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

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

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Energy Efficiency in Gas Turbine Generator (GTG) at Indo Gulf Fertilisers (A Unit of Aditya Birla Nuvo Limited), Jagdishpur.

Version 01

Date 25/01/2008

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

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Indo Gulf Fertilisers (IGF) is a flag ship company of Aditya Birla Nuvo Limited (ABNL). IGF had started commercial production of Urea in 1988 with production capacity of 0.864 MTPA. IGF is the first Natural Gas (NG) based Urea complex in private sector with ISO 9001, ISO 14001, and OHSAS 18001 certification. IGF markets Urea in the brand name of 'Birla Shaktiman' catering to the states of northern and eastern parts of India (U.P., Bihar, Jharkhand and West Bengal).

Purpose of the project activity

The power requirement of the IGF fertiliser complex is currently met by two Gas Turbine Generators (GTG) of 18MW capacity each, and additional requirement is catered by Uttar Pradesh State Electricity Board (UPSEB) grid.

The proposed project activity aims to reduce the heat rate by carrying out retrofit measure in one of the existing GTG, which would lead to reduce the heat rate of the GTG and subsequently reduce the NG consumption in GTG. The project activity would lead to reduce the over all energy requirement of IGF Urea complex and reduces the overall GHG emission.

The reduction in heat rate of GTG is achieved by increasing the work done by the compressor of GTG and implementation of other energy efficiency measure in phase manner. In first phase heat rate reducing is achieved by cooling the inlet air/ suction air of inbuilt air compressor of the GTG by mee fogging system. Second phase of the project activity includes the up rating of GTG by carrying out various other energy efficiency measures like replacement of new fuel firing and combustion system, new heat path design, replacement of inlet guide vane etc.

In the first phase, Mee fogging system was installed for inlet air-cooling of GTG. Mee fogging system reduces the temperature of the inlet air/suction air of the inbuilt compressor. Any decrease

in temperature of air would result in reduction in volume of air per unit mass, also the air handled by inbuilt air compressor. In the second phase of project activity, various other retrofit measures are implemented in the GTG to increase the compressor work done and rate of heat transfer. These retrofit measure includes the redesigning and replacement of inlet guide vanes, compressor stator vanes, fuel-firing system (nozzle assembly, combustion chamber, flame detector), cross fire tubes, first stage nozzle, first stage bucket, first stage shroud, second stage nozzle, second stage shroud, second stage bucket and inner barrel with high pressure brush seal etc. in place of originally designed system.

All these energy efficiency measures would results in reduction of heat rate of GTG and increases the efficiency of the GTG. The project activity therefore, reduces GHG emissions by displacing equivalent amount of fossil fuel; that would have been used for generating electricity due to operating of GTG at higher heat rate/ lower efficiency.

In the absence of the project activity, IGF would have continued with existing GTG system with higher heat rate and higher fuel demand in the complex. This would have resulted in higher amount of GHG emissions.

Project's contribution in sustainable development

The project activity assists the host country in achieving sustainable development. Project activity also oriented towards social and environmental benefits.
The sustainable development indicators for the project activity are:

Social well being- Project activity would be generating direct and indirect employment for the unskilled / semi skilled and skilled persons, during different stages of the project- design, construction and implementation.

Environmental well being- Project activity would reduce the fossil fuel consumption and leads to resource sustainability. The net savings of fuel also leads to reduction of Greenhouse Gas (GHG) emissions due to fuel processing and transportation. The project activity would reduce CO_2 (GHG) emissions, helping in abating global warming.

Economic well-being- Project activity would result in conservation of fossil fuel and natural resources. The project activity therefore reduces the burden on Indian economy for the import of fossil fuel.

Technological well being- Project activity would employ unique technology which is first of its kind and unconventional in Indian fertilizer industry. The project activity has good replication potential in Indian fertilizer industry.

A.3. Project participants:

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Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
India	Indo Gulf Fertilisers (IGF) (A Unit of Aditya Birla Nuvo Limited)	No

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

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

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The project activity is located at Indo Gulf Fertilizers Urea manufacturing facility at Jagdishpur

A.4.1.1. Host Party(ies):

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India

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

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Uttar Pradesh

A.4.1.3. City/Town/Community etc:

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Jagdishpur

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

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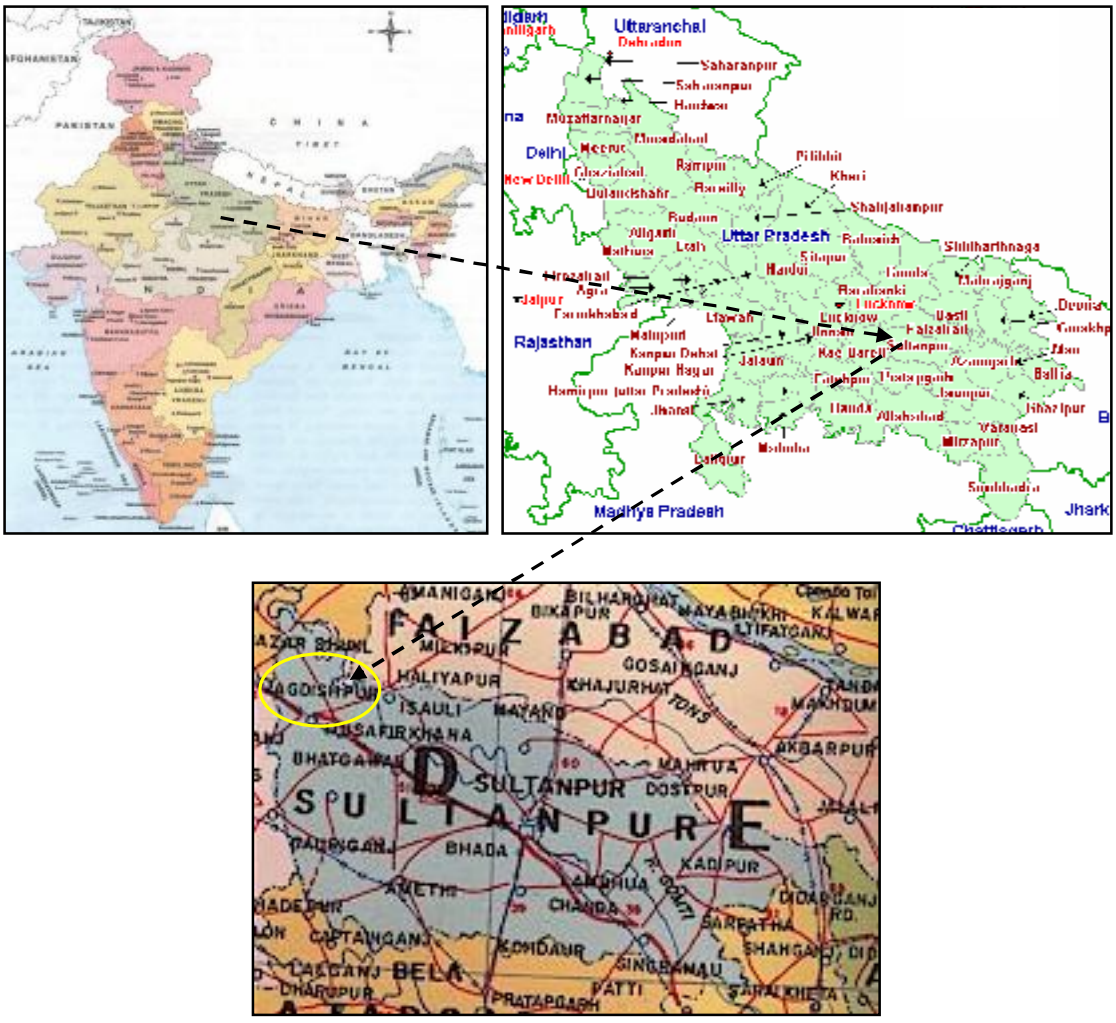
This project is implemented at Urea manufacturing facility of Indo Gulf Fertilisers (A Unit of Aditya Birla Nuvo Limited), Jagdishpur Distt. Sultanpur, Uttar Pradesh. Jagdishpur is situated at about 60 km from district head quarter of Sultanpur on Lucknow-Varanasi National Highway. Nearest Railway station is Nihalgarh, which is 10 Km. and nearest Airport is Lucknow 90 km from project activity site.

