CDM Feasibility Study 2011: Final Report

CDM Feasibility Study on
CDM PoA Feasibility Study for Energy Utilisation of Broiler Chicken Manure in Ust-Kamenogorsk, Kazakhstan

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EX Research Institute Ltd.

Table of Content

1. Outline of the Study

1.1 Background and Objective of the Study

The main purpose of this feasibility study is to investigate the feasibility of converting the currently utilized coal boilers to the boilers with poultry manure as fuel in the broiler farm of Ust-Kamenogorskaya Ptitse Fabrika (UK-PF) in the Republic of Kazakhstan. Ust-Kamenogorskaya Ptitse Fabrika (UK-PF) is one of the largest broiler chicken farms in Ust-Kamenogorsk, the Eastern Kazakhstan, annually raising approximately 1 million heads of chicken. The broiler farm currently utilizes coal boilers to produce heat and hot water for air-conditioning of broiler houses. The amount of coal consumption reaches around 40 thousand tons per year. On the other hand, it also generates about 30 thousand tons of chicken manure that are disposed at the open dumping area located within the boundary of UK-PF broiler chicken farm.

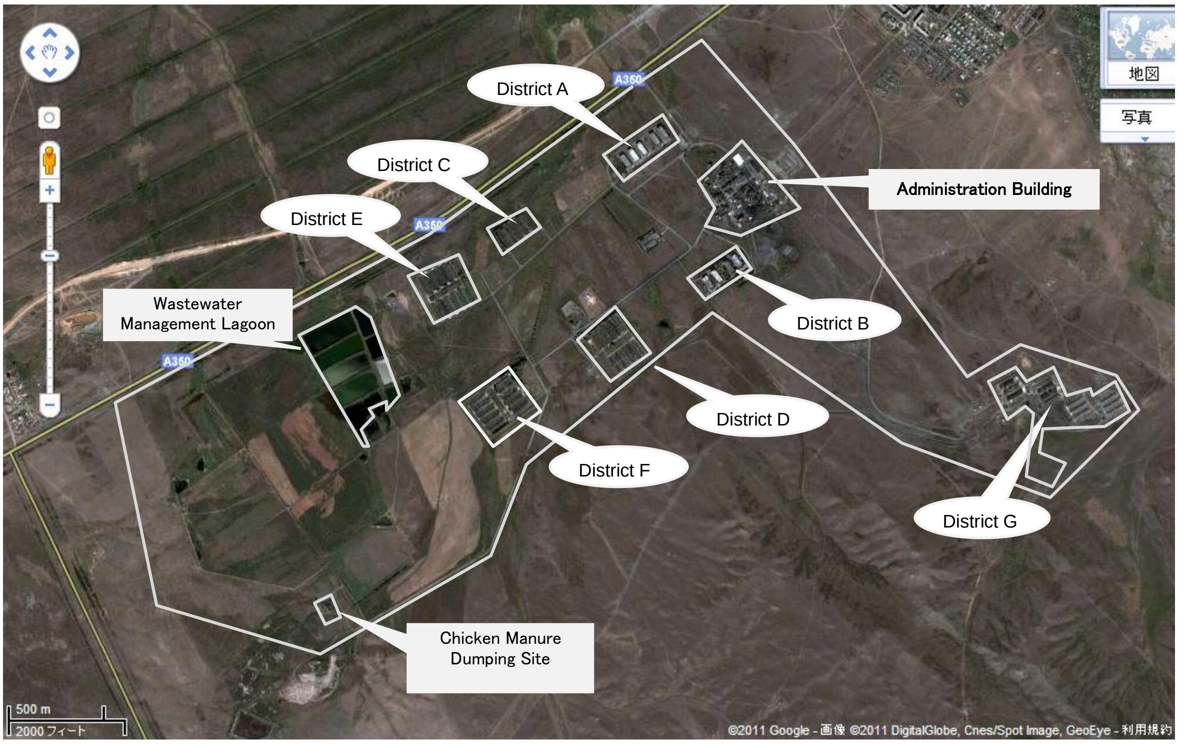


Photo 1: View of the UK-PF Broiler Farm

The central coal boiler is installed within the administration building and supplies hot water to each broiler houses shown as district A to F in the photo above. There is another small coal boiler within the district G to supply the hot water to the broiler houses in this district.

The basic concept of the project subject to this feasibility study is to convert the currently used coal boilers by installing the small-scale chicken manure boilers for each district in a phased manner under the scheme of programmatic CDM.

The goal of this project is to completely convert the heat production and supply by coal boilers to chicken manure boilers in UK-PF.

Considering the potential environmental impacts by using the existing coal boilers such as air pollution (dust and SOx emission) as well as the open dumping of chicken manure, UK-PF decided itself to install chicken manure boilers for the purpose of solving these two serious environmental impacts as the coordinating/management entity of this programmatic CDM project.

This programmatic CDM project contributes to sustainable development of the Kazakhstan in the following contexts:

Environmental Sustainability

The project utilizes renewable energy resources (poultry manure) to produce heat for supplying hot water to broiler houses. It reduces the emission of greenhouse gases and other air pollutants by reducing coal consumption in the currently used boilers. It also lowers the emission of methane from the open dumping site of poultry manure generated in the farm with minimization of poultry waste and offensive odour and potential pest generation. Thus, the project contributes to environmental well-being and sustainability.

Social and Economic Sustainability

The project contributes to increase economic sustainability of poultry farms through conversion from coal to poultry manure as the energy resource for heat production and supply to broiler houses. The fuel cost of poultry farm can be minimized in the mid and long term by increasing the use of poultry manure. It also reduces the cost of proper handling of manure. The potential environmental impacts arising from coal fuel use and poultry manure disposal are minimized to increase social and environmental acceptance of broiler farms. Thus, the project increases social and economic sustainability of broiler production, which is one of the policy priority areas of development in agriculture sector in Kazakhstan.

Technical Sustainability

The proposed project implements an innovative renewable energy technology that has never been applied in anywhere in Kazakhstan. However, the technology itself (poultry manure boiler) is a proven technology with enough operation records in Japan and the other countries. The successful introduction of this technology will increase the potential of poultry manure as the alternative renewable energy resources and mitigate the dependence upon coal in many poultry farms in Kazakhstan.

