FY2010 CDM/JI Feasibility Study (FS) Programme Report
Executive Summary

Title of the Feasibility Study: "Feasibility Study on Wind Power Generation CDM Project in Galapagos Islands, Ecuador"

Name of the Company Conducting the Study: Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.

1. Implementation Framework:

- Energías Renovables para Galápagos (ERGAL)
  ERGAL is one of the project proponents supporting the fieldwork of the Feasibility Study (the Study)

- Det Norske Veritas Certification AS (DNV):
  Designated Operating Entity (DOE). DNV is to conduct validation for the Project.

2. Project Outline

（1）Project

The Project reduces CO_2 emissions by establishing a small scale wind power plant of 7.5MW capacity in stages and supplying the electricity to the neighboring Island of Santa Cruz through mini-grid to displace diesel based electricity under the "Zero Fossil Fuel for the Galapagos Islands" initiative of the Ecuadorian government that aims at reducing dependency on oil. The Project's biggest objectives are: The mitigation of the environmental impact brought about by the oil spillage incident from a stranded tanker which became a factor in initiation of the Zero Fossil Fuel Programme, as well as protecting the ecosystem of Galapagos Islands by phasing out the use of diesel oil currently transported by tankers for the purpose electricity generation.

The wind power generation under the Project is expected to start operation in October 2011 and based on the latest conservative estimates according to the data provided by equipment producer in December 2010, the amount of annual average greenhouse gas emissions reduction is 8,936 t-CO_2/year during the first crediting period. At the same time, by introducing renewable energy, the co-benefit of reduction in air pollutants due to the reduction of fossil fuel use is expected.

The Project will be implemented by the financial outlay of Fideicomiso Mercantil Energía Renovable para Galápagos, a trust. The actual power plant operation and monitoring will be carried out by Galapagos Electricity Company, (ELECGALAPAGOS) while the overall management of the Project will be conducted by Energías Renovables para Galápagos (ERGAL).

（2）Applicable Methodology: MS-I.F. "Renewable electricity generation for captive use and mini-grid (Version 1)"

3. Study Methods

（1）Issues：

(In relation to the project implementation)

- **Project Outline:** Fideicomiso Mercantil Energía Renovable para Galápagos responsible for equipment procurement and contracts for the Project signed a contract on 21 July 2010 with a wind turbine manufacturer. It is possible that project location, estimated amount of power generation and technology to be utilized may be reviewed subsequent to the contract; therefore such possibility is to be confirmed as part of the Study. The power generation capacity to be installed in Phase 1 has been decided in the contract; however, the capacity for Phase 2 is yet to be decided. Therefore, in view of confirming consistency of description in a draft PDD, the Study is to confirm the possibility of having minor

modifications of installed equipment as well as installed capacity in the future.

- **Environmental Impact:** At the time of the contract, the construction for Phase 1 is expected to start in early 2011; therefore, preparation of EMP (Environmental Monitoring Plan) is to be confirmed.

- **Project Feasibility:** Although the wind power equipment to be installed in Phase 1 has already been ordered, the equipment provider for the transmission line is yet to be decided. In addition, the future outlook of Phase 2 is still uncertain which will be further investigated in the Study.

- **Country Risk:** Country risk in relation to the implementation of the Project will be evaluated in the Study.

(In relation to Co-benefits)

- **Measuring gas emissions from the tail pipe of the generator:** The next measuring date will be confirmed and information on the measuring method will be collected.

(In relation to CDM)

- **Revision of PDD:** The PDD drafted last year will be reviewed and revised as necessary. Last year, the small-scale CDM methodology, AMS-I.D. (Grid connected renewable electricity generation) was used. Subsequently, reference to the mini-grid was removed from AMS-I.D., and instead was incorporated into the new small-scale methodology, AMS-I.F. (Renewable electricity generation for captive use and mini-grid) in May 2010. Therefore, the applicability of AMS-I.F. to the Project will be confirmed.

- **Documented evidence required in validation:** Documented evidence that can justify what is described in the PDD will be collected prior to the project site visit of validation. The contents of such evidence will be checked and prepared for the project site visit.