Geographical coordinates: 26° 29' 15" North 81° 33' 30" East

The Location of the project activity on the map of India is depicted below:



Location of the Project Activity (map not to scale)

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

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

Type-II: Energy efficiency improvement projects

Category II.D: Energy efficiency and fuel switching measures for industrial facilities, (version 11, EB35)

Technology

The novel concept of increasing the compressor work done and increase in rate of heat transfer is applied to reduce the heat rate of GTG. The project activity is carried out in two phases; in first phase, Mee fogging system was installed for inlet air-cooling of GTG and in second phase, various other energy efficiency measures are carried out to increase the compressor work done and rate of heat transfer. Mee fogging system consists of a high-pressure pump that pressurizes water through the nozzles, which in turn atomize the water into billions of quickly evaporating micro-fine fog droplets. When the fog droplets evaporate they cool the inlet air and make it denser. Gas turbine compressor moves a nearly constant volume of air at a fixed shaft speed, so denser air results in an increase in the mass flow of air through the turbine and thereby increases the power output of the turbine. The work required to compress air is less at cooler inlet temperatures, which means that more power is available at the turbine output shaft. The increased mass flow and reduction in compressor work gives an improvement in turbine output and fuel efficiency. Further, the GTG efficiency is increase by injecting more fog into the inlet air stream than will evaporate with the given ambient climate conditions.

Nozzle Specification	
Nozzle Body	Stainless steel
Nozzle Orifice	0.006”diameter
Thread	1/8" NPT thread size
Manifold Tube	Stainless steel, 1/2" O.D., 0.035 inch thick wall, up to 2000 psi operating pressure

In order to further, increase the work done by the compressor other retrofit measures are carried out like redesign and replacement of inlet guide vanes, replacement of sealing system. The rate of heat transfer increased by increasing the inside temperature of combustion chamber. To achieve the higher temperature inside the combustion chamber entire fuel firing system and metallurgy of the equipments are changed. All the energy efficiency measures are implemented keeping the concept that to achieve the energy efficiency losses should be reduce. Following new technology / new designed equipments are replaced to increase the heat rate of turbine:

1. Inlet Guide Vanes

2. Compressor Stator Vanes
3. Fuel Nozzle assembly
4. Combustion Chamber
5. Flame Detector
6. Combustion liner
7. Transition Pieces
8. Cross Fire Tubes
9. First Stage Nozzle
10. First stage Bucket
11. First stage Shroud
12. Second Stage Nozzle
13. Removable Wheel space thermocouple
14. Second stage Shroud
15. Inner Barrel with High-pressure brush seal
16. Repair of Exhaust plenum insulation

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

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Years	Annual estimation of emission reductions in tones of CO_2 e
2008-2009	13511
2009-2010	13511
2010-2011	13511
2011-2012	13511
2012-2013	13511
2013-2014	13511
2014-2015	13511

2015-2016	13511
2016-2017	13511
2017-2018	13511
Total estimated reductions (tones of CO_2 e)	**135110**
Total number of crediting years	**10 years**
Annual average over the crediting period of estimated reductions ((tones of CO_2 e)	13511

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

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

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

As per appendix C of simplified modalities and procedures for small-scale CDM project activities, 'debundling' is defined as the fragmentation of a large project activity into smaller parts. A small-scale project activity that is part of a large project activity is not eligible to use the simplified modalities and procedures for small-scale CDM project activities.

According to para 2 of appendix C

A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

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

According to above-mentioned points of de-bunding, IGF's project activity is not a part of any of the above, therefore, considered as small-scale CDM project activity. However, project proponent has already registered other CDM project activity under different technology/measures.

SECTION B. Application of a baseline and monitoring methodology

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

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The baseline and monitoring methodology applied for the proposed project activity is:

Type II **Energy efficiency improvement projects.**

Category D **Energy efficiency and fuel switching measures for industrial facilities, (AMS II.D. version 11, EB 35)**

Reference: UNFCCCwebsite[1]

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

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As per the applicability criteria of "Type II- Energy efficiency improvement projects and Category II.D. - Energy efficiency and fuel switching measures for industrial facilities, (version 11, EB 35)"; proposed project activity falls under this methodology. The applicability criteria of the 'Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories' AMS II.D is defined as follows:

1. This category comprises any energy efficiency and fuel switching measure implemented at a single industrial or mining and mineral production facility. This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B.1 Examples include energy efficiency measures (such as efficient motors), fuel switching measures (such as switching from steam or compressed air to electricity) and efficiency measures for specific industrial or mining and mineral production processes (such as steel furnaces, paper drying, tobacco curing, etc.). The measures may replace, modify or retrofit existing facilities or be installed in a new facility. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWh_e per year. A total saving of 60 GWh_e per year is equivalent to a maximal saving of 180 GWh_{th} per year in fuel input.

   The project activity fulfils all the requirements of the applied methodology in ensuing manner:

i. The project activity is implemented at single industrial facility i.e. at Indo Gulf Fertiliser (IGF) urea complex at Jagdishpur (Uttar Pradesh).

ii. The project activity primarily aims to increase the energy efficiency of GTG by reducing the heat rate (TJ/MWh) of GTG.

iii. The project activity retrofits the mee fogging system in existing air suction system of GTG. In addition, replaces the existing components/equipments with technologically advance components/equipments. Mee fogging system is installed in-between the air filter and gas compressor air inlet. The inlet air gets cooled as it passes through the fog created by the mee fogging system and reduces the load on the compressor. However, other energy efficiency measures significantly increase the heat transfer and increases the work done by compressor. Hence, the project activity increases the efficiency of the GTG.

iv. The aggregate energy savings from the project is less than 180 GWh_{th} per year in fuel input. The project activity at Indo Gulf Fertilisers (IGF), Jagdishpur would result in annual aggregate energy saving of 66.65 $GWh_{th.}$ The energy savings of the project would be below the equivalent of 180 GWh_{th} (60 GWh_e / per year) every year throughout the crediting period.