1.2 Scope of the Study

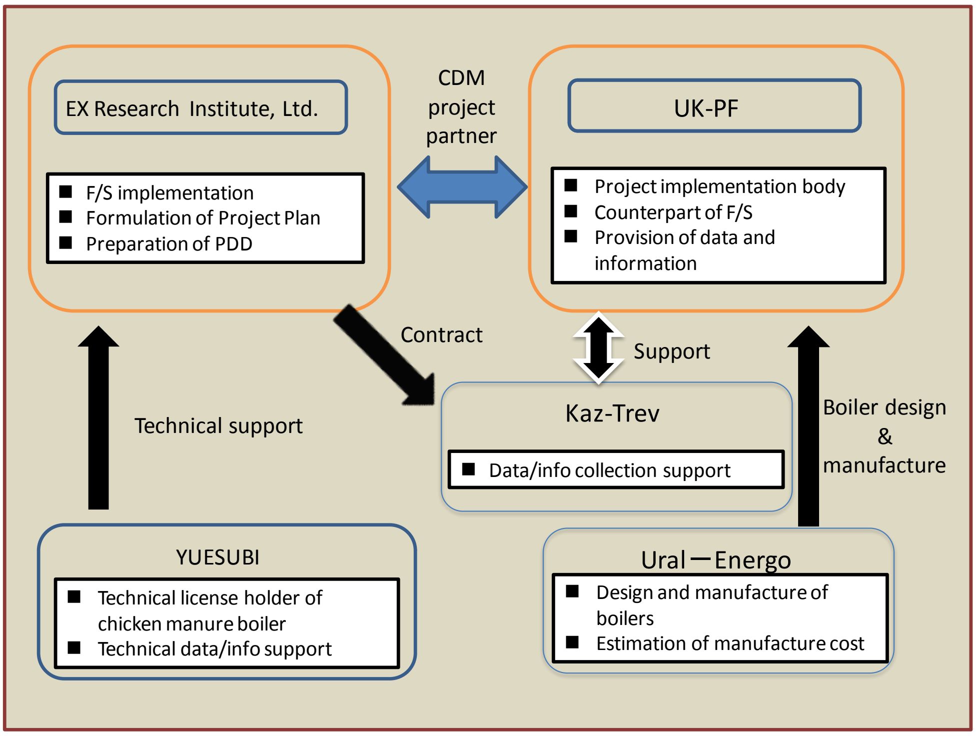
The scope of the study mainly consists of 2 (two) components. The first component is to conduct a full-scale feasibility study of the proposed project based on the analysis of financial viability of the proposed project. It includes formulation of a detailed project plan, initial design of the project facility, estimation of the project income and cost, financial planning, project cashflow analysis, and so forth. The second component of the study is to develop a set of so-called Project Design Document (PDD) for official registration of the proposed project under Clean Development Mechanism of the Kyoto Protocol so that the greenhouse gas (GHG) emissions to be achieved by the proposed project can be traded as carbon credit in the carbon market in the form of the Certified Emission Reduction (CER) under CDM. If the proposed project is registered as a CDM project, selling of the CER at the carbon market can be an additional revenue of the project to increase its financial feasibility. To prepare the PDD, this feasibility study collects all the necessary information and data required to be incorporated into it with the exact estimation of potential GHG emission reduction that can be achieved. The information and data to be collected and incorporated into PDD includes:

- Detail plan of the project
- Baseline scenario of GHGs emission in the absence of the proposed project
- Project scenario of GHGs emission
- Demonstration of project additionality (To prove that the proposed project would never be implemented without the scheme of CDM
- Estimation of GHGs emission reduction to be achieved by the project
- Collecting comments on the Project from key relevant stakeholders
- Identification of potential environment impacts of the project
- Identification of potential environmental co-benefit of the Project

All the results above of the Study will be incorporated into PDD as the principal document for registration of the project under CDM. The financial feasibility of the project is assessed for 2 cases, i.e. the case without the income from selling the CERs and the case without income from selling the CERs.

1.3 Organizational Framework for the Study

The figure below illustrates the organizational framework for conducting this feasibility study.



UK-PF is the implementation body of the proposed project and also the main counterpart (client) of this feasibility study. All the required information and data on relation to the current broiler farm operation will be provided by UK-PF.

EX Research Institute, Ltd. is the implementation of body of this feasibility study. It also formulates the detailed project plan and a set of PDD for the proposed programmatic CDM project.

Kaz-Trev is a local consultant company, which supports collection of data and information and provide necessary local information input to this Study. It is also a main counterpart of this study

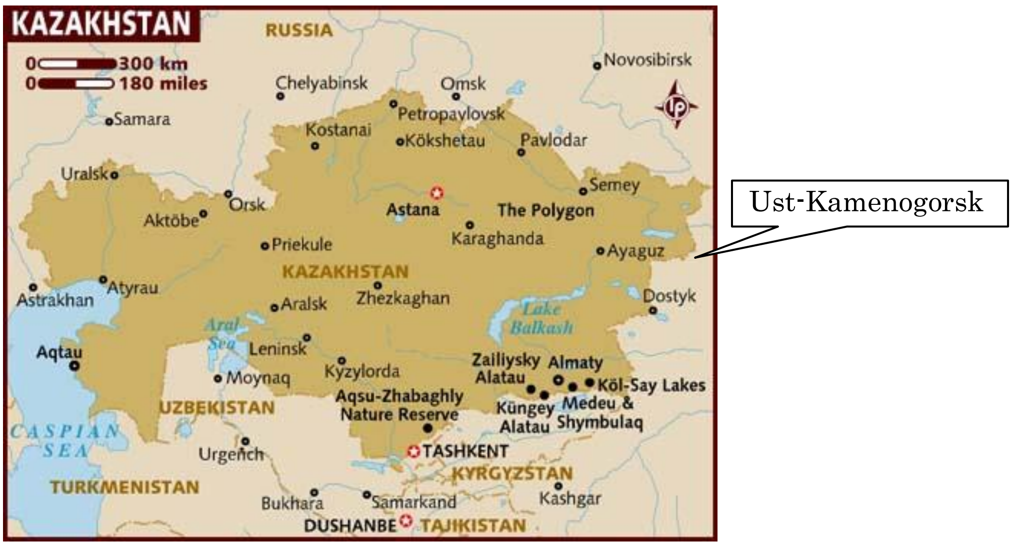
YUESUBI is the technical license holder of the poultry manure boiler to be introduced in the proposed project. It will provide technical support for design of the boilers, estimation of the project cost for the Study.

Ural-Energo is the local partner of the proposed project to be responsible for design and manufacture of the poultry manure boilers. It will provide necessary cost information for local production of the poultry manure boilers under the technical assistance by YUESUBI.