- **Investigation of the baseline:** The baseline scenario of the Project reflects the result of last year's Study; however, emission reduction estimates are based on the data before equipment provider was decided. Therefore, the need for changes to the data used in the baseline emission estimates as well as the project outline will be confirmed in the Study.

- **Equipment used in monitoring:** As detailed study could not be carried out last year because the equipment to be installed was not decided, details of monitoring equipment and calibration method will be confirmed for their consistency with AMS-I.F.

- **Project implementation period:** Project implementation period and crediting period will be confirmed again with local counterparts taking into account the lifetime of the wind power plant. Also, selection of a contact point and timeline for submitting "Prior consideration of CDM" will be confirmed with local counterparts.

- **Confirmation of stakeholders' comments:** Although comments collected during the EIA process and actions planned to address such comments have been referred, stakeholders are to be invited again to give comments as considerable amount of time has passed since the last meeting.

- **Validation by DOE:** Validation will be conducted in the Study through which issues for CDM registration will be confirmed.

(2) **Study Contents**：

The Study was conducted by commissioning ERGAL to collect local information in addition to two field works and literature survey.

(In relation to project implementation)

- **Project outline:** The equipment manufacturer and an engineer dispatched from FIDIC (International Federation of Consulting Engineers) visited the project site in September and reviewed project location, estimated amount of power generation and technology to be utilized. As a result, utilizing Phase 2 location instead of Phase 1 location with bad access to the land was a better option as the already existing access road makes its impact on environment minimal and wind condition data are also good. Both locations had been declared as planned construction sites in the EIA approved in 2009, but because Environmental Monitoring Plans (EMP) were prepared separately, a request for approval of minor modification in the EIA was submitted based on consultation with EIA authorities, namely the Galapagos National Parks and Ministry of Environment. The minor modification to EIA was approved by Galapagos National Parks and Ministry of Environment in 2011. Upon consultation with local counterparts, it is now clear there is no problem in mentioning both locations in the PDD; therefore PDD has been amended based on the new information.

  PDD was further amended based on the revised estimated amount of power generation the equipment manufacturer provided, using the latest wind condition data. If the operation of equipment installed under Phase 1 is confirmed to have no problem, 7 sets of turbines similar to the equipment of Phase 1 are planned to be ordered for Phase 2. As such, under the two phases, 10 sets of 750 kW turbines totaling 7.5MW are to be installed under the current plan. The Operation start date of Phase 1 has been changed to October 2011 due to delay in wind power plant construction.

- **Project feasibility:** An MOU has been signed with the equipment provider for the transmission line; however a contract is yet to be signed. Currently, relevant organizations are in discussion on the construction schedule for the transmission line.

- **Country risk:** In September 2010, the President of Ecuador issued the state of emergency due to civil unrest. According to reports from local counterparts, the safety situation temporarily exacerbated in major cities for a short while, but there was no impact on the Galapagos Islands. Therefore, the country risk in relation to the implementation of the Project is unchanged.

(In relation to Co-benefits)

- Measuring gas emissions from the tail pipe of the generator: It has been confirmed that the next measurements will be taken in February-March 2011. Therefore, data measured at the beginning of 2010 have been used. In relation to measuring method, measurements are confirmed to be carried out in accordance with the US Environmental Protection Agency's guidelines.

(In relation to CDM)

- **PDD revision:** The PDD drafted last year was revised according to the changes that took place after the equipment order. As AMS-I.F. approved in May 2010 was also confirmed to be applicable to the Project, PDD was revised according to AMS-I.F. and validation process was begun. The PDD has also been translated into Spanish for acquiring host country DNA approval.

- **Documented evidence required in validation:** Collecting and filing documented evidence that supports project information including additionality justification was conducted in January 2011 for the validation project site visit by a DOE. Additional documentation will be submitted to the DOE according to the list of clarification points drawn during the site visit.

- **Investigation of the baseline:** Based on the confirmation with local counterparts, no change has been added to the baseline scenario of the Project. However, estimated emissions reduction has been re-calculated according to the lower value of expected amount of power generation based on the updated data by the equipment manufacturer.