2. This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).

   The Natural gas (energy) used for combustion and power generation in GTG is directly measured and recorded in the plant log sheet.

3. This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).

   The impact of project activity /energy efficiency measure is directly distinguished in the heat rate of the GTG, also, no other variable directly affect the heat rate.

Thus, the project activity fulfils all the applicability conditions of the methodology.

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1 http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_61544KRBY1HQWG0JGK85N4K640

B.3. Description of the project boundary:

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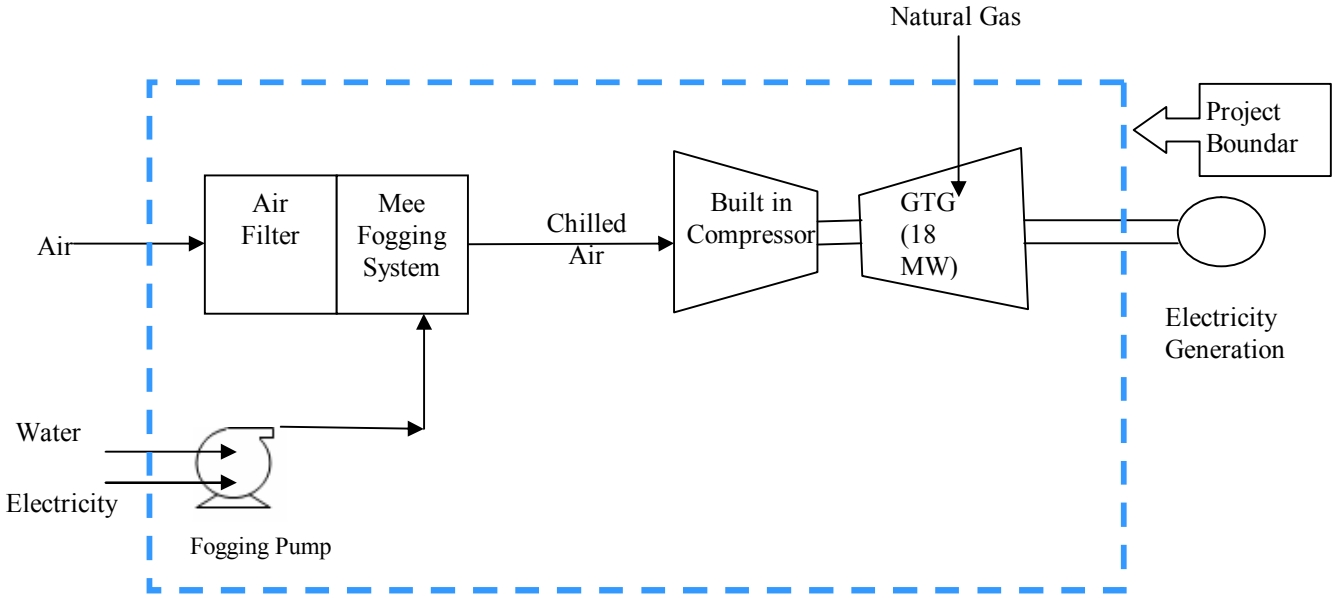
For the proposed project activity, project boundary encloses the GTG and fogging device as shown in the following diagram:



B.4. Description of baseline and its development:

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As per the Appendix B Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories for Type II – Energy Efficiency Improvement Projects, II.D. (Version 11, EB 35) Energy efficiency and fuel switching measures for industrial facilities, baseline is defined by paragraph 5, 6 and 7 as:

5. In the case of replacement, modification or retrofit measures, the baseline consists of the energy baseline of the existing facility or sub-system that is replaced, modified or retrofitted. In the case of a new facility, the energy baseline consists of the facility that would otherwise be built.

   The proposed project activity involves the retrofit of mee fogging system for inlet/suction air-cooling and retrofit of energy efficient equipments/measures in the existing GTG system. Hence, heat rate for the GTG before implementation of the project activity is considered as energy baseline.

6. In the absence of the CDM project activity, the existing facility would continue to consume energy (ECbaseline, in GWh/year) at historical average levels (EChistorical, in GWh/year), until the time at which the industrial or mining and mineral production facility would be likely to be replaced, modified or retrofitted in the absence of the CDM project activity (DATEBaselineRetrofit). From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and baseline energy consumption (ECbaseline) is assumed to equal project energy consumption (ECy, in GWh/year), and no emission reductions are assumed to occur.

   ECbaseline = EChistorical until DATEBaselineRetrofit

   ECbaseline = ECy on/after DATEBaselineRetrofit

   In order to estimate the point in time when the existing equipment would need to be replaced in the absence of the project activity (DATEBaselineRetrofit), project participants may take the following approaches into account:

   (a) The typical average technical lifetime of the equipment type may be determined and documented, taking into account common practices in the sector and country, e.g. based on industry surveys, statistics, technical literature, etc.

   (b) The common practices of the responsible industry regarding replacement schedules may be evaluated and documented, e.g. based on historical replacement records for similar equipment.

   The point in time when the existing equipment would need to be replaced in the absence of the project activity should be chosen in a conservative manner, i.e. if a range is identified, the earliest date should be chosen.

   GTG had a significant operational lifetime and was not likely to be replaced within the crediting period. Hence, in absence of the project activity, GTG would have continued to operate and leading to higher specific energy consumption (baseline). Therefore, no change is anticipated in the above-mentioned baseline, within the crediting period.

7. Each energy form in the emission baseline is multiplied by an emission coefficient (in kg CO2e/kWh). For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category I.D. For fossil fuels, the IPCC default values for emission coefficients may be used.

In the project case, thermal energy is supplied by combustion of Natural gas for power generation in GTG. Hence, to estimate the baseline and project emission, thermal energy is multiplied by IPCC emission factor of natural gas.

Date of completion: 30/01/2008

Contact Person: Mr. C.K. Datta
Indo Gulf Fertiliser,
Industrial Area Jagdishpur,
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Uttar Pradesh (India)

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

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The proposed project activity primarily aims to increase the energy efficiency of GTG system by reducing the heat rate of GTG. The proposed project activity reduces the fossil fuel consumption and subsequently reduces the anthropogenic emissions of GHG by sources below those that would have occurred in absence of the CDM project activity.

The project activity is carried out in two phases; during first phase of project activity mee fogging system is installed to cools the inlet air/suction air of inbuilt compressor of GTG. In second phase up rating of the GTG carried out by implementing various other energy efficiency measure like heat path design, replacement of fuel firing system etc. Thus, GTG would require lesser power to generate same amount of output. This leads to reduction in the heat rate of GTG, leading to fuel savings in GTG and equivalent GHG emission reductions.