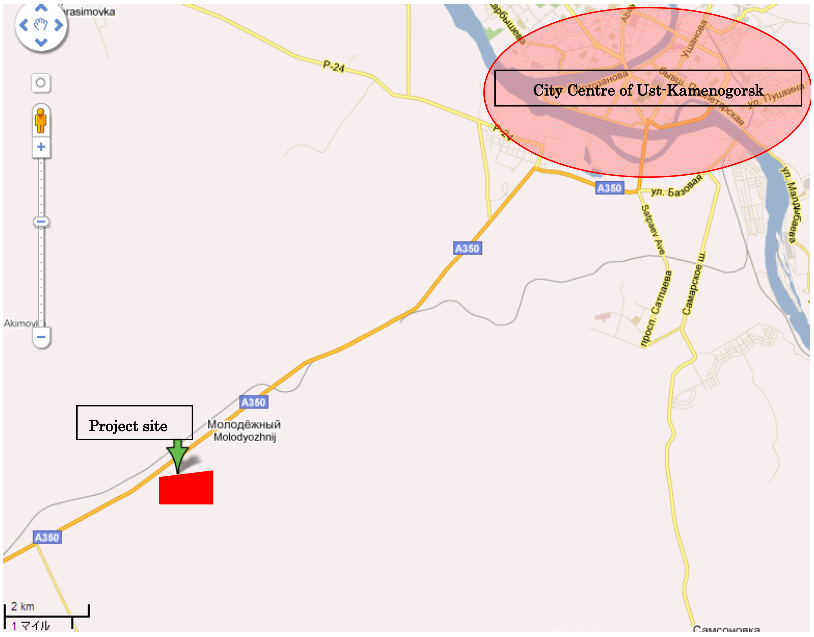
2. Outline of the Proposed Project

2.1 Location

The proposed project is to be implemented at the poultry farm owned by UK-PF at Ust-Kamenogorsk, Kazakhstan. The following map shows the location and physical boundary of the POA. The latitude and longitude of the project site are 49°86'77.88" N and 82°46'71.55" E., which is about 20km away from the city centre area of Ust-Kamenogorsk. It is located along the national road of A360, which connects the project site directly to the city centre.



Map 1: Location of Ust-Kamenogorsk in Kazakhstan



Map 2: Location of Project site in Ust-Kamenogorsk

2.2 Project Facilities and Technologies to be Employed

The technology to be employed by a typical small-scale CDM programme activity (SSC-CPA) is the heat production and hot water supply system with poultry manure boilers. The system comprises of 1 or 2 units of small scale poultry manure boilers with the maximum manure treatment (combustion) capacity not exceeding 400kg per hour that are to be introduced in a CPA of this PoA. It also consists of manure drying/storage facility, dust silo, and hot water heater as drawn in the figure below.

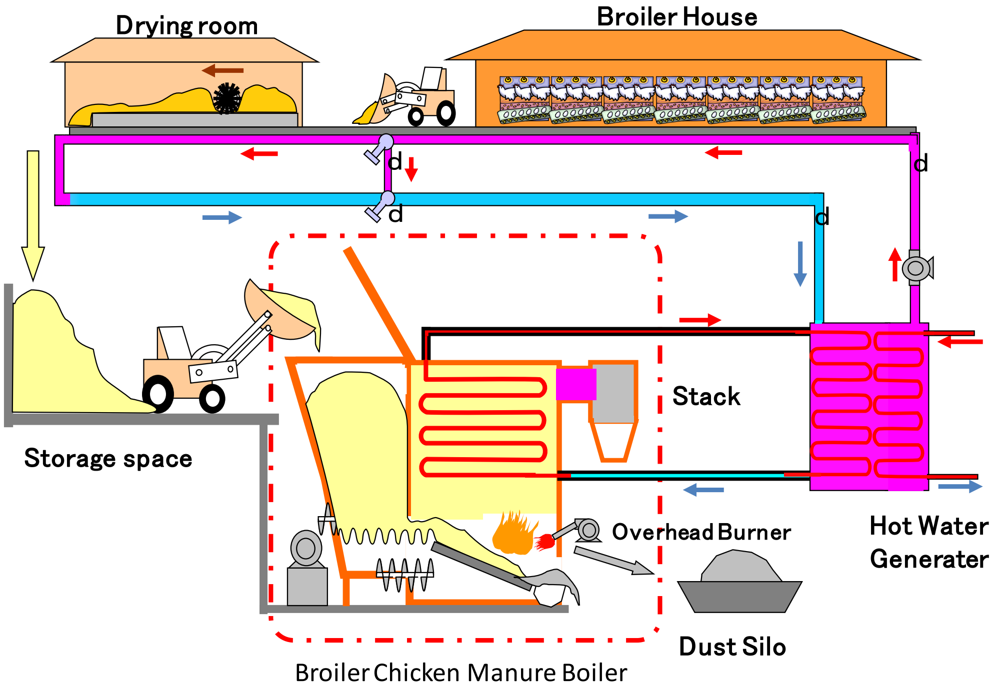


Figure 1: Typical Hot Water Supply System with Poultry Manure Boiler

The poultry manure boiler is a storker-type boiler, continuously incinerating poultry manure conveyed into the boiler while the heat produced from incineration is used for producing hot water with hot water generator. The amount of manure will be reduced by about 80% by weight with generation of non-hazardous ashes that can be utilized as soil conditioner or fertilizer.

This type of boilers are widely used in Japan as an environmentally-friendly poultry manure boilers with its complete compliance with the strict air emission standard.

The key specification of a typical poultry manure boiler are as follows:

- Poultry manure treatment (combustion capacity): 250kg/hour]
- Blower (capacity): 0.75kw ×3 sets
- Manure feed screw: 1.5kw (1unit)
- Dust discharging screw: 0.8kw (1unit)
- Line pump: 2.2kw (1set)
- Size: 4410mm×2516mm×2392mm (height)

The basic layout of the project facilities are as shown in the figure below.