- **Equipment used in monitoring:** Details of the monitoring equipment to be installed could not be confirmed during the Study. However, it has been identified that calibration of the monitoring equipment is required every 2 years according to domestic regulation and therefore conforms to the AMS-I.F. as well as CDM project guidelines. The amount of electricity consumed on the Island of Baltra is included as a monitoring point in addition to what is required by AMS-I.F.. This has been confirmed by the validator during the project site visit and clarified that there is no need for a request for deviation from the applicable methodology. The PDD has also been revised to further incorporate a possible case where a substation to be constructed under the proposed CDM project will receive electricity from other renewable energy sources that may be installed in the future.

- **Project implementation period:** The project implementation period has been determined as 20 years considering the lifetime of wind power equipment. However, as erosion and other damage caused by the sea air may shorten the equipment lifetime, the crediting period has been determined as renewable 7-year period. Renewal of the crediting period will be discussed with the wind turbine manufacturer and other experts at the time of each renewal. The prior consideration form was submitted to host country DNA as well as UNFCCC Secretariat, although it had been delayed due to delay in obtaining approval on the minor modification of EIA. It was confirmed that the modification of EIA does not directly affect the content of prior consideration submission, and the submission is also required to take place within 6 months of project start.

- **Confirmation of stakeholders' comments:** Although a full stakeholders' consultation have been already conducted during the EIA process, stakeholders were invited again to express comments for the Project in January 2011. Local counterparts have reported that there have been no negative comments: The stakeholders consented to the overall project design and minor modifications to EMP, and explanation of CDM was already given to the stakeholders during a previous CDM feasibility study.

- **Validation by DOE:** Issues of the Project towards CDM registration have been identified through initial desk review and project site visit as part of the validation process. Public comments were also accepted on the UNFCCC website from 8 January to 11 February 2011. The Project site visit by a validator was carried out during the study, which requested submission of additional evidence related to additionality and modifying the PDD by inserting additional description of the Project. Upon the completion of the Study, it has been confirmed with the local counterparts that these issues will continue to be addressed with the aim of project registration with the UNFCCC.

4. Study Results in relation to the Implementation of the CDM Project

（1） Identification of the baseline scenario and project boundary:

- Applicability condition of the methodology

The Project is consistent with the applicability condition of AMS-I.F. as it installs a facility to generate renewable energy with the installed capacity of less than 15 MW that supplies electricity to the mini-grid on the Island of Santa Cruz.

- Project boundary

In accordance with the methodology AMS-I.F., which states the project boundary being the physical, geographical site of the renewable generation source, the boundary for this proposed Project will be the site where wind energy is generated. The transmission line is outside of the project boundary.

- Baseline scenario

The first section of AMS-I.F. indicates that the baseline scenario is such where "in the absence of the project activity, the users would have been supplied electricity from one or more sources listed below: (a) A national or a regional grid (grid hereafter); (b) Fossil fuel fired captive power plant; (c) A carbon intensive mini-grid.". Therefore, it is possible to form a single baseline combining the Island of Santa Cruz to which the renewable electricity produced by the Project will be supplied (applies to the aforementioned

(c)) and Island of Baltra where 19 facilities each own captive power plants (applies to the aforementioned (b)). However, in estimating baseline emissions by captive power plants in (b), it is expected to use “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” which requires latest data on electricity consumption as well as fossil fuel consumption. As a result of the Study, it became apparent that such data are not available from the individual installations in the Baltra Island. For this reason, it has been decided that electricity consumption on the Island of Baltra will be excluded from the baseline emission calculation, and only emissions from the mini-grid on the Island of Santa Cruz will be considered in the project baseline.

The baseline emission of the Project is calculated in accordance with the following equation.

$BE_y = EG_{BL,y} \times EF_{CO2,y}$

$EG_{BL,y}$ Quantity of net electricity displaced as a result of the implementation of the CDM project activity in year *y* (MWh/y)
$EF_{CO2,y}$ Emission factor (t CO_2/MWh)

（2） Project emissions:

As per AMS-I.F, project emissions are not considered unless in geothermal or hydropower projects with a reservoir. Therefore, project emissions from the Project which involves wind power generation is zero.

