

**MONITORING REPORT FORM (CDM-MR) \***  
**Version 01 - in effect as of: 28/09/2010**

**CONTENTS**

- A. General description of the project activity
  - A.1. Brief description of the project activity
  - A.2. Project participants
  - A.3. Location of the project activity
  - A.4. Technical description of the project
  - A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity
  - A.6. Registration date of the project activity
  - A.7. Crediting period of the project activity and related information
  - A.8. Name of responsible person(s)/entity(ies)
- B. Implementation of the project activity
  - B.1. Implementation status of the project activity
  - B.2. Revision of the monitoring plan
  - B.3. Request for deviation applied to this monitoring period
  - B.4. Notification or request of approval of changes
- C. Description of the monitoring system
- D. Data and parameters monitored
  - D.1. Data and parameters used to calculate baseline emissions
  - D.2. Data and parameters used to calculate project emissions
  - D.3. Data and parameters used to calculate leakage emissions
  - D.4. Other relevant data and parameters
- E. Emission reductions calculation
  - E.1. Baseline emissions calculation
  - E.2. Project emissions calculation
  - E.3. Leakage calculation
  - E.4. Emission reductions calculation
  - E.5. Comparison of actual emission reductions with estimates in the registered CDM-PDD
  - E.6. Remarks on difference from estimated value

\* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

**MONITORING REPORT**  
**Version: 01 and date 07/12/2011**

**Construction of additional cooling tower cells at AES Lal Pir (Pvt) Limited. Muzaffar Garh,  
Pakistan.**

**Reference No. 2401**

**Monitoring period - 1.0 dates (first and last days included (01/05/2009 - 30/04/2011))**

**SECTION A. General description of the project activity**

**A.1. Brief description of the project activity: >>**

>>

AES Lal Pir (Pvt.) Limited, Pakistan owns and operates Lal Pir & Pak Gen power plants (two units) located near Muzaffar Garh, Pakistan. Each unit consists of a 365 MW steam turbine and cooling tower with seven cells. The purpose of this project is to utilize the latest technology to improve the heat rate of the power plants which is construction of an additional cooling tower cell for each unit's cooling tower. A better heat rate will lower CO<sub>2</sub> emissions via a reduction in the quantity of fuel required to generate electricity. So, the intention in this project activity is to reduce the CO<sub>2</sub> emission by replacing the existing technology with the latest technology.

**Project Background:** Heavy fuel oil is combusted to produce steam which rotates the rotor of the turbine in order to generate electricity. The steam is then routed through a water-cooled condenser which condenses the steam by removing the heat of vaporization. A vacuum is then produced in the steam space of the condenser through the rapid and considerable change in volume as each pound of steam condenses into water. By maintaining a vacuum in the steam condenser, the efficiency of the power plant can be increased due to the fact the greater the vacuum in the system, the greater the enthalpy drop of the steam. This allows more work to be available per kilogram of steam condensing. The vacuum reduces the back pressure upon the turbine by a considerable degree, and the work done per kg of steam during expansion is increased. This results in greater electricity production per unit of fuel input.

Cooling towers have a direct impact on the heat rate of the power plant. The heat rate is a measurement that describes how well the heat from combustion of fuel is being converted into electricity. A high heat rate indicates an inefficient use of fuel which creates higher CO<sub>2</sub> emissions. The cooling water used to condense the steam comes from the cooling towers. The cooler the water is coming from these towers, the more heat of vaporization removed during the condensing process. The result is a stronger vacuum and more work being done per unit of fuel input. Installing an additional cooling tower cell that employs the most advanced technology will result in cooling water with a lower temperature than is produced by the current cooling tower configuration. Cooler water will lower the heat rate of the system, improving the efficiency of the power plant and resulting in fewer CO<sub>2</sub> emissions.

The project was registered in May 2009. Credits are being claimed from 01/05/2009 to 30/04/2011. Total emission reductions achieved during the period were 41,081 tCO<sub>2</sub>e.