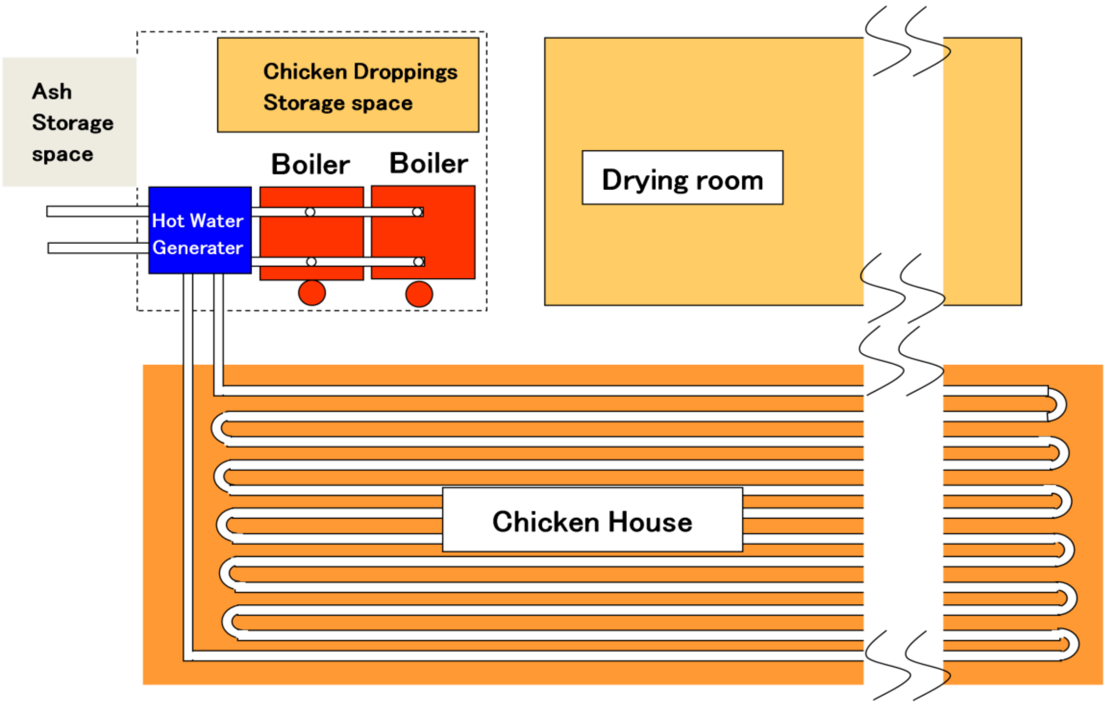


Figure 2: Facility Layout of Chicken Manure Boiler and Broiler Houses

3. Estimation of GHGs Emission Reduction

3.1 Methodologies applied for for estimation of GHGs emission reduction

As to the estimation of GHGs emission reduction by the conversion of coal boilers with poultry manure boilers, the SSC methodology "AMS-IC: Thermal energy production with or without electricity (Version 19)" was applied with the following methodological tools:

- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion,
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption, and
- Tool to determine the baseline efficiency of thermal or electric energy generation systems.

On the other hand, the estimation of GHGs emission reduction through avoidance of methane emission from the disposal site is made by utilizing the SSC methodology "AMS-III.E.: Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment (Version 16.0)" with some relevant methodological tools.

Justification of the choice of the methodologies (AMS-I.C. and AMS-III.E.) and its applicability to a SSC-CPA under this PoA is explained in the following tables respectively.

(Application of AMS-I.C.)

AMS-I.C. comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. The poultry manure is categorized as the renewable biomass that converts the current use of coal for thermal energy supply by the CPAs under this PoA. Justification of the choice of AMS-I.C. and its applicability related to the CPA under this PoA is shown in the table below.

Table 1: Justification of the choice of AMS-I.C. and its Applicability

Applicability Criteria	Justification
The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal	The total installed thermal energy generation capacity of the project equipment (poultry manure boiler) is equal to or less than 45 MW thermal.

Remark: Other Criteria in AMS-I.C. is not relevant to the CPA under this PoA

(Application of AMS-III.E.)

AMS-III.E. can be applied for the measures that avoid the methane production from decay of biomass through controlled combustion, gasification, or mechanical/thermal treatment. Justification of its choice and applicability related to the CPA under this PoA is shown in the table below.

Table 2: Justification of the choice of AMS-III.E. and its Applicability

Applicability Criteria	Justification
(1) This project category comprises measures that avoid the production of methane from biomass or	The proposed project complies with the condition (a) since the project will use poultry

other organic matter that: (a) Would have otherwise been left to decay under clearly anaerobic conditions throughout the crediting period in a solid waste disposal site without methane recovery, or (b) Is already deposited in a waste disposal site without methane recovery.	manure that would be disposed and left to decay under somehow anaerobic conditions to produce methane.
(2) Due to the project activity, decay of the wastes of type referred to in paragraph 1(a) and/or1(b) above is prevented through one of the following measures: (a) Controlled combustion; (b) Gasification to produce syngas/producer gas; (c) Mechanical/thermal treatment to produce refuse-derived fuel (RDF) or stabilized biomass (SB). An example of a mechanical/thermal treatment process is the pelletization of wood particles2	The proposed project avoids the methane emission through controlled combustion of manure with manure boilers, so complies with the condition (a).
(3) Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually.	The emission reduction achieved by the proposed project is less than 60kt CO_2.
(4) Where in the baseline usually there is a reduction in the amount of waste through regular open burning or removal for other applications, the use of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" shall be adjusted to take account of this burning or removal in order to estimate correctly the baseline emission.	In the proposed project, the amount of waste will not be reduced by open burning.
(5) The project activity does not recover or combust methane unlike AMS-III.G. Nevertheless, the location and characteristics of the disposal site in the baseline condition shall be known, in such a way as to allow the estimation of its methane emissions.	The proposed project does not capture, collect and combust the methane from the waste disposal site.
(6) If the combustion facility, the produced syngas, producer gas or RDF/SB is used for heat and electricity generation within the project boundary, that component of the project activity shall use a corresponding methodology under Type I project activities.	Heat generation part of the proposed project used AMS-I.C.that corresponds to the methodology under Type I project activities.
(7) In case residual waste from controlled combustion, gasification or mechanical/thermal is stored under anaerobic conditions and/or delivered to a landfill emissions from the residual waste shall to be taken into account using the first order decay model (FOD) described in AMS-III.G.	As the residue does not contain organic matters, it will generate no methane emission.

3.2 Sources and Gases Subject to GHGs Emission Reduction

The sources and gases included in the SSC-CPA boundary are as follows:

(Baseline Scenario)

Type of GHGs	Emission Source
CO_2	▪ Emission from consumption of coal in the baseline boilers that is converted by the proposed project with the heat supply from the poultry manure boilers
CH_4	▪ Emission from disposal of poultry manure that would have been disposed in the

Type of GHGs	Emission Source
	absence of the proposed project

(Project Scenario)

Type of GHGs	Emission Source
CO_2	▪ Emission from consumption of fossil fuels in the poultry manure boilers. (Not estimated in this proposed project since the use of fossil fuels in the boilers are minimal.)
	▪ Emission from consumption of electricity in the project.