（3） Monitoring plan:

The only monitoring item required in AMS-I.F. is the net amount of electricity supplied to the grid. However, since electricity supplied to the Island of Baltra will be subtracted from baseline emission calculation, the amount of electricity transmitted to Island of Baltra will also be monitored in the project activity. Similarly, the amount of electricity generated from renewable sources outside of the project activity and supplied through the same substation is also added as a monitoring item. For all indices, an electricity meter will be utilized for continuous monitoring.

Metering equipment will be calibrated in accordance with national standards. The generation and transmission data to the Islands of Baltra and Santa Cruz will be electronically transferred through a SCADA system, which automatically logs the data electronically. The technician responsible for the wind turbine operation will check this data and ensure that there is no anomaly in the operation. The manager will check the generation data on a regular basis.

（4） Amount of GHG emissions reduction:

The emissions reduction achieved by the Project is demonstrated in Table 1.

Table 1: GHG emissions reduction

Year	Estimation of project activity emissions (tCO_2)	Estimation of baseline emissions (tCO_2)	Estimation of leakage (tCO_2)	Estimation of overall emission reductions (tCO_2)
October 2011-September 2012	0	3,840	0	3,840
October 2012-September 2013	0	3,840	0	3,840
October 2013-September 2014	0	10,974	0	10,974
October 2014-September 2015	0	10,974	0	10,974
October 2015-September 2016	0	10,974	0	10,974
October 2016-September 2017	0	10,974	0	10,974
October 2017-September 2018	0	10,974	0	10,974
Total	0	62,550	0	62,550

（5）Project implementation period and crediting period:

In accordance with the definition of a CDM project, The Project start date is 21 July 2010 when the equipment procurement contract was signed. The Project is expected to continue operation for a minimum of 20 years.

The crediting period is 7 years from 1 October 2011 or the date of registration request with the CDM Executive board, whichever is earlier, and is renewable.

（6）Environmental impact and other indirect impact:

The Environmental Impact Assessment (EIA) of the Project was carried out from January to October of 2008. The approval from authorities was obtained in March 2009, and the license was issued in July 2009. Following the change of the wind power facility location in October 2010, the request for a minor modification in an EMP was submitted, and the approval of the change was subsequently given by both the Galapagos National Parks and the Ministry of Environment.

Expected environmental impact due to the implementation of the Project and countermeasures described in the previously approved EMP are listed in Table 2.

Table 2: Environmental Impact

Predicted environmental impact	**Environmental Management Plan (EMP)**
Soil removal and alteration of nests and temporary displacement of birds and reptiles	Prior to an excavation for creating and establishing the wind generator foundations, access roads and other infrastructure, the nests and presence of Conolophus subcristatus (Land Iguanas) must be verified. For wind farm construction, fences along with access roads need to be installed to protect the iguanas, a vulnerable species.
Change in the landscape view with wind turbines	Reduce the number of installed turbines by selecting wind power turbines with a nominal power higher than 500 kW. This was included in tender documents.
Alteration of flying routes of birds and bats	The EIA study revealed that birds and bats found at the project site do not fly higher than 10 meters. Therefore, the wind power turbines must have the minimum height of 10 meters from the lower extreme of the blade to

	the ground surface to minimize the risk of collision with birds and bats. In addition, EMP requires the wind towers to be installed without guy-wires in order to prevent potential bird collision and mortality. The height restriction was included in the tender documents and wind turbine manufacturers using guy-wired towers were excluded from participation in the tender.
Generation of solid and liquid waste	Any solid wastes generated during the construction phase need to be brought back to the mainland. For operation, gearbox wind turbines were considered as a source of generating liquid waste (lubricant oil). The project developer selected the equipment supplier without gearbox turbines in order to avoid any additional waste during the operation.
Temporary impacts to tourism due to construction activities	Educational campaigns. ERGAL has hired a local NGO to conduct the wind energy project and energy efficiency education campaign.
Possible migration of non-native species	A phyto-sanitary control will be conducted on equipment at the port on entry, upon arrival at the Galapagos Islands.

(7) Stakeholders' comments:

Four Stakeholders' meetings were officially organized during the EIA process in 2007 and 2008. On both the Island of Baltra where the Project will be located and on the Island of Santa Cruz where the majority of the electricity generated in the project activity will be supplied, residents, facilities/installations managers and government officials were invited to the meetings through newspaper, radio and TV broadcast. A total of 65 people attended the meetings.