In the absence of the project activity, IGF would have continued to existing GTG with higher heat rate and would have lead increase in fuel demand in the complex. This would have resulted in equivalent GHG emissions due to the combustion of additional fossil fuels in the GTG.

Barriers and Additionality

As per Appendix B "Indicative Simplified baseline and monitoring methodologies for selected small scale CDM project activity categories" of the simplified modalities and procedures for small-scale CDM project activities. The attachment A of appendix B states that project participants shall

provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

- Barrier due to prevailing Practice
- Technological Barriers
- Other Barriers

Barrier due to prevailing practice

The project activity aims to increase the energy efficiency of GTG system. The energy efficiency is achieved by reducing the heat rate of GTG. The project activity would reduce the heat rate of GTG by implementing various energy efficiency measures in phase manner. In the first phase of the project activity, IGF has installed Mee fogging system to reduce the suction air temperature this would help in increase of work done by the compressor of GTG. In second phase of project activity, other various energy efficiency measures are carried out by ultimate objective of increasing the increasing the efficiency if GTG.

The major part of total power demand of IGF fertiliser complex is catered by two no of GTG of 18MW each. In addition, small amount of power is imported from the UPSEB grid. GTG is a major contributor of power supply at IGF fertiliser complex. Hence, operation of GTG is the most critical part of IGF production process and any disturbance in operation of GTG directly affect the operation of IGF urea complex and IGF may have to suffer huge financial losses.

IGF project activity "Reduction in heat rate of Gas Turbine Generator (GTG)" involves the installation of mee fogging system and up rating of gas turbine by replacing higher energy efficient equipments/system. The up rating of the GTG is first of its kind in Indian fertiliser sector. Moreover, IGF had no prior experience to conduct the energy efficiency measure / retrofit measure in GTG. IGF has taken voluntarily initiative to achieve energy efficiency in GTG system. The project activity is not a prevailing practice in fertiliser industry in India. Therefore, IGF lacked the familiarity about the technology. In absence of any precedence of successful implementation of similar new technology based up rating, IGF has taken huge technical and financial risk.

Barrier to innovation

IGF being an energy conscious organization continuously explores possibility for achieving energy efficiency. Based on technical expertise and basic concept of engineering IGF realized that, there is potential exists to increase the heat rate of GTG by increasing the work done by the compressor

and increasing the rate of heat transfer. IGF realised that compressor is the only power consuming equipment of the GTG system and there is huge potential lies if the work output/work done by the compressor increases. Also heat rate can be further reduce by increasing the rate of heat transfer. IGF worked on the basic concept of the reducing the losses and increase in efficiency of the in-built compressor of the GTG. Based on the analysis of the previous logged performance data IGF realise that during the winter GTG works on higher efficiency as compare to other season. Taking this concept in the mind IGF has done various analyses and concluded that energy efficiency can be achieved by reducing temperature of inlet /suction air of GTG compressor. With this objective IGF explored various possibilities for suction air chilling by carrying out meticulous R&D and numerous trails and experiments. The journey of innovation started with installing a sparger pipe of holes of 1.5 mm diameter. This increased the power output of the GTG by 0.7 MW without any additional fuel (reduced specific energy consumption ratio of GTG). However, the system resulted in huge water loss of about $15m^3$/hr. Subsequently, IGF installed a sparger pipe with in house designed nozzles, for better atomization of water droplets. The system though reduced the water losses significantly with the same increase in power output comparable with initial system but still the water loss was on the higher side about 6 m^3/hr. To reduce the water losses further, IGF installed in house designed and fabricated half cone fine spray nozzles to cool the inlet air. This technology reduced the water loss to about $2.5m^3$/hr maintaining the same level on increase in the power output of GTG. To achieve more efficiency and reduce the water losses to a minimum IGF formed a cross functional team consisting of officials from various sections like Power plant, Process etc. The team spent good man hours in exploring various possible technologies and methods to chill suction air efficiently, effectively and reduce specific energy consumption ratio (increase in heat rate) of GTG. After meticulous efforts and ground work, IGF proposed to install specially designed efficient fine spray nozzles. This technology not only accomplished the objective of reducing specific energy consumption ratio of the GTG to the maximum extent (increased power output of GTG by 1.5 MW without any significant increase in additional fuel) but also reduced the water losses to a negligible amount. For this meticulous Research and Development, IGF received "National award for excellence in Energy management- 2004" in fertilizer sector from Confederation of Indian Industry (CII). IGF received the above award for implementing innovative energy saving schemes and mee fogging project was one of imperative project among the schemes.

After achieving energy efficiency in suction chilling by Mee fogging system IGF concentrated on various other parameters, which affects the performance of GTG. Power consumption and work done by the compressor, rate of heat transfer are the key parameters, which affects the heat rate and ultimately efficiency of the GTG. IGF has contacted various technology suppliers to improve the efficiency of GTG and explore the possibilities to decrease the heat rate of the GTG. Based on the discussion with various technology suppliers IGF identified that further potential exists in up rating of the GTG. The up rating of GTG involves the implementation of various other energy efficiency measures in the existing GTG system; which result in reducing the power consumption of inbuilt compressor and increasing the heat transfer in the GTG system. The ultimate objective of up rating was to reduce the heat rate of GTG and achieve energy efficiency. IGF people has spent considerable amount of man-hours on discussing various options/possibilities suggested by technology suppliers. Technology supplier various other possibilities with the existing GTG system like improving the performance of compressor by replacing the inlet guide vanes, new sealing system, also rate of heat transfer can be achieved by replacing the fuel firing system and increasing the temperature of inside chamber by redesigning of heat path etc.

After spending various man-hours and highly technical analysis of the recommendation of technology supplier, IGF task force recommended the up-rating of GTG to management. Since GTG contributes, the major part of total power requirement of urea complex IGF management was not readily agreed on the implementation of new technology measures in the GTG. The major concern of the management was that; all the recommendation of the technology supplier is based on new concept and they have not implemented elsewhere in India. In the absence of any precedence and success story, it is difficult to go ahead with the major technology up rating in GTG. Hance, IGF management was not agreed on implementation of the technology measures recommended by task force and technology supplier. After analysis of various other alternatives and IGF realise that the project activity would lead to reduce the fuel consumption of the plant and subsequently reduce the GHG emissions. Taking these environmental benefits and considering the carbon revenue benefits to mitigate the risk involved with the project, Management has taken decision to go ahead with the project activity.

