalam). • Review of operation structure of BEASL, the prospective CME • Regarding potential sites for PDD preparation, collection of additional information from Lion Brewery and Ceylon Cold storage, and presentation of current status • Regarding quantitative evaluation of co-benefit, flue gas and waste water sampling points for data analysis for fossil fuel usage facility and Gliricidia fuel usage facility were confirmed. • Arrangements for the February seminar
Fifth visit 2010.1.12 to20	<p>Final information collection for PDD preparation and final report. Discussion with stakeholders.</p> <ul style="list-style-type: none"> • Progress management of sub contracted work • Finalization of the content of the February seminar, related logistics • Progress report to JICA, Designated National Authority (DNA) and opinion exchange • Information collection from the Ministry of environment and financial institutions
Sixth visit 2010.2.20 to25	<p>A seminar was organized on 23rd February to disseminate information regarding CDM. Information was provided on the promotion of this CDM from DNA, the Ministry of finance, BEASL, MGC, Local financial institutions, technology companies, and potential credit buyers (Hokkaido Electric Power). Ex corporation presented the details of this Programmatic CDM. The seminar had over 100 participants. A site visit of a site using Gliricidia fuel was conducted on the 24th with Hokkaido Electric Power .</p>

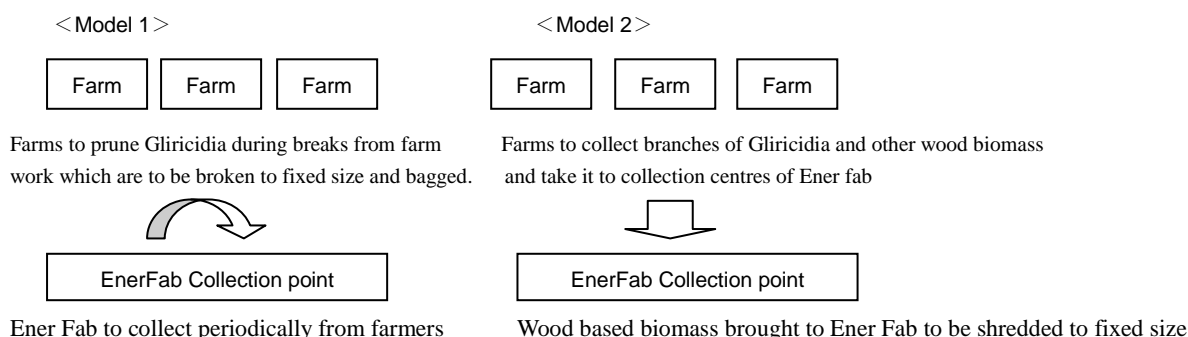
(Task 1: Selection of suitable sites)

For the first phase of CPA for this PoA, PDD was prepared for the following three (3) companies who have demonstrated a strong interest of participation.

- (a) Lion Brewery Ceylon Limited.
- (b) Premium Exports Ceylon Limited
- (c) Ceylon Cold Stores PLC

(Task 2: Analysis of logistics for the procurement of Gliricidia fuel)

Analysis of biomass storage amount and potential supply amount and logistics for the procurement of these wood based biomass was carried out. The following two (2) models were considered for supply to the potential sites.



(Task 3: CME framework and PoA implementation structure)

Regarding the implementation structure of PoA, the validation and verification of Programmatic CDM, as compared to small scale CDM project development, costs more and hence a consensus was reached between stakeholders to maximize effectiveness including monitoring. As a result, a facility vender and maintenance company affiliated to BEASL (who will function as CME) is to be the operating partner and is to monitor the clients, hence maximizing effectiveness. In the first phase, Ener Fab was designated as the operation partner.

(Task 4: Environmental Impact Analysis and co-benefit analysis)

Evaluation of environmental considerations of gasification facility (which is expected to be introduced) was carried out. Please refer to "Section 4. Survey result regarding co-benefit" for results.