**A.2. Project Participants**

&gt;&gt;

<b>Name of Party involved (* (host) indicates a host Party)</b>	<b>Private and/or public entity(ies) project participants (*) (as applicable)</b>	<b>Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)</b>
Pakistan (host)	AES Lal Pir (Pvt) Limited.	No
Netherlands	AES Carbon Exchange Limited	No

**A.3. Location of the project activity:**

&gt;&gt;

Project location: The Project is located in southern Punjab region of Punjab Province, Pakistan near District Muzaffar Garh which is approximately 70 km from Multan.

Project longitude: 70° 59' 51" E, latitude: 30° 10' 27" N and altitude: 113 Meters

**A.4. Technical description of the project**

&gt;&gt;

**Project equipment:**

The project equipment was installed as described in the PDD. There are no deviations. The project activity used the newest available technology for cooling tower components such as the gear boxes, nozzles, fills, and fans. In specific, the nozzles installed whereof a new design which improves the distribution system of the water and helps to reduce the temperature.

**Technology:**

The project technology was installed as described in the PDD and became operational on 01/05/2009. The efficiency improvement program under the project activity consists of the following:

- ✓ Construction of additional cooling tower cells
- ✓ Installation of advanced technology
- ✓ Mechanical works including piping, connections, etc.
- ✓ Electric connection with the existing system
- ✓ Logics from DCS for new cooling tower cells
- ✓ Constant monitoring of the operation

New technologies being introduced in this project activity, of which the new cooling tower cell is a major part, bode well for technological development. These advances have come about through continuous research and development on new technology to increase energy efficiency.

The technology includes the following components:

1. The distribution system inside the cooling tower cell will use ecojet spray nozzles. This innovative nozzle is Spig patented and has been designed in order to reach the followings main goals:
  - Large square water distribution area (approximately 1 m<sup>2</sup>) in order to avoid overlap of water distribution area
  - Uniform specific water load in order to prevent air by-pass when the feed water is low
  - Self cleaning surface by means of rotating impeller
  - Anti clogging

2. The self-spacing film packing that will act as filling is constructed with slightly sloped waves and corrugated surfaces. This serves to mix the external and internal layers of water thereby considerably improving the heat and mass exchange coefficients.
3. The drift eliminators are a wave type which utilizes a series of sinusoidal shaped rows that allow for very low pressure drop losses.
4. The electric motor driving the fans is designed for rigorous cooling tower service. Motor supports are designed to transfer dynamic loads to the cooling tower structure, minimizing vibrations and allowing easy maintenance and alignment.

The fan is a multi-blade type and has the primary function of ensuring the cooling tower air volume necessary for cooling. The fan is placed on the highest section of the cell (fan deck) and is directly coupled with the gear box. The cooling tower is completed with the following items which have been designed in accordance with the most up to date safety regulations: fan deck handrails, inspection hatch, and stair and ladder.

This kind of innovative and effective energy saving measure serves to demonstrate to other companies the operational efficacy of such improvements and encourage others to adopt similar measures which will lead to further conservation of energy, fuel and environment.

By adopting this technology, energy improvement within power plants will provide local distributed generation and site-specific reliability, transmission and distribution benefits indicated below:

- Improved power quality
- Reduced fuel consumption
- Power control
- Mitigation of natural resource losses.

It is also proposed by a third party that by installing new cells with new technology the performance of the existing tower cells will be improved. As a result of this performance improvement, emissions will be further reduced

#### **Monitoring and metering equipment:**

Monitoring and metering equipment was installed as described in the PDD. The devices installed and their location is as follows:

- Net electricity Generation Metering system: It is installed on the outgoing power transmission lines in the switch yard area. An online reading is also available in the control room via the computerized system.
- Emissions Flow: CEMS analyzer is installed on the air duct near stacks to measure the flow of flue gases emitting from the stack through continuous online computer system in the control room.
- Fuel Properties: Density of fuel is monitored in the lab through density meter.
- Fossil Fuel Consumption: Fossil Fuel consumption will be recorded, which is located on the fuel supply line of boiler at ground floor. Its online consumption will be monitored in the control room through DCS.