Technological barriers

Since total electricity demand of IGF urea complex is catered by Two Gas turbine (18 MW each,; one operate at a time). GTG is imperative equipment and its continuous operation is very important

for salubrious operation of the urea-manufacturing complex. Any failure in GTG would significantly affect the process plant operation and IGF would incur huge production losses due to power failure. Since it is not possible for IGF to directly switch over to grid supply the failure of GTG may create critical situation. Hence, taking this in mind IGF has taken huge risk to implement the project activity. Over and above there are various other risks involved with the implementation of this innovative and novel concepts of IGF are given below:

- *Failure of water circulation pump of mee-fogging system*

The pump installed in mee-fogging system is a critical equipment of the project activity, since it pumps water to the mee-fogging system; which is placed in the suction side of inbuilt compressor. If pump fails there would be surge in inlet temperature of GTG and subsequently there would be sudden increase in volume of air handled by compressor of GTG. This scenario would create vibration in the compressor and may lead to tripping of GTG thus affecting plant operations and production.

- *Failure of mee-fogging system*

The mee-fogging system has number of fine spray nozzles. As the fog Nozzles are designed for high quality demineralised water their performance is doubtful in Indian conditions. The fog nozzles are susceptible to damage by the foreign objects in the air and mee fogging system trips then suction air chilling gets affected, there would be surge in inlet temperature of process air and subsequently there would be sudden increase in volume of air handled by compressor of GTG. This scenario would also affect GTG operation and would result in tripping of the GTG thus stopping the Urea production.

- *Failure of Nozzle*

Water at very high pressure supplied through water tubes at the end of tube Nozzles are screwed. Due to very high pressure nozzles may come out and may inter in the compressor chamber this may lead to compressor shutdown.

The malfunctioning of the Nozzle due to choking / blocking etc. would lead to spray the water in place of micro fine drops. This would increase the moisture carryover problem in the gas turbine compressor equipment and impeller. Also Proper amount of fog mass flow and proper drainage has to be maintained to minimize water build up in the duct. Excessive water can enter the air stream and can cause corrosion of the GTG components.

There is huge risk of GTG failure or capacity limitation in case of malfunctioning of modified system under abnormal condition for which system is never tested in past.

- *Failure of fuel firing system* : The fuel firing system of the GTG is entirely replaced with new nozzles and fuel firing accessories. New fuel firing system is based on the higher combustion temperature and higher pressure. At these conditions, the operation of the nozzles and fuel firing system may lead to higher carbon deposit and failure of the nozzle. This may increase the additional maintenance cost and operation cost of the turbine. Failure or malfunctioning of fuel firing system directly affect the operation of GTG and lead to stoppage of the GTG.
- *Failure of air seal:* With the up rating of the gas turbine, new air sealing system is installed with suction air system. The leakage of the air sealing system may increase the load on compressor and increase in fuel consumption of the GTG. This may also allow the foreign component in the compressor and increase the maintenance cost. This may lead to operational problem in compressor and may lead to stoppage of gas turbine.
- *Metallurgical problems*

  As a part of up rating activity IGF has decided to increase the inside temperature of the combustion chamber. Considering this, it was important to change the metallurgy of the existing equipment and replace the equipments, which can sustain at very high temperature. The new designed equipments where not tested in the field operation for such a higher temperature, specifically in the Indian climatic conditions. Hence there is always a possibility of failure of the equipment due the metallurgical problem and IGF has to suffer the huge financial and operational losses.

By implementing the project activity, IGF has faced such barriers, which would not been faced in the baseline scenario.

IGF has implemented the project activity considering that the CDM fund would cover the risk faced by the project activity. Following impacts of CDM fund are identified from the point of view of removal of barriers:

1. The CDM fund from the project would be used as additional coverage to the various risks faced by the project. The CDM revenue would help in offsetting any financial losses due to shutdown of plant, production losses etc., resulting from implementation of the project.

2. The CDM fund will stimulate R&D efforts of IGF to find methods of mitigating risks and enhance replication of such projects in the Indian fertilizer industry, to promote GHG abatement.

B.6. Emission reductions

B.6.1. Explanation of methodological choices:

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As per applied methodology AMS.II.D, no specific formula available to estimate the emission reduction due to project activity. Hence, following approach is adapted to estimating the emission reduction.

Step 01: Heat rate of the GTG is calculated from the total power generated and fuel consumption of GTG in base case and project case.

Step 02: By multiplying the heat rate in base case and total power generated by GTG in project case baseline emission is calculated. IPCC emission factor for Natural gas is used for the baseline emission calculation.

Step 03: Subsequently, project emission is calculated from the net[2] power generated by GTG in project case and project case heat rate. IPCC emission factor for Natural gas is used for project emission calculation.

The baseline parameters (total electrical energy generated by GTG, quantity of fuel consumed in GTG, NCV of fuel consumed) are monitored from April 2002 to March 2003 to estimate the baseline heat rate of GTG.

Baseline Heat Rate of GTG = 0.0146 TJ/MWh

Heat rate for GTG in the project case is calculated from project parameters (net electrical energy generated by GTG, quantity of fuel consumed in GTG, NCV of fuel consumed); which are monitored from April 2005 to March 2006.

One-year data is used for baseline and project emission calculation, since it considers all seasonal variations (summer and winter season).

The procedure applied to calculate project emissions, baseline emissions, leakage emissions and emission reductions attributable to the energy efficiency in GTG is the following:

Baseline Emissions:

[2] Net power generated arrived by excluding the 'power consumption by additional motor' from the total power generated in the project case.

Estimation of Heat Rate Base Case (HR_{BL})

$$HR_{BL} = \frac{\sum FF_{BL} \times NCV_{FF}}{P_{BL}}$$

Where:

HR_{BL} = Heat rate in base case (TJ/MWh)

P_{BL} = Power Generated in the Base case (MWh)

FF_{BL} = Fossil Fuel consumption in base case (Tonnes, SM^3)

NCV_{FF} = Net calorific value of Fossil fuel (kCal/kg, kCal/SM^3)

Baseline Emissions (BE_y)

$$BE_y = HR_{BL} \times P_{Total,PL} \times EF_{CO2,NG}$$

Where:

BE_y = Baseline emission (tCO_2 / year)

HR_{BL} = Heat rate in base case (TJ/MWh)

$P_{Total,PL}$ = Total power generation in project case (MWh)

$EF_{CO2,NG}$ = Emission factor of Natural gas (tCO_2 / TJ)

Project Emissions:

Estimation of Heat Rate Project Case (HR_{PL})

$$HR_{PL} = \frac{\sum FF_{PL} \times NCV_{FF}}{P_{Total,PL}}$$

Where:

HR_{PL} = Heat rate in project case (TJ/MWh)

$P_{Total,PL}$ = Total power generated in project case (MWh)

FF_{PL} = Fossil fuel consumption in Project case (Tonnes, SM^3)

NCV_{FF} = Net calorific value of Fossil fuel (kCal/kg, kCal/SM^3)

Project Emissions(PE_y)

$$PE_y = HR_{PL} \times P_{Net,PL} \times EF_{CO2,NG}$$

$$P_{Net,PL} = P_{Total,PL} - P_{Additional,PL}$$

Where:

PE_y = Project emission (tCO_2 / year)

HR_{PL} = Heat rate in base case (TJ/MWh)

$P_{Net,PL}$ = Net power generation in project case (MWh)

$P_{Total,PL}$ = Total power generated in project case (MWh)

$P_{Additional,PL}$ = Power consumption due t additional motors (MWh)

$EF_{CO2,NG}$ = Emission factor of Natural gas (tCO_2 / TJ)

Leakage Emissions:

As per the methodology AMS.II.D (version 11, EB 35) "If the energy efficiency technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered".