(Task 5: Analysis of Biomass usage technologies (Gasification facility, Boiler facility)

A technological analysis of biomass using gasification facility and boiler facility, expected to be introduced, was carried out. This facility has ensured calorific value of produced gas of over 1,050kcal/Nm³ and also has the function of fuel gas production facility. Regarding the handling of by products produced during gasification, the carbonated matter is collected and the flue gas is treated with a cyclone and scrubber hence ensuring that environmental impact is alleviated. The following measures ensure that calorific value of the produced gas and amount of poisonous gas in the flue gas is improved, hence improving the energy efficiency and simplifying the gas treatment facility.

i) Flue gas measures (Usage facility for fuel gas/ gas engine and gas combustion boiler etc)

From the survey it was found out that the concentrations of CO and NO_x were high and hence measures were thought to be necessary. The reason is that the air ratio is a large figure of 1.85 resulting in decrease of combustion temperature and hence giving rise to the possibility of incomplete combustion. This requires lowering of air ratio hence increasing the combustion temperature and lowering the CO concentration. The lowering of air ratio is also an effective measure for NO_x and hence it can be concluded that the operation of the combustion gas usage facility at an adequate air ratio is very important.

ii) Measures for waste effluent (Wood based biomass gasification facility)

The water circulation system is closed and as long as there is no discharge of effluent outside the system, no impact can be expected to the surrounding. However it is desirable to monitor the water quality as appropriate. The survey showed that COD was high. The reason for this is that as T-SS is also high, COD from SS is contributing to the high value of COD. Hence, it can be expected that SS extraction through solid-liquid separation can be an effective measure.

iii) Solid matter from Wood based biomass Gas formation

Charcoal formed during the gasification process of wood based biomass has a calorific value of 6,252kcal/kg (26MJ/t) obtained from actual measurement and hence can have potential demand as an alternate to fossil fuel.

(Task 6: Analysis of fund procurement for project implementation)

In Sri Lanka, the lending interest rate had reached a very large number, and the central government intervened to decrease the interest rate of the central bank from 19% from the previous year to upto 8%. However, when the commercial banks supply the funding, the annual interest comes to be around 12-15%. Further, guarantee is required to acquire the loans and hence the majority of ESCO businesses who do not have a strong financial condition cannot actualize business although there is a potential demand from large consumers of fossil fuel (manufacturers) to change to alternative sources. An analysis of funding possibilities was carried out including funding from commercial banks and usage of E-Friends Loan which is a low interest loan provided by JICA.

3. Results of Study for CDM Project Implementation

(1) Determination of Baseline Scenario and Project Boundary

Baseline Scenario

The baseline of the proposed project is that the industrial thermal energy is continued to be supplied by the usage of fossil fuels such as furnace oil and diesel. Biomass, mainly Gliricidia branch, which is pruned periodically, is left at backyards of farms or farmlands to decay and is not sold or utilized. In cases where biomass such as Gliricidia (which can be harvested on short rotations) is newly grown in unutilized land and the harvested biomass is supplied to industry for thermal purpose, the baseline scenario is the continual soil degradation due to the unused state of the land to be continued.

Applied Baseline and Monitoring Methodology

This project applies SSC AMS-I.C. "Thermal energy production with or without electricity(Ver.16)". In addition, based on this methodology, AM0042 "Grid-connected electricity generation using biomass from newly developed dedicated plantations (Ver.02)" was applied for biomass utilization.

Project Boundary

- PoA boundary: within Sri Lanka
- CPA boundary: the physical and geographic location of each biomass thermal energy generating facility

(2) Project Emissions

Project emission is composed of the following two components: (1)Emissions from on-site consumption of fossil

fuels due to the project activity, and (2) Emissions from electricity consumption by the project activity. Emission (1) occurring from the three (3) candidate projects for the first phase is estimated to be zero (0) as the usage of on-site fossil fuel is not assumed for operating the installed facilities. On the other hand, expected amount of emission (2) is as shown in the Table 3.

Table 3. Emissions from electricity consumption by the project activity

Item	Lion Brewery	Premium Exports	Cold Store	Remark
Electricity consumption (MWh/y)	149.8	299.5	74.9	
Emission factor of grid electricity (kgCO ₂ /kWh)	0.662	0.662	0.662	
Emissions from electricity consumption (tCO ₂ /kWh)	99	198	50	Electricity consumption x Emission factor

Table 4. Project emissions to be expected from the three candidate projects

Item	Lion Brewery	Premium Exports	Cold Store
Emissions from on-site consumption of fossil fuels due to the project activity (tCO ₂ /y)	0	0	0
Emissions from electricity consumption (tCO ₂ /y)	99	198	50
Project emissions (tCO ₂ /y)	99	198	50