**A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:**

&gt;&gt;

**Methodology Title:** Supply side energy efficiency improvements – generation**Methodology/Version:** AMS-ILB / Version 9**A.6. Registration date of the project activity:**

&gt;&gt;

Project activity registered in UNFCCC as on 01/05/2009.

**A.7. Crediting period of the project activity and related information (start date and choice of crediting period):**

&gt;&gt;

Crediting period: 01/05/2009 – 30/04/2016 (Renewable).

Start date: 01/05/2009

**A.8. Name of responsible person(s)/entity(ies):**

&gt;&gt;

- Mr. Farhan Javed  
Operations Manager  
Lal Pir Thermal Power plant, Muzaffar Garh. Pakistan. Ph: +92 66 2300030  
[Farhan.javed@lalpir.com](mailto:Farhan.javed@lalpir.com)
- Mr. Muhammad Farhan  
Performance Engineer  
Lal Pir Thermal Power plant, Muzaffar Garh. Pakistan. Ph: +92 66 2300030  
[Muhammad.farhan@lalpir.com](mailto:Muhammad.farhan@lalpir.com)

**SECTION B. Implementation of the project activity****B.1. Implementation status of the project activity**

&gt;&gt;

The project is in operation since May 2009. Project activity was implemented as per plan and all monitoring done in accordance with the plan as prescribed in PDD.

Following is the detail of electricity export and Fuel Consumption from 01/05/2009 to 30/04/2011.

<b>Generation &amp; Fuel Consumption Data (May 2009 to April 2010)</b>						
Month	Lal Pir		Pak Gen		Total	
	Net Gen MWh	Fuel Cons Ton	Net Gen MWh	Fuel Cons Ton	Net Gen MWh	Fuel Cons Ton
May-09	232,484	56,153	233,270	55,817	465,754	111,970
Jun-09	220,425	54,449	223,735	53,577	444,160	108,026
Jul-09	218,728	53,828	180,302	43,893	399,030	97,721
Aug-09	4,061	2,060	166,324	40,696	170,385	42,756
Sep-09	164,044	40,598	120,568	29,660	284,612	70,258
Oct-09	191,076	45,473	66,164	15,913	257,240	61,386
Nov-09	135,022	33,100	193,789	46,296	328,811	79,396
Dec-09	180,109	43,357	198,338	47,530	378,447	90,887
Jan-10	170,125	41,860	197,860	47,503	367,985	89,363
Feb-10	204,250	49,028	175,455	42,074	379,705	91,102
Mar-10	250,389	59,586	147,283	35,258	397,672	94,844
Apr-10	237,579	56,736	210,610	50,122	448,189	106,858
<b>Total</b>					<b>4,321,989</b>	<b>1,044,567</b>

<b>Generation &amp; Fuel Consumption Data (May 2010 to April 2011)</b>						
	Lal Pir		Pak Gen		Total	
Month	Net Gen	Fuel Cons	Net Gen	Fuel Cons	Net Gen	Fuel Cons
	MWh	Ton	MWh	Ton	MWh	Ton
May-10	207,885	50,083	196,256	47,021	404,141	97,104
Jun-10	190,087	47,053	166,006	40,460	356,093	87,513
Jul-10	109,268	27,443	202,609	49,990	311,877	77,432
Aug-10	16,188	4,062	26,854	6,659	43,042	10,721
Sep-10	Force Majeure Period due to flood.					
Oct-10						
Nov-10	-	-	88,752	22,477	88,752	22,477
Dec-10	53,665	12,496	158,823	38,286	212,488	50,782
Jan-11	207,752	49,019	172,588	41,216	380,340	90,235
Feb-11	155,631	37,443	87,551	21,244	243,182	58,687
Mar-11	83,426	19,768	184,882	44,693	268,308	64,461
Apr-11	187,150	44,392	43,168	10,581	230,318	54,973
<b>Total</b>					<b>2,538,541</b>	<b>614,386</b>

Data for the period 06/08/2010 to 05/11/2010 for Pak Gen and 06/08/2010 to 23/12/2010 for Lal Pir could not be collected as Plant was under shutdown/force majeure due to flood in this area. That's why data of this period excluded from the calculations of monitoring period.