Leakage Emission(LE_y)

For the proposed project activity, neither energy efficiency equipment transferred from another project activity nor existing equipment is transferred to another project activity, hence no leakage considered.

$$LE_y = 0$$

Emission Reductions (ER_y)

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission reductions (tCO_2 / year)

BE_y = Baseline emissions (tCO_2/year)

PE_y = Project emissions (tCO_2/year)

LE_y = Leakage emissions (tCO_2/year)

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

Data / Parameter:	**P_{BL}**
Data unit:	MWh

Description:	Total electricity generated by GTG in base case. This parameter is used to calculate the heat rate in base case.
Source of data used:	TOP (FICC Document)
Value applied:	152316
Justification of the choice of data or description of measurement methods and procedures actually applied :	Total electricity generated by GTG is measured using energy meters of class 2 with an accuracy of 0.5%. This parameter is used to calculate the heat rate of GTG in baseline scenario.
Any comment:	The data will be archived until 2 years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data / Parameter:	**FF_{BL}**
Data unit:	SM^3 for NG, Tonnes for Naphtha and HSD
Description:	Quantity of fossil fuel consumption by GTG in base case
Source of data used:	TOP (FICC Document)
Value applied:	NG – 53299907 Naphtha – 7486 HSD – 22
Justification of the choice of data or description of measurement methods and procedures actually applied :	Quantity of the fuel used in measured by online fuel flow meter with integrator. The flow meter is of accuracy ±0.6%. This parameter is used to calculate the Specific energy consumption ratio of GTG in the baseline scenario.
Any comment:	The data will be archived until 2 years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data / Parameter:	NCV_{FF}
Data unit:	kcal/Sm^3 for NG, kcal/kg for Naphtha, kcal/kg for HSD
Description:	Net calorific value of fossil fuel in the base case
Source of data used:	TOP (FICC Document)
Value applied:	NG – 8458 Naphtha – 10591 HSD – 10400
Justification of the choice of data or description of measurement methods and procedures actually applied :	The NCV parameter supplied with every delivery of fuel by fuel supplier is logged in PRC Report.
Any comment:	The data would be archived until 2 years after end of the crediting period

B.6.3 Ex-ante calculation of emission reductions:

>>

Emission Reduction is calculated in the following manner:

Baseline Emissions:

Estimation of Heat Rate Base Case (HR_{BL})

$$HR_{BL} = \frac{\sum FF_{BL} \times NCV_{FF}}{P_{BL}}$$

Baseline Heat Rate (HR_{BL})for GTG= 0.0146 TJ/MWh

Baseline Emissions

$$BE_y = HR_{BL} \times P_{Total,PL} \times EF_{CO2,NG}$$

Baseline emission (BE_y) = 142391 tCO_2/year

Project Emissions:

Estimation of Heat Rate Project Case (HR_{PL})

$$HR_{PL} = \frac{\sum FF_{PL} \times NCV_{FF}}{P_{Total,PL}}$$

Project case Heat Rate (HR_{PL})for GTG= 0.0133 TJ/MWh

Project Emissions(PE_y)

$$PE_y = HR_{PL} \times P_{Net,PL} \times EF_{CO2,NG}$$

$$P_{Net,PL} = P_{Total,PL} - P_{Additional,PL}$$

Net power generation in project case = 173242 MWh

Project emission (PE_y) = 128880 tCO_2/year

Leakage Emission(LE_y)

$$LE_y = 0$$

Emission Reductions (ER_y)

$$ER_y = BE_y - PE_y - LE_y$$

Baseline Emissions(BEy)	***Project Emissions(PEy)***	***Leakage Emissions(LE_y)***	***Emission Reduction (ER_y)***
142391	**12880**	**0**	**13511**

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

>>

Year	***Estimation of Project activity emissions (tonnes of CO2e)***	***Estimation of Baseline emissions (tonnes of CO2e)***	***Estimation of Leakage (tonnes of CO2e)***	***Estimation of overall emission reductions (tonnes of CO2e)***
2008-2009	128880	142391	0	13511
2009-2010	128880	142391	0	13511
2010-2011	128880	142391	0	13511
2011-2012	128880	142391	0	13511
2012-2013	128880	142391	0	13511
2013-2014	128880	142391	0	13511

2014-2015	128880	142391	0	13511
2015-2016	128880	142391	0	13511
2016-2017	128880	142391	0	13511
2017-2018	128880	142391	0	13511
Total	**1288800**	**1423910**	**0**	**135110**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	P_{PL}
Data unit:	MWh
Description:	Total electricity generation by GTG in the project case
Source of data to be used:	Daily Electrical Report (ELE) / Electrical Energy Generation & Consumption Report
Value of data	146726
Description of measurement methods and procedures to be applied:	Total electricity generated would be measured using energy meters of class 2 with an accuracy of ±0.5%. This parameter is used to calculate the heat rate for GTG in the project scenario.
QA/QC procedures to be applied:	The parameter is monitored and logged in daily electrical report and send process department. Based on the logged data and a report consisting of the parameter is prepared by Process (MIS) Engineer in soft copy and is forwarded to CDM Coordinator through email on monthly basis. The data used is reviewed by conducting a inter department review meeting once in 6 months. The Coordinator CDM will discuss the data (received from respective departments) with CDM Team member of concerned departments. Once the data is compiled and checked, it will be handed over to Verifier (IGF official) for Verification. After data verification, Auditor (IGF official) will be informed to carry out the Audit for concerned data. The instruments used for monitoring data are calibrated by third party and calibration procedure no ISO Manual INM-P-09 is used for