Regarding leakage, the following three (3) factors need to be considered. However, due to reasons listed below, emission is not expected from any of the factors described below.

i) Leakage associated to transfer of energy producing equipments

This leakage is expected to be zero (0) as these equipments will not be transferred from other sites in the three candidate projects.

ii) Emissions from biomass generation / cultivation

This leakage is expected to be zero (0) as the three candidate projects do not involve any new cultivation of biomass.

iii) Competing use of biomass

This leakage is expected to be zero (0) because of the following reasons:

- Domestically in Sri Lanka, branches of Gliricida are hardly used and generally, after periodic pruning, the branches are left at back yards of farms to decay, and
- The amount of Gliricidia availability at tea estates, pepper cultivation sites and households as live fences is expected to be 25% more than the expected requirement of Gliricidia at the three candidate project sites and hence there is no requirement to consider leakage.

(3) Monitoring Plan

In this Programmatic CDM, the potential facilities to be introduced are gasification plant and boilers. In the small scale methodology I.C (Ver.16), the monitoring parameters depend upon the form of the produced energy and the alternate energy and hence the monitoring parameters are planned to be as follows.

Table 5. Monitoring parameters for cases of installing boilers and gasification facilities of over 45kW

Parameter	Unit	Measurement method	Frequency	QA/AC Method
Flow rate of produce energy	M3/y, t/y	flow meter	Continuous	Calibration of the measuring instrument, maintenance according to the manufacturer`s recommendation
Temperature of produced energy	°C	thermometer	Continuous	Calibration of the measuring instrument, maintenance according to the manufacturer`s recommendation
Pressure of produced energy (only in case of steam energy)	Bar	Pressure gauge	Continuous	Calibration of the measuring instrument, maintenance according to the manufacturer`s recommendation
Biomass input amount (type wise)	t/y	voucher	daily	Onsite check by a third party
Amount of fossil fuel used (when used)	t/y	voucher	daily	Onsite check by a third party

Table 6. Monitoring parameters for cases of gasification facilities of 45kW and less

Parameter	Unit	Measurement method	Frequency	QA/AC Method
Biomass input amount (type wise)	t/y	voucher	Daily	Onsite check by a third party
Amount of fossil fuel used (when used)	t/y	voucher	Daily	Onsite check by a third party

(4) Reduction of GHG (or amount absorbed)

The reduction amount expected from this estimate is 5,443tCO₂/y for Lion Brewery, 7,273tCO₂/y for Premium Exports and 1,166tCO₂/y for Cold Store and the total for the three (3) companies is an annual reduction of 13,882tCO₂/y. Details are provided below.

Table 7. GHG emission reduction (Total)

Year	Baseline emissions	Project emissions	Leakage emissions	GHG emissions
	tCO ₂ /y	tCO ₂ /y	tCO ₂ /y	tCO ₂ /y
2011	14,229	347	0	13,882
2012	14,229	347	0	13,882
2013	14,229	347	0	13,882
2014	14,229	347	0	13,882
2015	14,229	347	0	13,882
2016	14,229	347	0	13,882
2017	14,229	347	0	13,882
2018	14,229	347	0	13,882
2019	14,229	347	0	13,882
2020	14,229	347	0	13,882
Total	142,290	3,470	0	138,820

(5) Project time, Credit acquirement time

The project span for the PoA is to be eight (8) years. The final decision on credit acquirement time for the respective CPA will be made later by discussion between stakeholders but at present it is expected as 10 years

without renewal. Further, the project start date is set as the date of construction which is a date when a large amount of cost will be generated in the project implementation phase.

(6) Environmental impact and other indirect impacts

i) Analysis of environmental impact assessment as required by the PDD

In order to decide on the projects that require Environmental Impact Assessment (EIA), it is necessary to consider the type of business, its scale and the area or refer to the evaluating agency. When referring to the gazette 772/22 of June 24, 1993 which determines the businesses requiring EIA, the alternate heat source activities of this project are not subject to the requirements of EIA. Further, the fact that this project does not require EIA to be undertaken has been confirmed during a meeting held on January 13, 2010 at the central environment agency with Mr P.V.S. Shantha, and senior environmental officer Mr Ajith Ethugala. However, after the first phase of this project (for resource supply to the respective CPA to be added) CME, the project implementation sites, facility suppliers and energy replacing entities need to closely consider the fact that the conditions in the gazette mentioned above are met i.e. ensure that they do not carry out activities like reclamation of land or marshlands larger than 4ha (section 2), clearing of woods in land area over 5ha (section 3), non-forest use of forest area of over 1 ha (section 4), land clearance of over 50ha (section 5) etc. .