#### **B.2. Revision of the monitoring plan**

>>

There has been no revision in the monitoring plan.

#### **B.3. Request for deviation applied to this monitoring period**

>>

There has been no request for deviation applied to the monitoring period.

#### **B.4. Notification or request of approval of changes**

>>

There has been no notification or request of approval of changes from the project activity as described in the registered CDM-PDD.

### **SECTION C. Description of the monitoring system**

>>

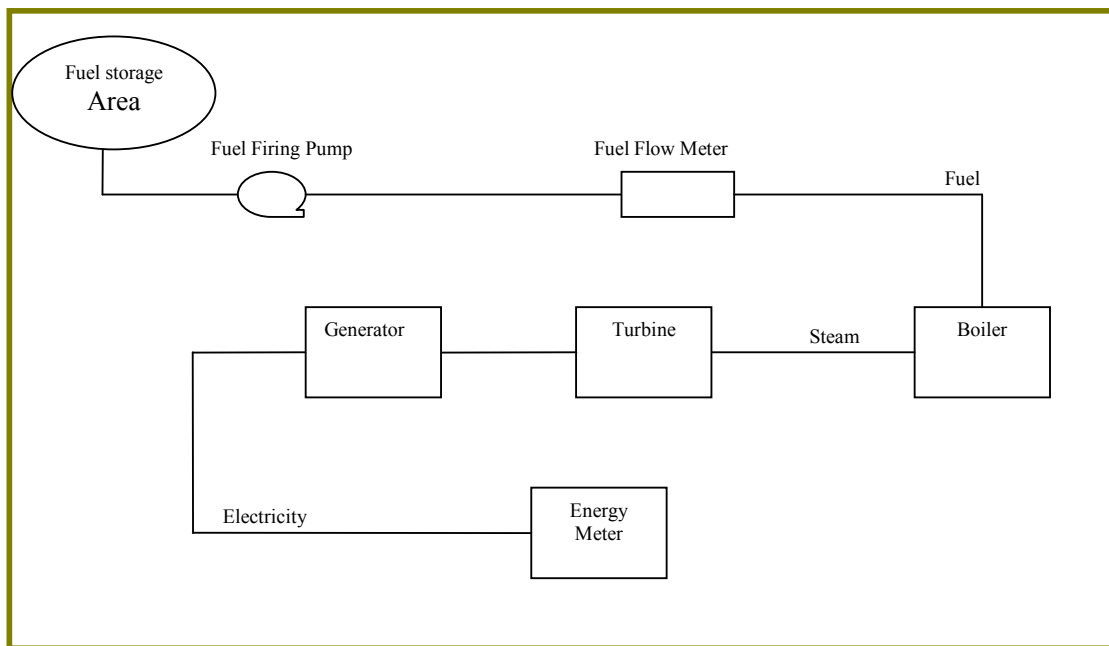
The Commercial group of Lal Pir is responsible for the collection and management of data. The group has also documented the data and sources, carried out the analysis of the data collected, and filed all the information (monitored and calculated) needed for the crediting of the emission reductions to be claimed by the project activity. The Project Developer has a team of professional engineers on site that are responsible for monitoring emissions reductions of the project activity, as well.

#### **Monitoring procedures:**

Details of monitoring procedures provided below;

- The monitoring equipment allowed automated and continuous recording and reporting of data. These readings were checked for any anomalies before being filed for future reference.
- The data were monitored and recorded by control room engineers and commercial Engineers according to the monitoring plan. Electricity records were cross verified with the Water & Power Authority of the country – WAPDA on monthly basis.

- The data were electronically archived.
- Proper management process and routine procedures are in place to ensure the quality of reports required by verification audits.
- The maintenance team calibrated and maintained the monitoring equipment on defined intervals in accordance with the high standards of the organization.