The Project has been well received by the regulatory authorities and the community members. In particular, the Santa Cruz Municipality finds the Project a very important step towards the island's sustainable development. Nevertheless, some community members expressed concerns about the Project many of which were based on lack of awareness in technical matters. Table 3 summarizes the responses given to the concerns raised during the stakeholders' meetings.

Table 3: Concerns raised during the stakeholders' meetings and response from the project proponent

Concerns raised by the stakeholders	Answers by the project developer
Electricity price will increase because of the Project.	The price that consumer pays is established by the power utility regulator (CONELEC). The price is decided by the government; therefore, the Project will not contribute to an increase in electricity price in the future.
There will be more electric blackouts than now.	Project design has considered measures to prevent this situation from occurring.
There would be enough amount of electricity, so the local electricity consumers can consume more than now.	No, energy is a limited resource, and rational use of energy has to be promoted. The project developer has designated a local NGO to raise the environmental consciousness and promote good energy saving practices.
The transmission line will harm our health and affect the cattle.	No, the voltage level is in the medium voltage scale. The transmission line will be mainly installed in the Galapagos National park. Though the line passes through some farms, the voltage level is sufficiently low that it is unlikely to cause any harm or diseases to human beings and cattle.

The CDM aspect of the Project was again explained to the stakeholders as part of the field work of previous year's Study. When another stakeholder meeting was convened on 6 January 2011, they voiced their no objection to the minor modification to the EMP and there were no comments of concern.

(8) Project implementation framework:

The proponent of the project activity is Fideicomiso Mercantil Energía Renovable para Galápagos, a commercial trust. The actual power plant operation and monitoring will be carried out by ELECGALAPAGOS, the manager of the transmission line while the overall management and coordination will be conducted by ERGAL. The operational framework is described in Figure 1.

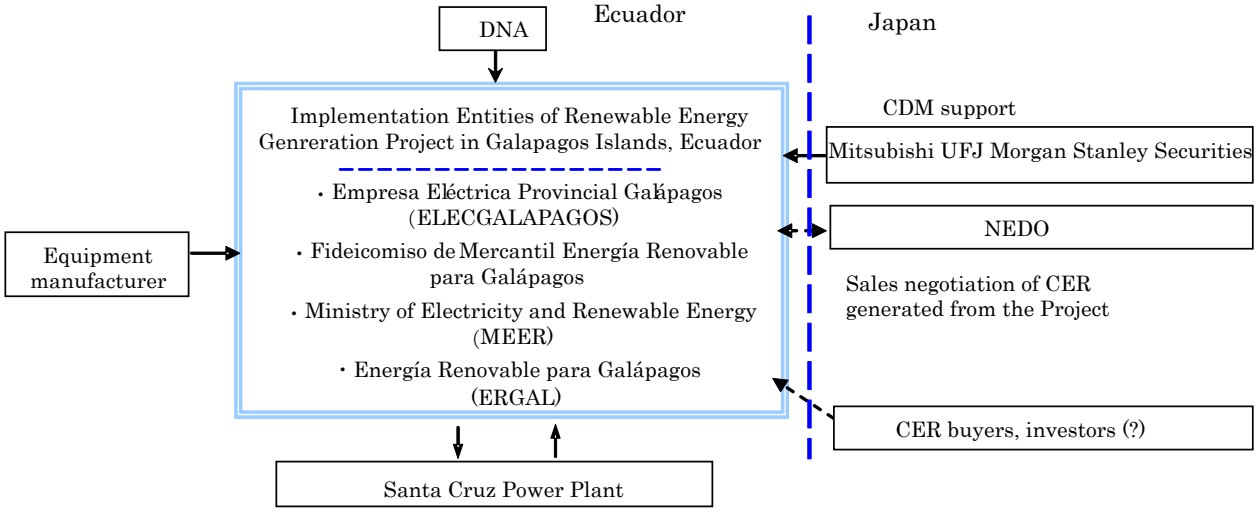

Figure 1: Project implementation framework

(9) Financial plan:

Table 4 describes the financial plan of the Project.