ii) Analysis of environmental impact from this project

This project aims to introduce environment friendly facilities to cheap boilers that use fossil fuel and release air pollutants and hence is a business that contributes to the improvement of environment. Hence, alleviation of environmental load in the surrounding area from the replacement of equipment is expected.

(7) Stakeholders comments

In this study, stakeholders comments were collected from three methods of i) Interview of governmental bodies and promotional bodies, ii) Interview with farmers to understand the cultivation and usage of Gliricidia and iii) Questionnaires to participants of the seminar held in February 2010.

Regarding i) above, there were comments from DNA, the Power and Energy Ministry, the Science and Technology Ministry regarding strong expectations of the promotion of renewable energy and CDM, comments from Peradeniya University and BEASL supporting this project from the viewpoint of promotion of cultivation and usage of Gliricidia. The comment from MGC was the importance of Gliricidia as the role it could play to provide relief to the civil war affected areas of Sri Lanka and also the details on promotion of the cultivation of Gliricidia. The National Development Bank commented on the usage of CDM to decrease the risk factor in Biomass projects and hence decrease the hurdle for the procurement of funds. There were expectations on beneficial effects to the Gliricidia producing villages from JICA.

Regarding ii) above, it was understood that many farms did cultivate Gliricidia within their farms and that the branches were periodically pruned, but these branches were left within their premises without any usage. Many farms commented on the lack of market for the sale of Gliricidia and some farms misunderstood Gliricidia, which is a fast growing plant to be a land grabbing plant. These facts highlighted the need of awareness-raising.

Regarding iii) above, 25 replies were received to the questionnaires. 13 replies were from potential users of biomass fuel and out of that 12 were interested in participating in this PoA. Majority of the comments were positive and showed interest in this project.

(8) Project implementation structure.

The project implementation structure is demonstrated below with BEASL acting as the CME and Ener Fab acting as the operation partner for the first phase CPA. When BEASL is involved in monitoring etc for all the CPA additional cost will be required and hence it will be more effective for Ener Fab, supplier of plants for the CPA, to carry out the monitoring and management as a part of regular maintenance which will contribute to an adequate maintenance system.