(Leakage)

Type of GHGs	Emission Source
CO_2	▪ Leakage from the transfer of the currently used poultry manure boilers from outside project boundary. (Not estimated in this proposed project since the boilers are newly designed, manufactured and installed by the project.
	▪ Leakage from the transfer of the existing coal boilers are transferred outside the project boudndary. (Not estimated in this propose project since the existing coal boilers will be operated within the project boundary for the purpose of heat supply to the remaining broiler house after the implementation of the proposed project.

3.3 Baseline Scenario and GHGs Emission

The baseline scenario was determined in accordance with the methodology applied for the proposed project; namely AMS-I.C. and AMS-III.E.

(Determination on the type of fuels used for heat production and supply to the broiler house in the baseline scenario)

The current practice of heat production and supply by the existing coal boilers is identified as the baseline scenario. This determination was made based on the identification of the most cost-effective heat supply for UK-PF at the present situation within the project boundary. There will be no additional investment required if the current heat supply from the existing boiler continues. Therefore, the type of fuel used is coal.

(Determination on the handling method of poultry manure in the baseline scenario)

In connection with the estimation of methane emission in accordance with AMS-III.E., the baseline scenario related to handling method of poultry manure is identified. At the present situation, the lowest cost option of manure handling is its disposal at the currently used disposal site within the project boundary. Therefore, the continuation of current practice of direct disposal of poultry manure at disposal site is identified as the baseline scenario related to AMS-III.E.

3.4 Estimation of GHGs Emission Reduction

3.4.1 Estimation based on AMS-I.C.

(Baseline Emission)

In accordance with the simplified baseline methodology for the small scale CDM projects under AMS-I.C., the baseline emission is estimated by the following equation:

$$BE_{thermal,CO2,y} = (\mathrm{EG_{thermal,y}} / \mathrm{_{BL,thermal}}) \cdot \mathrm{EF_{FF,CO2}}$$

Where:

$BE_{thermal,CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year *y* (TJ)
$EF_{FF,CO2}$	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant; tCO_2/TJ, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used
□$_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

For ex-ante estimation, the following values are applied.

Parameter	Unit	Value	Data Source
$EG_{thermal,y}$	TJ	25,100	Based on estimation of heat supplied by the poultry manure boilers
$EF_{FF,CO2}$	tCO_2/TJ	0.1	Nationally available coal statistics
□$_{BL,thermal}$	-	0.6	Based on the calibrated data provided by UP-KF

Thus, the baseline emission is estimated as follows:

$$BE_{thermal,CO2,y} = (\mathrm{EG_{thermal,y}} / \mathrm{_{BL,thermal}}) \cdot \mathrm{EF_{FF,CO2}} = \frac{25{,}100 \bullet 0.1}{0.6} = 4{,}183 (tonCO2 / yr)$$

(Project Emission)

Project emission in accordance with AMS-I.C., shall include the following sources:

- CO_2 emissions from on-site consumption of fossil fuels due to the project activity
- CO_2 emissions from electricity consumption by the project activity
- Any other significant emissions associated with project activity within the project boundary

In the case of the proposed project, on-site consumption of fossil fuels by the poultry manure boilers in the project activity is minimal and ignorable since they are only utilized at the time of its ignition. It also has no other significant emission emissions associated with project activity than the emission from electricity consumption by the project activity. Therefore, the project emission in the proposed project is estimated by the equation below.

$$PE_y = PE_{CO2,EC,y}$$

Where:

PE_y = Project emissions in year *y* (tCO_2/y)

$PE_{CO2,EC,y}$ = CO_2 emissions from electricity consumption by the project activity (tCO_2/yr)

In the equation above, CO2 emission from electricity consumption by the project activity (PECO2,EC,y) is estimated by the formula below.

$$PE_{CO2,EC,y} = EC_{PJ,y} \cdot EF_{grid,y}$$

Where:

$PE_{CO2,EC,y}$ = CO_2 emissions from electricity consumption by the project activity (tCO_2/yr)

$EC_{PJ,y}$ = Electricity consumption by the project activity (MWh)

$EF_{grid,y}$ = CO_2 emission factor of the grid electricity (tCO_2/MWh)

For ex-ante estimation, the following values are applied:

Parameter	Unit	Value	Data Source
$EC_{PJ,y}$	MWh	54	Based on the actual power consumption records of the same boilers in Japan.
$EF_{grid,y}$	tCO_2/MWh	1.506	Nationally available grid emission factor

Thus, the project emission is estimated as follows:

$$PE_{CO2,EC,y} = EC_{PJ,y} \cdot EF_{grid,y} = 54 \bullet 1.506 = 81(tonCO2 / year)$$

(Leakage)

AMS-I.C. requires the following leakage estimation:

- If the energy generating equipment currently being utilised is transferred from outside the boundary to the project activity, leakage is to be considered.
- In case collection/processing/transportation of biomass residues is outside the project boundary CO_2 emissions from collection/processing/transportation[13] of biomass residues to the project site.

In the case of the proposed project, the poultry manure boilers are newly manufactured for the project: therefore no leakage will occur due to transfer of equipment from outside the project boundary. On the other hand, poultry manure to be utilized as the fuel is also procured within the project boundary and no leakage will arise from collection/processing/transport of biomass residues to the project site.

Thus, the leakage emission from the proposed project in accordance with AMS-I.C. can be regarded as none.

(Emission reduction)

The emission reduction from the proposed project is estimated by the equation below:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)
PE_y	=	Project emissions in year *y* (tCO_2)
LE_y	=	Leakage emissions in year *y* (tCO_2)

Thus, the emission reduction of this CPA in accordance with AMS-I.C. is estimated as follows:

$$ER_y = BE_y - PE_y - LE_y = 4{,}183 - 81 - 0 = 4{,}100\,(tonCO2/yr)$$

(a) <u>Estimation based on AMS-III.E.</u>

(Baseline emission)

The baseline emission in the CPA is estimated as the amount of methane emission from decay of the poultry manure to be disposed at the disposal site in the absence of the project activity. According to AMS-III.E., the amount of methane emission is estimated by the use of the “Tool to determine methane emissions avoided from disposal of waste at a solid disposal site”, as shown in the equation below.