	calibrating the instruments.
Any comment:	The data will be archived until 2 years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data / Parameter:	**NCV_{FF}**
Data unit:	kcal/Sm^3 for NG, kcal/kg for naphtha, kcal / kg for HSD
Description:	Calorific value of fuel used in the GTG
Source of data to be used:	Supplier report
Value of data :	NG – 8306 Naptha – 10600 HSD – 10400 The above values are for ex-ante calculations only. This will be monitored ex-post
Description of measurement methods and procedures to be applied:	Reputed Supplier data / Laboratory analysis
QA/QC procedures to be applied:	The NCV parameter supplied with every delivery of fuel-by-fuel supplier is logged in report. Based on the logged data and a report consisting of the parameter is prepared by Process (MIS) Engineer in soft copy and is forwarded to CDM Coordinator through email on monthly basis. The data used is reviewed by conducting a inter department review meeting once in 6 months. The Coordinator CDM will discuss the data (received from respective departments) with CDM Team member of concerned departments. Once the data is compiled and checked, it will be handed over to Verifier (IGF official) for Verification. After data verification, Auditor (IGF official) will be informed to carry out the Audit for concerned data. The instruments used for monitoring data are calibrated once in a year.
Any comment:	The data will be archived until 2 years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data / Parameter:	**FF_{PL}**
Data unit:	SM^3/month for NG, tonnes/month for Naphtha, tonnes/month for HSD
Description:	Quantity of fossil fuel consumed in GTG
Source of data to be used:	Daily PPU report (PPU) / Log Book / DCS Data
Value of data :	NG – 53503571 Naphtha – 8.791 HSD – 0.005788
Description of measurement methods and procedures to be applied:	Quantity of the fuel used in GTG is measured by online fuel meter with integrator. The flow meter is of accuracy ±0.6%. This parameter is used to calculate the Specific energy consumption ratio of GTG in the project scenario.
QA/QC procedures to be applied:	The parameter is monitored and logged in log books. Based on the logged data and a report consisting of the parameter is prepared by Shift in charge in soft copy and is forwarded to CDM Coordinator through email on monthly basis. The data used is reviewed by conducting a inter department review meeting once in 6 months. The Coordinator CDM will discuss the data (received from respective departments) with CDM Team member of concerned departments. Once the data is compiled and checked, it will be handed over to Verifier (IGF official) for Verification. After data verification, Auditor (IGF official) will be informed to carry out the Audit for concerned data. The instruments used for monitoring data are calibrated once in a year and calibration procedure no. INM-P-09 is used for calibrating the instruments.
Any comment:	The data will be archived until 2 years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

B.7.2 Description of the monitoring plan:

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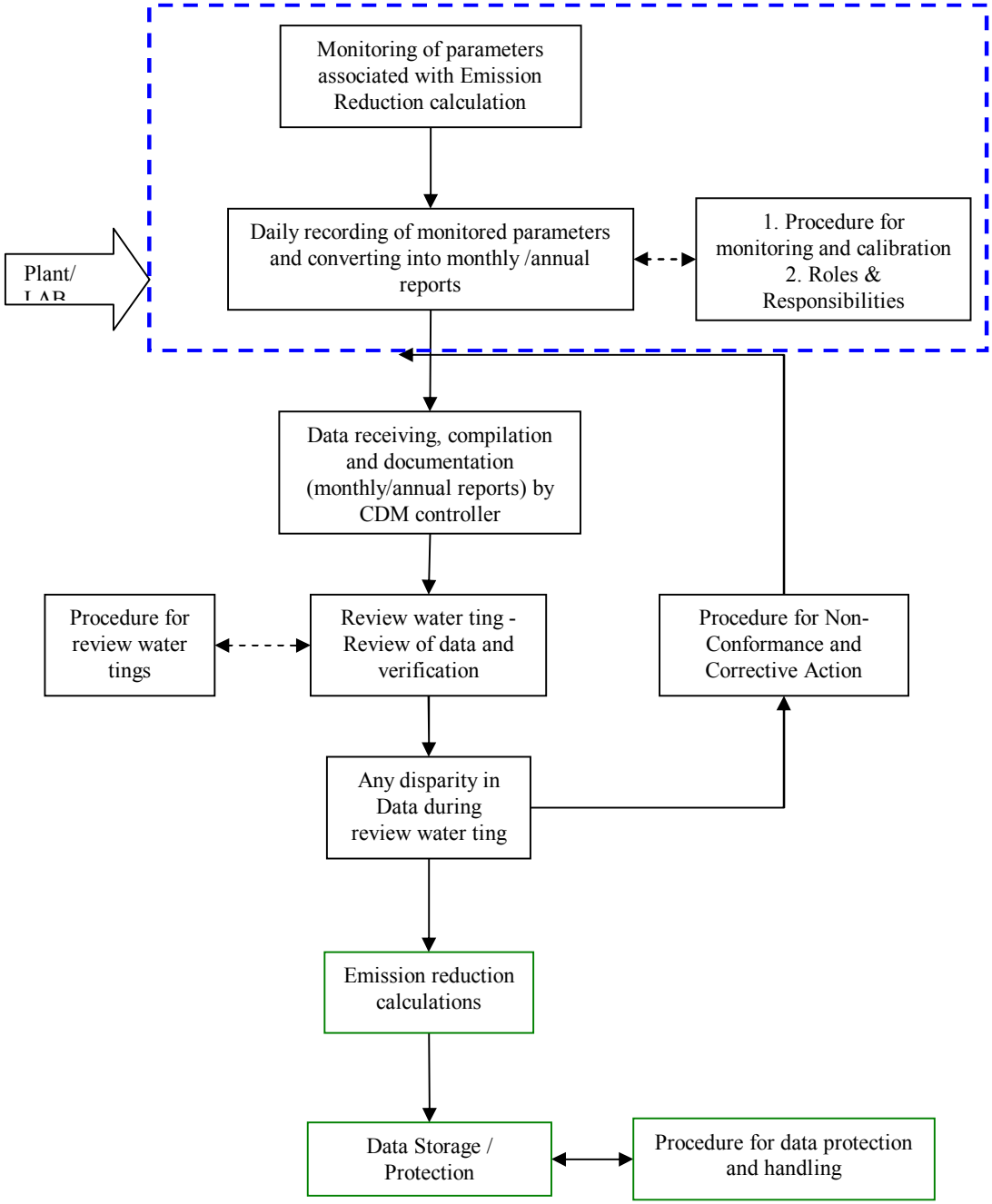
The flow chart for CDM data ring, recording and storage is given below:



The project activity falls under the Type-II Energy Efficiency Improvement Project, Subcategory: II.D. : Energy efficiency and fuel switching measures for industrial facilities. The monitoring methodology and plan as per the paragraphs 6 and 7 of the methodology are:

6. In the case of replacement, modification and retrofit measures the monitoring shall consist of:

(a) Documenting the specifications of the equipment replaced;

(b) Metering the energy use of the industrial or mining and mineral production facility, processes or the equipment affected by the project activity;

(c) Calculating the energy savings using the metered energy obtained from subparagraph (b)

7. In the case of a new facility, monitoring shall consist of:

(a) Metering the energy use of the equipment installed;

(b) Calculating the energy savings due to the equipment installed.

Since the project activity is energy efficiency project, emission reductions from the project activity mainly depends on the amount of additional electrical energy being generated by GTG after the implementation of the project. The net electrical energy generated (energy) by GTG, as well as fuel (energy use) consumed by GTG and NCV of fuel used is monitored before and after implementation of the project. Hence according to the methodology, Specific energy consumption ratio use of GTG (energy use) is monitored and additional electrical energy generated by GTG is calculated from energy use of GTG before and after implementation of the project.