#### QA/QC roles and responsibilities:

Below are summary of QA/QC responsibilities and documentation applied for the monitored parameters:

Parameter	Documentation	Performed by	QA/QC check performed by
Yearly consumption of fossil fuel " $FC_{\text{fuel oil, y}}$ "	Daily Monitoring Report (Electronic)	OP	QA, CG
Net Electricity generation by the facility " $EG_y$ "	Daily Monitoring Report (Electronic)	OP	QA, CG
Measurement of calorific value of the fuel oil consumed " $CV_{\text{fuel oil}}$ "	Batch wise Monitoring Report (Paper) from Lab. record	OP	QA, CG
Measurement of density of the fuel oil consumed " $\rho_{\text{fuel oil}}$ "	Batch wise Monitoring Report (Paper) from Lab. record	OP	QA, CG
Month End Net electricity generated invoice to WAPDA which also includes the fuel consumption of the month	Month End Invoice	CG	CG

**CG- Commercial Group; QA - quality assurance; OP - operations**

**Training of operations and monitoring personnel:**

Following training program was conducted for the concerned persons to look after all responsibilities of project activity which are;

- Off site training from Singapore by the supplier to handle the project activity.
- Installation of the latest technology program for contractors & supervisors
- Operation of the project activity instructions/training

Training topics included in the training program were:

- CDM project overview
- System overview like engineering of gear boxes with fan
- Protections applicable on gear box operation
- Mechanism of nozzles for water distribution
- How surface area has been increased by applying latest technology measures
- Data collection & monitoring, malfunction diagnostics, fault reporting and escalation measures
- QA & QC Procedures

<b>SECTION D. Data and parameters</b>
---------------------------------------

The amount of CO<sub>2</sub> that would be emitted to the atmosphere due to the project activity and within the project boundaries can be estimated based on the technical losses multiplied by the IPCC emission coefficient for fuel oil. Project activity technical losses are calculated based on an estimated percentage increase in heat rate which will affect the efficiency of the generating unit thereby requiring less fuel input to produce the same amount of electricity production. Below is details of parameters used in the whole project activity calculations;

<b>D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors</b>	
<b>Data / Parameter:</b>	Emission Coefficient
Data unit:	tonnes CO <sub>2</sub> /TJ NCV
Description:	Emission Coefficient of CO <sub>2</sub> per TJ of NCV
Source of data used:	Table 2.3, page 2.18 in Chapter 2 Stationary Combustion IPCC 2006
Value(s) :	77 tonnes CO <sub>2</sub> /TJ NCV
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used to calculate Baseline emission.
Additional comment:	The value is fixed for the entire crediting period.

<b>Data / Parameter:</b>	<b>CV<sub>fuel oil</sub></b>
Data unit:	TJ/tonne
Description:	Net calorific value of Fuel
Source of data used:	
Value(s) :	0.0404 TJ/tonne
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used to calculate Baseline emission.
Additional comment:	The value is fixed for the entire crediting period.



<b>D.2. Data and parameters monitored</b>	
<b>Data / Parameter:</b>	FC <sub>fuel oil, y</sub>
Data unit:	TJ
Description:	Yearly consumption of fossil fuel in year “y” by the facility.
Measured /Calculated /Default:	Measured
Source of data:	Data collected during monitoring period.
Value(s) of monitored parameter:	As measured and mentioned in the spread sheet.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used to measure the baseline value/project emission.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The parameters fuel consumption is measured using the Continuous Flow meter installed in the power plant. This equipment calibrated on annual basis.
Measuring/ Reading/ Recording frequency:	The parameters are measured and recorded on hourly basis.
Calculation method (if applicable):	Data will be archived electronically and kept for the duration of the project + 2 years.
QA/QC procedures applied:	Lal Pir employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.