$$BE_{y,CH4} = \varphi \cdot (1-\mathrm{f}) \cdot \mathrm{GWP_{CH4}} \cdot (1-\mathrm{OX}) \cdot \frac{16}{12} \cdot \mathrm{F} \cdot \mathrm{DOC_f} \cdot \mathrm{MCF} \cdot \sum_{x=1}^{y} \sum_{j} \mathrm{W_{j,x}} \cdot \mathrm{DOC_j} \cdot e^{-k_j \cdot (y-x)} \cdot (1 - e^{-k_j})$$

Where:

$BE_{y,CH4}$	Methane emissions during the year y from waste disposal at the solid waste disposal site (SWDS) during the period from the start of waste disposal activity to the end of the year y (tCO_2e)
Φ	Model correction factor to account for model uncertainties (fixed parameter: 0.9)
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner (fixed parameter: 0)
GWP_{CH4}	Global Warming Potential (GWP) of methane, valid for commitment(fixed parameter: 12)
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste (default value: 0.1)
F	Fraction of methane in the SWDS gas (volume fraction) (default value:0.5)
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose (default value:0.5)
MCF	Methane correction factor (determined by types of SWDS)

$W_{j,x}$	Amount of organic waste type j disposed at the SWDS in the year x (tons)
DOC_j	Fraction of degradable organic carbon (by weight) in the waste type j
k_j	Decay rate for the waste type j
J	Waste type category
X	Year during the crediting period: x runs from the first year of the first crediting period (x=1) to the year y for which avoided emissions are calculated (x=y)
Y	Year for which methane emissions are calculated.

For ex-ante estimation, the following values are applied.

Parameter	Unit	Value	Data Source
Φ	-	0.9	Conservative value is applied.
f	-	0	No methane is captured by the CPA.
GWP_{CH4}	-	12	2006 IPCC Guidelines
OX	-	0	Determined based on the result of on-site inspection of the conditions of the existing solid waste disposal site
F	-	0.5	IPCC default value
DOC_f	-	0.5	IPCC default value
MCF	-	0.28	Determined based on on-site inspection of the solid waste disposal site in terms of its physical and operational conditions.
$W_{j,x}$	Tons/yr	4,000	250 (kg/hour)×8000 (hours/yr) ×2 (units)
DOC_j	-	0.38	Determined based on analysis and characterization/ categorization of the poultry manure on-site.
k_j	-	0.05	The lower value of k for food waste in dry boreal and temperate climate is adopted in accordance with the recommendations on k value for stockpiling of waste in Chapter 3, volume 5 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Based on the above determination of the relevant values, baseline emission is estimated every year for 10 years of the crediting period as shown below.

Baseline Emission of the CPA based on AMS-III.E.

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
78	152	221	286	347	405	460	511	559	605	3,624

(Project Emission)

AMS-III.E. requires the estimation of the project emissions from the following sources:

- CO2 emissions related to the gasification and combustion of the non-biomass carbon content of the waste (plastics, rubber and fossil derived carbon) or RDF/SB and auxiliary fossil fuels used in the combustion, gasification or mechanical/thermal treatment facility;
- Incremental CO2 emissions due to:

- Incremental distances between the collection points to the project site as compared to the baseline disposal site;
- Transportation of combustion residues and final waste from controlled burning to disposal site;

- CO_2 emissions related to the fossil fuel and/or electricity consumed by the project activity facilities, including the equipment for air pollution control required by regulations. In case the project activity consumes grid-based electricity, the grid emission factor (tCO_2e/MWh) should be used, or it should be assumed that diesel generators would have provided a similar amount of electricity, calculated as described in category I.D.

In the case of the proposed project, consumption of fossil fuels by the project activity is minimal and igonorable as mentioned above.

Further, there is no incremental CO_2 emission due to incremental distance between the collection points to the project site as compared to the baseline project site since the project collects the poultry manure generated within the project site. The transportation of combustion residues from poultry manure boilers to disposal site does not increase the transport distance compared with baseline case.

The CO_2 emission from electricity consumption by the project activity is estimated in the equation above in accordance with AMS-I.C.
Thus, the project emission in relation to AMS-III.E. can be regarded as none in the proposed project.

(Leakage)
AMS-III.E. requires that leakage effects at the site of the other activity are to be considered if the controlled combustion, gasification or mechanical/thermal treatment technology is equipment transferred from another activity or if the existing equipment is transferred to another activity.

However, in the case of the proposed project, none of the above leakage effects occur as there is no transfer of project facilities and equipment from outside the project boundary while the existing equipment is not transferred to another activity.

Thus, the leakage emission can be regarded as none in the case of the proposed project.

(Emission reduction)
The emission reduction from the proposed project is estimated by the equation below:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emission reductions in year *y* (tCO_2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)

PE_y	=	Project emissions in year *y* (tCO_2)
LE_y	=	Leakage emissions in year *y* (tCO_2)

However, as not the project and leakage emission are none in the case of this CPA, the emission reduction equals to baseline emission. Thus, the total GHGs emission reduction by the proposed project was estimated as shown in the table below

Table 3: The estimated GHGs emission reduction during the project period

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2013	81	4,261	0	4,180
2014	81	4,335	0	4,254
2015	81	4,404	0	4,323
2016	81	4,469	0	4,388
2017	81	4,530	0	4,449
2018	81	4,588	0	4,507
2019	81	4,643	0	4,562
2020	81	4,694	0	4,613
2011	81	4,742	0	4,661
2022	81	4,788	0	4,707
Total (tonnes of CO_2 e)	810	45,454	0	44,644

4. Monitoring Plan

The monitoring methodologies to be applied to the proposed project are based on AMS-I.C. and AMS-III.E. respectively. Data and parameters to be monitored by each SSC-CPA during the credit period are given below.

Data / Parameter:	
Description:	Continuous operation of the equipment/system
Unit:	-
Monitoring/recording frequency:	Annual check of all appliances or a representative sample thereof to ensure that they are still operating or are replaced by an equivalent in service appliance.
Measurement methods and procedures:	Recording of thermal energy output based on metering of calibrated thermometer for each CPA.

Data / Parameter:	EF_{CO2}
Description:	CO_2 emission factor for the grid electricity in year y
Unit:	tCO_2e/kWh
Monitoring/recording frequency:	
Measurement methods and procedures:	As described in AMS-I.D

Data / Parameter:	$EF_{CO2,i}$

Description:	CO_2 emission factor of fossil fuel type i
Unit:	tCO_2e/GJ
Monitoring/recording frequency:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Measurement methods and procedures:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.

Data / Parameter:	
Description:	Quantity of electricity generated/supplied
Unit:	MWh
Monitoring/recording frequency:	Continuous monitoring, integrated hourly and at least monthly recording.
Measurement methods and procedures:	Measured using calibrated meters. Calibration shall be as per the relevant paragraphs of .General guidelines to SSC CDM methodologies. In case the project activity is exporting electricity to other facilities, the metering shall be carried out at the recipient’s end and measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts). Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient.