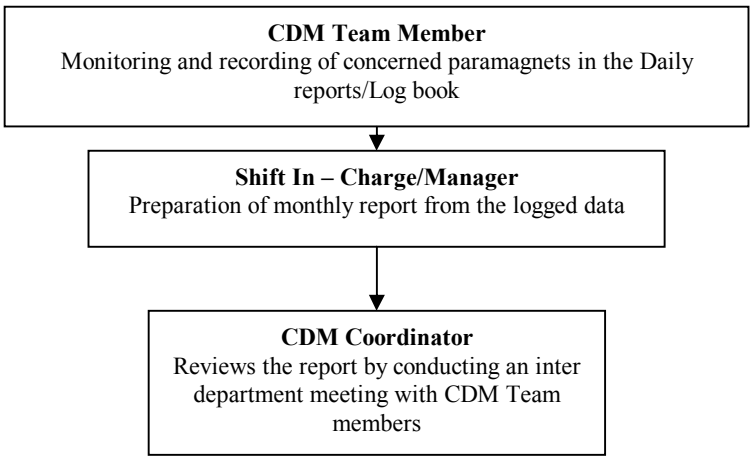
The following parameters are monitored in the project:

- Electricity Generation of GTG (MWh)
- Fuel consumption in GTG (Sm^3 or Tonnes)
- Net calorific value of fuel used in GTG (kcal/kg , kcal/Sm^3)

The parameter mentioned above would be monitored and logged in log sheet (which is a controlled ISO document) by the respective CDM Team member. Based on the logged data; a report would be prepared by Shift in charge in soft copy and forwarded to CDM Coordinator through email on a monthly basis.

The data would be reviewed by conducting a inter department review meeting. The Coordinator CDM will discuss the data (received from respective departments) with CDM Team member of concerned departments. Once the data is compiled and checked, it will be handed over to Verifier (IGF official) for Verification. After data verification, Auditor (IGF official) will be informed to carry out the Audit for concerned data.

The control panel log sheet which is ISO document is audited regularly according to ISO procedure. The organisational structure for the monitoring and recording of the project parameters is as follows:



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

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Date of completion: 30/01/2008

Contact Person: Mr. C.K. Datta

Indo Gulf Fertilisers,

Industrial Area Jagdishpur,

Dist. Sultanpur – 227 817

Uttar Pradesh (India)

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
29/03/2003

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

>>
35 year – 0 month

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

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

C.2.1. Renewable crediting period

>>
Not applicable

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

>>
Not applicable

C.2.1.2. Length of the first crediting period:

>>
Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
20/05/2008 or the date of registration, whichever occur later.

C.2.2.2. Length:

>>
10y -0m

SECTION D. Environmental impacts

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

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According to schedule-I of Environment Impact Assessment (EIA) Notification vide S.O. 1533 dated 14th September, 2006- which lists the project activities required to get Environmental clearance from Ministry of Environment and Forests (MoEF), Government of India, IGF project activity is not required to conduct EIA.

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

>>

The project activity involves reduction in Specific energy consumption ratio of the GTG by suction cooling of the inlet air of GTG. This results in fuel savings and subsequently reduces equivalent GHG emission reduction.

The project activity results in simultaneous benefits of conservation of fuel, achieving energy efficiency of the plant and has many associated environmental benefits. The environmental impacts and benefits on various parameters are discussed below:

Impact on Air

The project would not have any adverse impact on the air quality. The project activity would lead to reduction in fuel consumption of the GTG. Thus, the project activity would reduce CO_2 emissions associated with the combustion of equivalent amount of fossil fuel (NG) to cater to the fuel requirement in the absence of the project activity.

Impact on Water

The project activity reduces fuel consumption of the GTG. Thus the project activity reduces the demand for fossil fuel required in the project activity. There is no possible water pollution arising due to project activity.

Impact on Land

There is no possible soil or land pollution anticipated due to the project activity.

Impact on Ecology

There is no reserved or protected area in and around the project area. There are no endangered species located in and around the plant area and no adverse impact on the ecology of the area is anticipated due to the implementation of the project activity.

Socio – Economic Impacts

The location of project activity is inside the existing plant premises and therefore there will be no procurement of new land and hence there is no human displacement anticipated. No rehabilitation programme is therefore, required.

It is therefore evident that the project activity has no significant adverse impacts on the local and global environment.

SECTION E. Stakeholders' comments

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

>>

The project activity involves reduction in heat rate of GTG by suction cooling of the inlet air and implementing other energy efficiency measures in GTG. The project activity results in simultaneous benefits of conservation of fuel and achieving energy efficiency of the plant.

Stakeholders have been identified on the basis of their involvement at various stages of project activity. The list of relevant stakeholders includes all the organizations, which were communicated / applied to get necessary clearances. The stakeholders identified for the project are as under:

- Employees of IGF
- Ministry of Environment & Forest (MoEF), Government of India
- Uttar Pradesh Pollution Control Board (UPPCB)

IGF invited employees of various departments like Power plant, Ammonia, Urea etc for a meeting. During the meeting the various activities carried out by IGF in field of energy efficiency and environment was explained to the employees. IGF informed about techno-economical benefits of the energy efficiency project.

E.2. Summary of the comments received:

>>

IGF explained and deliberated with the employees on various features and benefits of the project activity. The employees expressed their appreciation for the project activity as it would reduce fuel consumption of GTG and the harmful effects due to associated GHG emissions.

There were no adverse comments received from stakeholders.

Equipment supplier would supply all the equipments required for the project activity as per the specification.

Ministry of Environment & Forest (MoEF), Government of India (GoI) would provide the host country approval for the project activity. IGF has received the 'Consent to operate' the plant from UPPCB.

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

>

No significant adverse comments were received from the stakeholders. However, relevant and important clauses mentioned in the project documents were considered while preparing the CDM Project Design Document.

As per UNFCCC requirement the PDD will be published at the validator's website for public comments.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	**Indo Gulf Fertiliser (A unit of Aditya Birla Nuvo Ltd.)**
Street/P.O.Box:	Jagdishpur Industrial area
Building:	
City:	Jagdishpur, District- Sultanpur
State/Region:	Uttar Pradesh
Postfix/ZIP:	227817
Country:	India
Telephone:	05361270032-38
FAX:	(05361)270165-270595
E-Mail:	chandan.datta@adityabirla.com
URL:	www.indo-gulf.com
Represented by:	
Title:	JP(Manufacturing & Operation)
Salutation:	Mr.
Last Name:	Datta
Middle Name:	Kumar
First Name:	Chandan
Department:	Manufacturing & Operation
Mobile:	+91-9889801801
Direct FAX:	+91-5361-270165/270595
Direct tel:	+91-5361-270032/38
Personal E-Mail:	chandan.datta@adityabirla.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

Annex 3

BASELINE INFORMATION

As per Section B.4. of the PDD

Annex 4

MONITORING INFORMATION

As per Section B.7.2. of the PDD

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