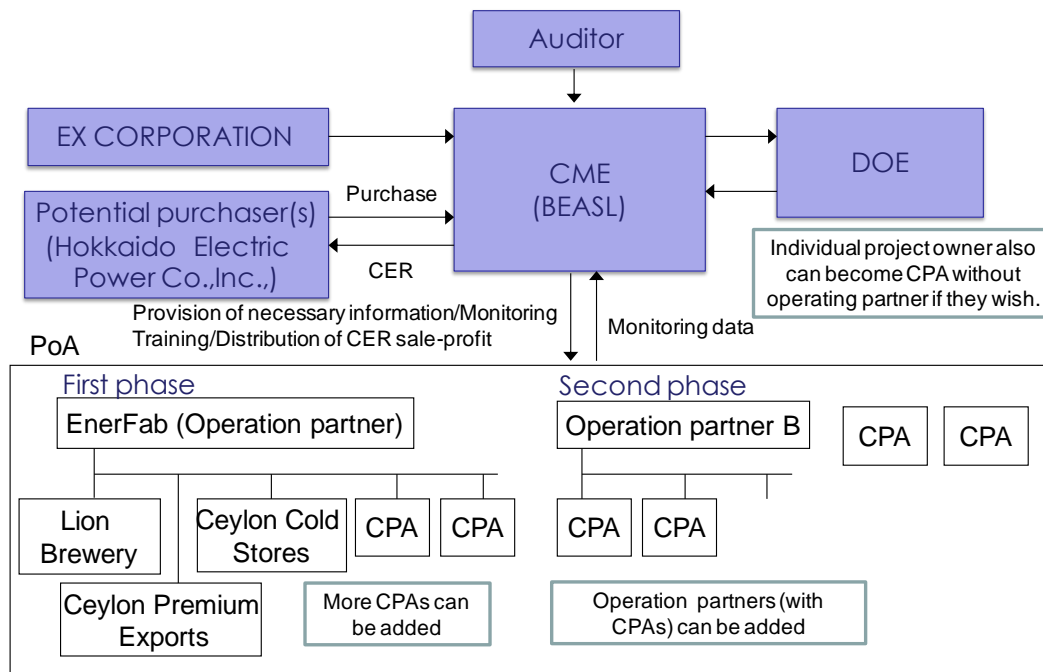


Figure 1. Project Implementation framework

(9) Fund planning

Lion Brewery is assuming of investing its own funds. For other sites, a part of the fund will have to be borrowed and the initial investment has become a barrier. In order to implement the project we will be collecting information regarding loans from commercial banks, support from the government etc.

(10) Economic Analysis

Economic viability of the three candidate projects is as follows. For Lion Brewery and Premium Exports where furnace oil is to be replaced, the economic viability without CER sales was very low and IRRs (15 years, after tax) do not even reach the benchmark, which was determined by the new interest rate of the Sri Lankan Central Bank after the drastic rollback of their interest rate. On the other hand, in the case of Cold Stores where diesel oil is to be replaced, the result was a very good figure with IRR (15 years, after tax) being 36.7% and the payback period being only six (6) years. This difference between the cases can be attributed to the difference between the price of furnace oil which receives government subsidy and diesel oil which does not receive any subsidy.

Table 8. Preconditions for the economic viability assessment

Item	Lion Brewery	Premium Exports	Cold Store
Finance	Equity: 100% Loan: 0%	Equity:0% Loan: 100%	Equity:40% Loan: 60%
Interest rate	-	12%	12%
Repayment period	-	10 years	10 years
Depreciation	15 years	15 years	15 years
Corporate tax	35%	35%	35%
Credit selling price	LKR 1,923/tCO2 (JPY1,500/tCO2)	LKR 1,923/tCO2 (JPY1,500/tCO2)	LKR 1,923/tCO2 (JPY1,500/tCO2)

Table 9. Economic viability Assessment

Sites	Without CER		With CER	
	IRR (15y, After tax)	Payback period (years)	IRR (15y, After tax)	Payback period (years)
Lion Brewery	-6.7%	-	13.2%	9
Premium Exports	-3.3%	-	13.9%	15
Cold Store	36.7%	6	44.6%	5

(11) Establishment of Additionality

Additionality is established based on *“Tool for the demonstration and assessment of additionality (Ver.05.2)” (EB39, Annex10)* according to the following steps: Step1) Identification of alternatives to the project activity consistent with current laws and regulation, Step2) Investment Analysis, Step3) Barrier Analysis, Step4) Common Practice Analysis.

【Investment Analysis】

Benchmark analysis was applied to investment analysis for this PoA. Interest rate on loans of the Sri Lanka central bank can be thought of as data available in public domain that can act as a benchmark for judgement of investments although the rate, which was 19% in December 2009, was decreased to up to 8% in January 2010 by the decision of the Government. IRR assessment was conducted assuming that the expected lifetime of the facilities to be installed was 15 years. For sensitivity analysis, parameters such as investment cost, fuel procurement cost of biomass, price of fuel to be replaced, operating ratio of the plant were set as plus or minus 10% from the basis assumption. In addition, assessment was also conducted assuming that project period was 20years. In case where the IRR is beyond benchmark, CPA needs to demonstrate the *“STEP3 barrier analysis” in accordance with the “Tool for the demonstration and assessment of additionality (Ver. 05.2)”*.

【Barrier Analysis】

- **Barrier due to prevailing practice**

Currently there are eight (8) facilities in Sri Lanka that utilize gasification of Grilicidia all of which have received initial investment support from foreign governments and there are no facilities operating purely on investment solely from private investors. Further although some medium to large plants that use waste rubber or forest biomass as fuel for boilers exist, not even a single plant that uses Gliricidia as a main biomass fuel exists.

Hence, as the ratio of medium to large scale heat using plants that uses biomass fuels based on Gliricidia is less than 1%, barrier due to prevailing practice is expected.