Data / Parameter:	
Description:	Quantity of hot air
Unit:	Nm^3/hr
Monitoring/recording frequency:	Continuous monitoring, integrated hourly and at least monthly recordings
Measurement methods and procedures:	Measured using calibrated meters. Calibration shall be as per the relevant paragraphs of .General guidelines to SSC CDM methodologies.. If applicable, measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts). Where it is not feasible (e.g. because of too high temperature), spot measurements can be used through sampling with a 90% confidence level and a 10% precision.

Data / Parameter:	
Description:	Quantity of steam
Unit:	Nm^3/hr
Monitoring/recording frequency:	Continuous monitoring, integrated hourly and at least monthly recordings
Measurement methods and procedures:	Measured using calibrated meters. Calibration shall be as per the relevant paragraphs of .General guidelines to SSC CDM methodologies.. If applicable, measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts).

Data / Parameter:	
Description:	Net quantity of thermal energy supplied by the project activity during the year y
Unit:	TJ
Monitoring/recording frequency:	Continuous monitoring, aggregated annually.
Measurement methods and procedures:	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and if applicable any condensate returns. The respective enthalpies should be determined based on the

	mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. In case of equipment that produces hot water/oil this is expressed as the difference in the enthalpy between the hot water/oil supplied to and returned by the plant. In case of equipment that produces hot gases or combustion gases, this is expressed as the difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be determined based on the monitored mass flow, temperature, pressure, density and specific heat of the gas. In case the project activity is exporting heat to other facilities, the metering shall be carried out at the recipient.s end and measurement results shall be cross checked with records for sold/purchased thermal energy (e.g. invoices/receipts). Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient.
Data / Parameter:	
Description:	Quantity of fossil fuel type j combusted in year y
Unit:	Mass or volume unit
Monitoring/recording frequency:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Measurement methods and procedures:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.

Data / Parameter:	$B_{Biomass,y}$
Description:	Net quantity of biomass consumed in year y
Unit:	Mass or volume
Monitoring/recording frequency:	Continuously and estimate using annual mass/energy balance
Measurement methods and procedures:	Use mass or volume based measurements. Adjust for the moisture content in order to determine the quantity of dry biomass. The quantity of biomass shall be measured continuously or in batches. If more than one type of biomass fuel is consumed, each shall be monitored separately. For the case of processed renewable biomass (e.g. briquettes) data shall be collected for mass, moisture content, NCV of the processed biomass that is supplied to users with an appropriate sampling frequency. Cross-check: Cross-check the measurements with an annual energy balance that is based on purchased quantities (e.g. with sales receipts) and stock changes. In cases where emission reductions are calculated based on energy output, check the consistency of measurements ex post with annual data on energy generation, fossil fuels and biomass used and the efficiency of energy generation as determined ex ante.

Data / Parameter:	
Description:	Moisture content of the biomass (wet basis)
Unit:	%
Monitoring/recording frequency:	The moisture content of biomass of homogeneous quality shall be monitored for each batch of biomass.

	The weighted average should be calculated for each monitoring period and used in the calculations.
Measurement methods and procedures:	On-site measurements. This applies in the case where emission reductions are calculated based on biomass energy input. For all cases, ex ante estimates should be provided in the PDD and used during the crediting period. In case of dry biomass, monitoring of this parameter is not necessary.

Data / Parameter:	T
Description:	Temperature
Unit:	°C
Monitoring/recording frequency:	Continuous monitoring, integrated hourly and at least monthly recording.
Measurement methods and procedures:	Measured using calibrated meters. Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies".

Data / Parameter:	P
Description:	Pressure
Unit:	kg/cm^2
Monitoring/recording frequency:	Continuous monitoring, integrated hourly and at least monthly recording.
Measurement methods and procedures:	Measured using calibrated meters. Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies".

Data / Parameter:	$NCV_{i,y}$
Description:	Net calorific value of fossil fuel type i
Unit:	GJ/mass or volume unit
Monitoring/recording frequency:	As per the "Tool to calculate project or leakage CO2 emissions from fossil fuel Combustion".
Measurement methods and procedures:	As per the "Tool to calculate project or leakage CO2 emissions from fossil fuel Combustion".

Data / Parameter:	NCV_k
Description:	Net calorific value of biomass type k
Unit:	GJ/mass or volume unit
Monitoring/recording frequency:	Determine once in the first year of the crediting period.
Measurement methods and procedures:	Measurement in laboratories according to relevant national/international standards. Measure quarterly, taking at least three samples for each measurement. The average value can be used for the rest of the crediting period. Measure the NCV based on dry biomass. Check the consistency of the measurements by comparing the measurement results with, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. (If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements)

Data / Parameter:	f

Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e / tCH_4
Description:	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Source of data	Decisions under UNFCCC and the Kyoto Protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol)
Monitoring frequency:	Annually
Any comment:	-

Data / Parameter:	W_x
Data unit:	Tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data	Measurements by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$p_{n,j,x}$
Data unit:	-
Description:	Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
Source of data	Sample measurements by project participants
Measurement procedures (if any):	Sample the waste prevented from disposal, using the waste categories *j*, as provided in the table for DOC_j and k_j, and weigh each waste fraction
Monitoring frequency:	The size and frequency of sampling should be statistically significant with a maximum uncertainty range of 20% at a 95% confidence level. As a minimum, sampling should be undertaken four times per year
QA/QC procedures:	-
Any comment:	This parameter only needs to be monitored if the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for DOC_j and k_j

Data / Parameter:	Z
Data unit:	-
Description:	Number of samples collected during the year *x*
Source of data	Project participants
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	-
Any comment:	This parameter only needs to be monitored if the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for DOC_j and k_j

5. Potential Environmental Impacts

The potential environmental impacts of the CPAs under this POA is identified as follows:

(a) Risk of bio-safety due to installation of poultry manure boilers close to broiler houses

So far, the poultry manure generated from the broiler houses has been immediately transferred to the designated disposed area within the geographical boundary of the broiler farm, but enough far away from broiler houses.

However, installation of the poultry manure boilers close to broiler houses possible cause a threat of retaining the waste for a certain period of time before putting it into boilers. It may increase the risk of bio-safety of the products of the farm, broiler chicken.