Table 4: Financial plan

(US Dollars)

		2010	2011	2012	2013
Investment Plan	Initial Investment				
	Phase 1 (3 units)	7,500,000			
	Phase 2 (6 units)			15,000,000	
	Other				
	Civil works	1,250,000		1,500,000	
	Engineering	475,000	325,000	300,000	200,000
	Ad hoc cost	450,000			
	Trasmission lines construction	5,000,000			
	Total	**14,675,000**	325,000	16,800,000	200,000
Financial Sources	Ecuadorian government				
	・Ministry of Energy and Mines	644,000			
	・Minsitry of Elericity and Renewable Energy	10,900,000			
	GEF(for transmission lines only)	2,500,000			
	UNF (for transmission lines only)	605,000			
	Total	**14,649,000**			
Fund short for Phase 1			351,000		

US$ 14.6 million is already secured by the Ecuadorian government for the Project. Nevertheless, approximately 3 % of the initial investment for Phase 1 and all investment cost for Phase 2 are still lacking.

In addition to initial investment, operation and maintenance cost amounting to US$ 272,000 per year and a one-time overhaul cost after 2020 are foreseen. Therefore, it is crucial to implement the Project as a CDM project activity and obtain income from CERs.

（10）Financial analysis:

Financial analysis has been carried out by examining Phase 1 and Phase 2 separately and both phases together. IRR for each scenario is calculated. However, it is clear that even Phase 1 cannot be implemented without the benefits of CDM considering the Project stalled due to lack of financial resources.

（11）Demonstration of additionality:

In line with Attachment A of Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the Project is deemed to be additional if it faces at least one of the following barriers:

(a) Investment barriers
(b) Technological barriers
(c) Barrier due to prevailing practice
(d) Other barriers

Because Galapagos are remote islands and UNESCO world heritage sites, it is necessary to consider protection of vulnerable ecosystems when installing turbines and transmission lines. As such, there have been many unforeseen technical issues including the necessity to change project location and design. Additionally, it has proven difficult to keep initial investment cost at a minimum as technology providers have not been so eager to bid for small-scale wind turbines due to limitations on design, distance from the mainland, issues with delivery and construction and global demand for wind turbines heating up. Under such circumstances, costs of project installation and operation have increased, worsening the cash flow of the project. Moreover, it is quite difficult to obtain additional financial outlay from the government as there are other pressing priorities the Ecuadorian government has especially related to the energy security in the mainland. Situations as described above have become barriers to project implementation.

Based on the analysis, the Project clearly faces investment barrier and thus, can be deemed additional.

（12）Outlook toward project implementation:

The Project is at the stage where an equipment provider has been selected and construction can be started. The project start date is 21 July 2010, the date on which the contract was signed for wind power generation equipment procurement. Since a project with the project start date prior to the new methodology submission or publication of PDD on the UNFCCC website is required to submit “Prior Consideration of CDM” within 6 months of project start date, Prior Consideration for the Project was submitted to UNFCCC Secretariat and host country DNA in early January 2011.

The operation start date of the wind power plant is expected in October 2011.

Table 5: Project implementation schedule

	2005 -2008	2009	2010	2011	2012	2013
Phase 1						
Engineering, EIA						
Bidding						
Contract						
Equipment production						
Civil works						
Power plant installation						
Test run						
Operation start						
Transmission lines, station						
Engineering						
Bidding						
Contract						
Civil works						
Transmission line installation						
Transmission test						
Operation start						
Phase 2						
Engineering Designing						
Equipment production						
Civil works						
Power plant installation						
Test run						
Operation start						

5. Validation

（1） Outline of validation:

Validation by Designated Operating Entity (DOE) is carried out as part of the Study. Pre-validation was not conducted, because the Project is small-scale energy type project and the methodology is relatively simple, and also because the Project is about to start operation in 2011 which calls for early registration.

Stages of validation carried out in the Study are described below:

- Invite public comments on the UNFCCC website for 30 days: Started on 8 January 2011.
- Desk review by DOE.
- Project site visit: Conducted in February, after the close of public comment period.
- Confirmation of outstanding issues after the project site visit.

After the Study is completed, communication with DOE as well as further investigation will continue regarding outstanding issues with the aim of early registration with UNFCCC.