- **Barrier regarding procurement of biomass resources**

In Sri Lanka, the areas with high demand of energy are located mainly along the western coast centred on Colombo. However, villages that can potentially act as supply regions for Gliricidia are mostly located in other regions. When considering the usage of Gliricidia and other biomass fuel, in addition to transportation from supply area to demand area, a lot of effort and investment will become necessary in areas that are not the main business in order to provide a stable supply of biomass demanded by the client. This will not only put other non-financial pressure on manufacturers but will also result in additional load such as negotiations with farms. This fact is becoming the major factor that is preventing investment on biomass using facilities. Therefore, it is necessary to prepare a system for stable supply of biomass within the CDM framework by matching suppliers with people with demand.

- **Access-to-finance barrier**

In Sri Lanka, companies that have been registered as ESCO service are generally of small to medium scale. When large consumers of fossil fuel that want an alternative to their energy source want a supply of renewable energy based on contracts with these ESCO service, it is expected that securing the initial and O&M cost becomes a large hindering factor for these ESCO companies. Further, providing guarantees is necessary when borrowing is necessary and for ESCO companies who are not well off financially it is very difficult to reach the stage of project formation although the demand for energy supply exists.

During discussions with Sri Lanka Central Bank, it was understood that investment in businesses involving transformation of fuel from fossil fuel to biomass fuel was difficult because of the various uncertainties involved (especially if the company involved is a small to medium enterprises), but when the project becomes a CDM project and guarantee can be provided by a Japanese or other investors, the attitude toward the risk factors associated with the project was thought to improve and hence the chances of investment in the project improved too. This fact demonstrates the access-to-finance barrier and it can be concluded that making this project a CDM project drastically reduces the barrier

【Common Practice Analysis】

Other activities similar to the project activity are described as follows: i) Existing gasifier facilities using biomass fuel mainly Gliricidia, ii) Existing boiler facilities using fuel wood other than Gliricidia, iii) Biomass utilization for thermal use at very small scale. However additionality of all the CPAs under this PoA is demonstrated as there are clear distinctions between these activities similar to the proposed activity and CPAs under this PoA.

(12) Expectations of implementation

The desires of the three (3) local partners chosen for PDD preparation to actually implement the project is very high and are seriously considering the implementation within a short time frame. Lion Brewery is strongly committed because it believes that the fuel conversion project as a CDM project not only helps to improve the image of the company, but will act as a risk hedge for energy management of the company in the future. Further, for Premium Exports and Cold Stores, procurement of fund from the commercial banks is a challenge. At present,

Ener Fab has plans for implementing the project as a ESCO business. They are in negotiations with banks for the possibility of a loan. If the risk for registration as a Programmatic CDM project is lowered as much as possible, there is a very high chance of the project being actually implemented and hence every effort will be made to register the PoA.

4. Survey result regarding co benefit

(1) Evaluation of the effect of environmental pollution measures etc in the host country

i) Evaluation parameters

In the evaluation of the co-benefit, the parameters chosen are SO_x, NO_x, dust and CO₂.

ii) Baseline/Project scenario.

The outline of baseline and project scenario and its components is shown below.

Table 10. Outline of Baseline and project scenario and its components

	Baseline scenario	Project scenario	Comment
Scenario outline	Heat production through combustion of fossil fuel in boilers	Gasification of Gliricidia by a equipment for Gasification of wood based biomass + heat production through the usage of the gas produced	—
Heat usage equipment	Pre existing boiler [Boiler + (flue gas treatment facility) + heat supply related equipments]	Equipment for Gasification of wood based biomass[gasification furnace + flue gas treatment facility + gas combustion boiler + heat supply related equipments]	By using the same fuel, compactness of the gasification equipment and a improved heat efficiency can be expected.
Fuel	Fossil fuel	Wood based biomass (Gliricidia chips)	Reduction of emission of CO ₂ and SO _x can be expected through the usage of Gliricidia chips
Heat production	Combustion of Fossil fuel	Gasification and gas combustion	
Heat exchange	Steam (water) etc	Steam from direct combustion gas etc	

iii) Evaluation method of the baseline and monitoring plan

The outline of evaluation method of the baseline and the monitoring plan is shown below.