To eliminate this threat, the poultry manure boiler system is designed in its scale and quality to immediately after its generation. The treatment capacity of boilers will be determined in accordance with the estimation of manure generation rate in the relevant broiler houses. It is also designed to accept manure with a comparatively high water content so that the generated manure can be immediately utillized as fuel for the boilers. The drying/storage house is constructed as a sealed facility to avoid transfer of any harmful substances to the products.

With these remedies, the potential bio-safety risk will be avoided by the Project.

(b) Residual incineration ashes generated from manure boilers

More or less of 20% by weight of the amount of manure incinerated by the boiler will be generated as residual ashes. However, the technology introduced to this project complies with the strict environmental standard and regulation in Japan. the potential environmental impact by generation of air emission and incineration ashes will be minimized while it will mitigate the impacts arising from air emission (dust and SOx from the existing coal boilers through reduction of coal consumption as well as the lowering the amount of manure disposed and stockpiled at the disposal site. The actual environmental condition will be improved through realizing these positive impacts.

(c) Handling of incineration residues generated from manure boilers

According to the actual operation of this manure boilers in Japan, the incineration residues (ashes) from the manure boilers can be utilized as the soil conditioner or fertilizers. Although the residues will be brought immediately to the designated disposal area within the project boundary in the early years of this project. The reuse and recycling of these residues will be considered to further minimize the waste generated from broiler houses.

According to the current laws and regulations in Kazakhstan, the proposed project is subject to environmental impact assessment regardless of its physical scale.

6. Stakeholders' Comments

Prior to the implementation of the Project, interviews were held for the purpose of explaining the objectives, processes, potential implications and benefits for the sustainable development of the proposed project to the key relevant stakeholders, including national and local government agencies, financial institutes, multi-national donors, and so forth. Additional comments from the surrounding residents and other potential affected stakeholders will be further collected in the process of conducting the environmental impact assessment of this proposed project through public hearing process or other methods. The stakeholders from which the public comments were collected are as follows:

National/local government agencies

- Climate Change Coordination Centre (Kazakhstan DNA under CDM)
- Government of the Eastern Kazakhstan

Private sector organizations

- UK-PF

International donors/institutes

- International Finance Corporation (IFC)
- European Bank for Reconstruction and Development (EBRD)

Interviewees are mostly supportive of the implementation of the proposed project, viewing it as a win-win project that contributes to diversification of energy sources as well as improving the environment quality through reducing the generation of environmental pollutants generated from the current economic activities. Many interviewees also showed their expectation on the dissemination of the technology employed in the proposed project, as the "First of its kind" as the alternative win-win energy sources not only in Kazakhstan, but also in the neighbouring countries.

7. Economic Analysis of the Project

To conduct economic analysis of the project, the study estimated its financial internal rate of return through discounted cashflow analysis. It also analyzed pay-back period of the project based on the estimation of project income and cost (initial investment and operation/maintenance). The result of this analysis is as shown in the table below.

Case 1	Financial Internal Rate of Return (IRR)	Payback Period
Case 1: The proposed project with income from selling the CERs	11.07%	7 years
Case 2: The proposed project without income from selling the CERs	-0.61%	11 years
Case 3: Case 1 with a decrease of the CER income by 10%	9.05%	7 years
Case 4: Case 1 with a decrease of the CER income by 20%	7.64%	7 years

In the case of the proposed project without the income from selling the CER, it is not feasible with a negative IRR (-0.61%) and payback period of 11years which is beyond the durable years of the project facility (poultry manure boilers). In the case of the proposed project wit the income from selling the CERs, the IRR shows higher value than the investment benchmark of Kaakhstan (7.5%) with the payback period of 7 years even though the CER income is discounted by 20% (US$8/tonCO2). This result clearly shows the investment barrier of the proposed project without CER under CDM.

8. Demonstration of Project Additionality

In accordance with the Annex 24 of EB63: Attachment A to Appendix B of the simplified modalities and procedures for small scale CDM project activities, the additionality of a small scale project can be demonstrated by objectively identifying one of the barriers mentioned below:

- Investment barrier
- Technological barrier
- Barrier due to prevailing practices
- Other barriers

The proposed project identified the barriers of (a), (b), (c) to demonstrate its additionality below.

(a) Investment barrier

As mentioned earlier in Chapter 8 above, the result of the analysis clearly shows the investment barrier of the proposed project without CER under CDM.

(b) Technological barrier

The fuel utilization technology of poultry manure in the boilers to be introduced in the proposed project is a technology of “First-of-its-kind” in Kazakhstan. Therefore, there is a definitive technological barrier against application of this technology in this country.

The Annex 11 of EB63: Guidelines on Additonality of First-of-its-kind Project Activities identify its definition and eligibility conditions as shown in the table below:

Definition	Eligible physical/geographical extent	▪ Default physical/geographical extent of “First-of-its-kind” is the whole area of the host country. ▪ If the project extends beyond a country, it can also extend beyond the country. ▪ If the geographical extent is less than the boundary of host country, justification is required to prove that the technology is the “First-of-its-kind” within the project boundary.
	Measures	▪ The measures in relation to the following areas are currently included as the technology of the “First-of-its-kind. ➢ Switch of fuel or feedstock ➢ Change of technology including fuel switch or not (Energy efficiency improvement technologies and measures are also included.) ➢ Destruction of methane ➢ Avoidance of methane generation
	Technology	▪ The technologies which provide same output (products or services) with one of the differences in the following terms: ➢ Energy sources/fuels ➢ Feedstock ➢ Scale of facility/equipment (micro, small or large)
Eligibility Conditions		▪ The measures/technologies adopted by the project are different from the currently applied ones (conventional measures/technologies) within the geographical extent of the proposed project at the beginning of the project. ▪ The project participants set the credit period of 10 years or less at its maximum.

The poultry manure boiler belongs to the measures of fuel switch and avoidance of methane emissions while it deals with energy sources/fuels. The technology has never been utilized in any areas or sectors of Kazakhstan. The project participants set the credit period of 10 years. Thus the proposed project complies with the definitions and eligibility conditions of “First-of-its-kind” and demonstrates its technological barrier.

(c) Barrier due to prevailing practices

Currently, almost all broiler farms in Kazakhstan utilizes coal boilers for air conditioning of broiler houses. Coal supply market and system is stable while all the broiler farms have sufficient experience and know-how of coal boiler maintenance and operation. On the other hand, there is completely no experience of manufacturing as well as operating poultry manure boilers in Kazakhstan. Supply of poultry manure as the alternative fuel is entirely unprepared.

In this respect, there is a clear barrier against introduction of the project technology due to prevailing practices.