（2） Communication with DOE:

The contract for validation was signed with DOE in November 2010. From 8 January 2011, the PDD was

made public on the UNFCCC website for validation requirements.

The project site visit took place in February 2011, after the 30 day public comment period. The visit proceeded smoothly due to documented evidence that was assumed to be requested for validation was well prepared in advance in order to facilitate the visit. As a result of the visit, letter of approval from DNA and supplemental evidence for additionality as well as additional description in the PDD were requested. Another important issue pointed out by DOE was about clarifying plans for Phase 3.

In addition, the design of the substation planned to be constructed with the wind power plant and confirmation of the monitoring points were informed to the DOE during the project site visit. As there is a possibility that electricity generated by renewable sources other than the proposed Project may be transmitted to the Project's substation, it has been explained to the DOE that electricity from such external renewable sources are added to the monitoring items in the PDD, in order to identify the electricity generation attributing to the CDM Project.

It was also explained to the DOE that a new set of power generation estimates will be used in the PDD when requesting registration, not the data currently being used which the equipment manufacturer provided in December 2010.

It has been agreed with local counterparts that efforts towards promptly obtaining DNA approval as well as registration at UNFCCC will be carried out while issues described above will continue to be addressed even after the completion of the Study.

6. Study Results on Co-benefits

The amount of air pollutants reduced from existing thermal generators of the mini-grid by the Project implementation was quantified using measured data such as concentration, exhaust gas flow rate and operation hours for SOx, NOx, PMs and CO_2 in accordance with "Co-benefit Quantification Manual Version 1.0". For the level of evaluation, Tier 3 of the manual[1] has been selected, and actual data on exhaust gas measured from the tailpipe in January 2010 have been used.

Baseline and project scenarios are as follows.

Table 6: Baseline/ Project Scenarios

Baseline scenario	SOx, NOx, dust and CO_2 are emitted from 6 units of power plants on the Island of Santa Cruz.
Project scenario	Due to the operation of the wind power plant, the amount of SOx, NOx, dust and CO_2 emission are reduced during Phase 1 and 2.

The amount of reduction of air pollutants will be the difference of baseline and project scenarios for each pollutant.

For baseline and project emissions, the following equations are used.

$$ER_{SOx,y} = BE_{SOx,y} - PE_{SOx,y}$$

$ER_{SOx,y}$ = Emission reduction of SOx (ton/year)
$BE_{SOx,y}$ = SOx emission in baseline scenario (ton/year)
$PE_{SOx,y}$ = SOx emission in project scenario (ton/year)

$$R_{NOx,y} = BE_{NOx,y} - PE_{NOx,y}$$

[1]When evaluating, actual data shall be used for activity level and parameters, equation shall individually be established and quantitative evaluation shall be conducted (Source: Co-benefit Quantification Manual Version 1.0)

$ER_{NOx,y}$ = Emission reduction of NOx (ton/year)
$BE_{NOx,y}$ = NOx emission in baseline scenario (ton/year)
$PE_{NOx,y}$ = NOx emission in project scenario (ton/year)

$ER_{PM,y} = BE_{PM,y} - PE_{PM,y}$

$ER_{PM,y}$ = Emissions reduction of dust (ton/year)
$BE_{PM,y}$ = Dust emission in baseline scenario(ton/year)
$PE_{PM,y}$ = Dust emission in project scenario (ton/year)

＜SOx＞
Method for baseline emission calculation

$BE_{SOx,y} = GFR_{BE,y} \times OT_{BE,y} \times CR_{BE,SOx,y} \times 60/10^{\wedge 9}$

Method for project emission calculation

$PE_{SOx,y}=(GFR_{PE,y} \times OT_{PE,y} \times CR_{PE,SOx,y} \times 60/10^{\wedge 9}) \times EF_{BL,SOx} \times (EG_{BL,2009} - EG_{BL,y})$
$EF_{BL,SOx}= BE_{SOx,2009} / EG_{BL,2009}$