Table 11. Evaluation method of the baseline (calculation method of emission)

Evaluation parameters	Unit	Calculation of the baseline emission
Emission of SOx	t/y	Emission of SOx (t/y) = Usage amount of fossil fuel (kL/ y) × ratio of fossil fuel (t/kL) × Amount of S in the used fossil fuel (mass %) × (1-desulphurisation efficiency) Furnace oil usage amount (kL/ y) = Heat produced from the project (MJ/y) / Baseline (Heat efficiency of fossil fuel boiler etc (MJ/fossil fuel kL)
Emission of NOx	t/y	Emission of NOx (t/y) = <u>Nox emission concentration (ppm)</u> × 10 ⁻⁶ × amount of flue gas-dry (<u>Nm³/h</u>) × facility operating hours (h/y) × 46/22.4 × 10 ⁻³
Emission of dust	t/y	Emission of dust (t/y) = Usage amount of fossil fuel (kL/ y) × Ratio of fossil fuel (t/kL) × (Ash amount of used fossil fuel% × Emission factor from ash portion) + (Amount of residual carbon from the used fossil fuel% × Emission factor from the residual carbon) / 100 Amount of fossil fuel used (kL/y) = Amount of heat produced from the project (MJ/y) / Heat efficiency (MJ/fossil fuel kL) of baseline (fossil fuel boiler etc)
Emission of GHG	t/y	Emission of GHG (t/y) = Amount of fossil fuel used (kL/ y) × Ratio of fossil fuel (t/kL) × Calorific value of fossil fuel (TJ/kL) × CO ₂ emission factor of fossil fuel (CO ₂ -t/TJ) / 1000 Amount of fossil fuel used (kL/y) = Amount of heat produced from the project (MJ/year) / Heat efficiency of the baseline (fossil fuel boiler etc) (MJ/fossil fuel kL)

※The underlined portions in the table are parameters that need to be measured. The parameters in red are monitoring parameters

Table 12. Monitoring plan (monitoring method and frequency)

Evaluation Parameter	Monitoring parameter	Frequency and monitoring method
Emission of Sox (fixed source)	Heat generated from the project (MJ/ y)	Select from one of the methods shown i) Get the annual amount of usage of produced heat (amount of steam, amount of electricity generated) and convert that to calorific value (once a year) ii) Calculated by the product of annual usage amount of Gliricidia chips and the calorific value of the chips (once a year)
Emission of NOx (fixed source)	NOx emission concentration from the project (ppm) Dry gas amount from the project (Nm ³ /h) Operating hours of the facility (h/y)	Measurement of NOx in the flue gas (once a month) Measurement of gas flow rate and conversion to dry state (once a month) Get the data for the annual operating hours of the facility (once a year)
Emission of Dust (fixed source)	Dust concentration from the project (g/m ³) Dry gas amount from the project (Nm ³ /h) Operating hours of the facility (h/y)	Measurement of the dust concentration in the flue gas (once a month) Measurement of gas flow rate and conversion to dry state (once a month) Get the data for the annual operating hours of the facility (once a year)
Emission of GHG (fixed source)	Heat generated from the project (MJ/ y)	Choose one of the methods indicated below. i) Get the annual amount of usage of produced heat (amount of steam, amount of electricity generated) and convert that to calorific value (once a year) ii) Calculated by the product of annual usage amount of Gliricidia chips and the calorific value of the chips (once a year)

iv) Result of the calculation before the implementation of the project

The result is shown below. The result shows that for furnace oil and diesel, all the parameters in consideration are expected to decrease.

Table 13. Evaluation method of the project line(method of calculation of emission amount)

Parameter	Unit	Method of emission amount of project line
Emission of SOx	t/y	Can be considered as zero
Emission of NOx	t/y	Emission of NOx (t/y)=Concentration of <u>Nox(ppm)</u> ×10 ⁻⁶ × <u>Amount of gas-dry (Nm3/h)</u> × <u>Operating hours of the facility (h/y)</u> ×46/22.4×10 ⁻³
Emission of dust	t/y	Emission amount of dust (t/y)=Dust concentration (<u>g/m3</u>) × <u>Amount of gas-dry (Nm3/h)</u> × <u>Operating hours of the facility (h/y)</u>
Emission of GHG	t/y	Can be considered as zero

※The underlined portions in the table are parameters that need to be measured. The parameters in red are monitoring parameters

Table 14. Calculation (quantification) before the implementation of the project (furnace oil)