$GFR_{BE,y}$ = Gas flow rate of thermal power plant in baseline （m^3/minute)
$OT_{BE,y}$ = Operating hours of thermal power plant$_{(1\sim6)}$ in baseline (h/year）
$CR_{BE,SOx,y}$ = SOx concentration at tailpipe of thermal power plant$_{(1\sim6)}$ in baseline (gas density)
$GFR_{PE,y}$ = Gas flow rate of thermal power plant in project （m^3/minute)
$OT_{PE,y}$ = Operating hours of thermal power plant$_{(1\sim6)}$ in project (h/year）
$CR_{PE,SOx,y}$ = SOx concentration at tailpipe of thermal power plant$_{(1\sim6)}$ in project (gas density)
$EF_{BL,SOx}$ = Amount of SOx emission per 1MWh of power generated in baseline (t/MWh)
$EG_{BL,2009}$ = Amount of electricity generated in 2009 (MWh/year)
$EG_{BL,y}$ = Energy baseline in year y (amount of electricity generated) (MWh/year) (sourced to CDM)

＜NOx＞
Method for baseline emission calculation

$BE_{NOx,y}=GFR_{BE,y} \times OT_{BE,y} \times CR_{BE,NOx,y} \times 60/10^{\wedge 9}$

Method for project emission calculation

$PE_{NOx,y}= (GFR_{PE,y} \times OT_{PE,y} \times CR_{PE,NOx,y} \times 60/10^{\wedge 9}) \times EF_{BL,NOx} \times (EG_{BL,2009} - EG_{BL,y})$
$EF_{BL,NOx}= BE_{NOx,2009} / EG_{BL,2009}$

$CR_{BE,NOx,y}$ = Average NOx concentration at tailpipe of thermal power plant$_{(1\sim6)}$ in baseline (gas concentration)
$CR_{PE,NOx,y}$ = Average NOx concentration at tailpipe of thermal power plant$_{(1\sim6)}$ in project (gas concentration)
$CR_{PE-NOx,y}$ = NOx concentration at tailpipe of thermal power plant$_{(1\sim6)}$ (gas concentration)
$EF_{BL,NOx}$ = Amount of NOx emission per 1MWh of power generated in baseline (t/MWh)

＜Dust＞
Method for baseline emission calculation

$BE_{PM,y}=GFR_y \times OT_y \times CR_{PM,y} \times 60/10^{\wedge 9}$

Method for project emission calculation

$PE_{PM,y}=(GFR_y \times OT_y \times CR_{PM,y} \times 60/10^{\wedge 9}) \times EF_{BL,PM} \times (EG_{BL,2009} - EG_{BL,y})$
$EF_{BL,PM}= BE_{PM,2009} / EG_{BL,2009}$

GFRy	=	Gas flow rate of thermal power plantm^3/minute)
OT_y	=	Operating hours of thermal power $plant_{(1\sim6)}$ (h/year)
$CR_{PM,y}$	=	Average PM concentration at tailpipe of thermal power $plant_{(1\sim6)}$ in (mg/m^3)
$EF_{BL,SOx}$	=	Amount of PM emission per 1MWh of power generated in baseline (t/MWh)

7. Study Results on Contribution to Sustainable Development

As a result of the Study, it has become clear that the implementation of the wind power generation project contributes to sustainable development through mitigation of ecosystem destruction risk, greenhouse gas emission reduction in fuel transport and improvement of soil and water quality.

(1) Mitigation of ecosystem destruction risk

The Study conducted a quantitative analysis on the incidence of fuel spillage caused by the shipping accident as well as increase in death of wild birds caused by land vehicles transporting diesel oil. By implementing the Project and reducing the demand for transport of diesel oil for existing power generation facilities with such demand completely eliminated in the future, ecosystem destruction risk as described here will be mitigated.

(2) Additional CO_2 emission reduction in drop in fuel consumption by land transport on the Island of Santa Cruz

It has been confirmed that a decline in diesel oil demand will lead to CO_2 emission reduction in trucks currently used for transporting diesel oil.

(3) Improvement of soil quality in the Island of Santa Cruz

A decline in diesel oil demand will mitigate soil contamination caused by spillage of diesel oil from the existing storage tank.

(4) Improvement of water quality on the Island of Santa Cruz

The mitigation of soil contamination previously described will also mitigate groundwater contamination.