Evaluation parameter	Unit	Indicator evaluation of the project line
Emission of SOx	t/y	SOx pls (t/y) – SOx bls (t/y) = 0 – 51.4 = -51.4 t/y Annual Sox reduction of 51.4 t
Emission of NOx	t/y	NOx pls (t/y) – NOx bls (t/y) = 14.0 – 21.2 = -7.2 t/y Annual Nox reduction of 7.2 t
Emission of dust	t/y	Dust pls (t/y) – Dust bls (t/y) = 43.2 – 62.0 = <u>-18.8</u> t/y Annual reduction of 18.2 t of dust
Emission of GHG	t/y	GHG pls (t/y) – GHG bls (t/y) = 0 – 5,542 = -5,542 t/y Annual reduction of 5,542 t of CO2

※The underlined portions in the table are parameters that need to be measured.

※pls: project scenario, bls: baseline scenario

Table 15. Calculation (quantification) before the implementation of the project (diesel)

Evaluation parameter	Unit	Indicator evaluation of the project line
Emission of SOx	t/y	SOx pls (t/y) – SOx bls (t/y) = 0 – 0.01 = -0.01 t/y Annual Sox reduction of 0.01 t
Emission of NOx	t/y	NOx pls (t/y) – NOx bls (t/y) = 3.2 – 5.4 = -2.2 t/y Annual Nox reduction of 2.2 t
Emission of dust	t/y	Dust pls (t/y) – Dust bls (t/y) = 11.5 – 9.9 = <u>-1.6</u> t/y Annual reduction of 1.6 t of dust
Emission of GHG	t/y	GHG pls (t/y) – GHG bls (t/y) = 0 – 1,216 = -1,216 t/y Annual reduction of 1,216 t of CO2

※The underlined portions in the table are parameters that need to be measured.

※pls: project scenario, bls: baseline scenario

5. Survey result for contribution to sustainable development

In addition to Effect of co-benefit evaluation (reduction of GHG gas, improvement of the environment), the following contributions to sustainable development is expected from this project.

■ **Soil protection and derived effects from soil protection in the host country**

Gliricidia belongs to the leguminosae family and has the ability to fix atmospheric Nitrogen. Its cultivation is possible in various different conditions except cases where there is absolutely no nutrient in the soil or the soil is highly acidic or alkaline. The leaf from this plant is full of Nitrogen and hence when it falls on the soil, the Nitrogen content is returned to the soil which helps improve the soil quality. The following effect can be expected by using Gliricidia in unused land and land with limited usage.

- a) Improvement of soil condition
- b) Prevention of soil erosion (cultivation areas and cultivation plot)
- c) Diversification of plants and living organisms
- d) Absorption of CO₂

■ **Environmental improvement and pollution prevention measures in the host country**

The fuel usage of Gliricidia chips, as compared to diesel and furnace oil, emits a lower amount of SO_x, NO_x, dust and SPM. The reduction is noteworthy especially when furnace oil is replaced. In coconut and tea farms which are the major agri products of Sri Lanka, many factories use furnace oil and hence by promoting the cultivation of Gliricidia in farms adjacent to factories and replacing the fuel, a big contribution can be made to prevent air pollution and also improve the health of the people residing in the surrounding areas.

■ **Improvement of energy self sufficiently, improvement of trade balance**

Sri Lanka relies heavily in the import of energy due to increase in domestic demand of energy and with the rise in price of fossil fuel, usage of Gliricidia is expected to contribute to help improve the self sufficiency of energy and also the trade balance.

■ **Development of rural villages and remedy to regional disparity**

Cultivation of Gliricidia can act as a mean of gaining hard cash for the people of rural areas. The effective usage of leaves (manure) can lead to a reduction in the usage of chemical fertilizers and the usage as animal feed can help improve the self sufficiency for rearing livestock resulting in the reduction of operating cost of the farms. This is expected to contribute to a sustainable development of the rural areas.

■ **Support to the war-ravaged areas and areas affected by natural disasters**

The host country has experienced civil war for a long time and in the Northern, Eastern and North Eastern areas severely affected by the civil war, the people have run away from their homes leaving the farm lands which have become unused. In these areas and areas in the southern regions which are affected by Tsunami and other natural disasters and coastal areas which are dry and cannot be cultivated, the cultivation of Gliricidia is reported to be possible and the cultivation of Gliricidia can be expected to increase in these areas.