<b>Data / Parameter:</b>	EG <sub>v</sub>
Data unit:	MWH
Description:	Net Electricity Generated exported by plant
Measured /Calculated /Default:	Measured
Source of data:	Electricity meter installed at main 220 KV line outlet.
Value(s) of monitored parameter:	As measured and mentioned in the spread sheet.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data is used to measure the baseline value/project emission.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The parameters fuel consumption are measured using the Electricity meters no: 42001-04 & 46001-04 installed in the power plant.
Measuring/ Reading/ Recording frequency:	The parameters are measured and recorded on half hourly basis.
Calculation method (if applicable):	Data will be archived electronically and kept for the duration of the project + 2 years.
QA/QC procedures applied:	Lal Pir employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported.

## Other Data and Parameters:

Below is history of equipments used in this project activity;

Equipment	Date of		Comments
	Removal	Replacement	
Fuel Meters on both units	15/10/2010	16/10/2010	Damaged due to Flood
Energy Meters on LP	10/12/2010	10/12/2010	Damaged Due to Flood
Energy Meters on PG	10/05/2011	10/05/2011	Damaged Due to Flood

## SECTION E. Emission reductions calculation

### E.1. Baseline emissions calculation

>>

#### Baseline Emissions

The amount of CO<sub>2</sub> that would be emitted in the absence of the project activity can be estimated by referring to the UNFCCC-approved methodology AMS II.B, version 9, *Supply side energy efficiency improvements – generation* which states that the emissions baseline is the energy baseline multiplied by an emission coefficient for the fuel used by the generating unit. The energy baseline is the technical losses of energy within the project boundary. This is demonstrated by the formulas below. Also, the EF value is an IPCC default value.

Equation 1: Total baseline emissions

$$BE_y = TL_{BL,y} * EF_{CO_2, \text{fuel oil}}$$

Where:

BE<sub>y</sub> Baseline emissions in the year “y” (tCO<sub>2</sub>)

TL<sub>BL,y</sub> Technical losses in baseline scenario in year “y”

EF<sub>CO<sub>2</sub>, fuel oil</sub> Emission coefficient for fuel used by the generating unit; IPCC default value

Equation 2: Energy Baseline

$$TL_{BL,y} = FC_{\text{fuel oil}, BL,y} - EG_{BL,y}$$

Where:

FC<sub>fuel oil, BL,y</sub> Energy potential of fossil fuel consumed in baseline in year “y” (TJ)

EG<sub>BL,y</sub> Energy potential of the electricity produced by the facility in baseline scenario in year “y” (TJ)

Equation 3: Baseline Energy Conversion Efficiency

$$\eta_{BL,y} = EG_{BL,y} / FC_{\text{fuel oil}, BL,y}$$

Baseline data appended below as per PDD;

<b>Baseline Emission:</b>			
			<b>Baseline</b>
Energy Potential of Baseline Energy Produced:	MWh to TJ	TJ	12,211.2
Energy Potential of Baseline Fuel Oil Consumed:	ton to TJ	TJ	33,399.5
Technical losses:		TJ	<b>21,188.3</b>
CO2 Emission	t CO2		1,639,971.4

## E.2. Project emissions calculation

>>

The amount of CO<sub>2</sub> that would be emitted to the atmosphere due to the project activity and within the project boundaries can be estimated based on the technical losses multiplied by the IPCC emission coefficient for fuel oil. Project activity technical losses are calculated based on an estimated percentage increase in heat rate which will affect the efficiency of the generating unit thereby requiring less fuel input to produce the same amount of electricity production.

### Equation 1: Estimated Emissions after Project Implementation

$$PE_y = TL_{PJ,y} * EF_{CO2,fuel\ oil}$$

Where:

PE<sub>y</sub> Estimated emissions after implementation of project for year “y” (tCO<sub>2</sub>)  
 TL<sub>PJ,y</sub> Estimated technical losses in project scenario in year “y”  
 EF<sub>CO2,fuel oil</sub> Emission coefficient for fuel used by the generating unit; IPCC default value

### Equation 2: Technical Losses in Project Scenario

$$TL_{PJ,y} = FC_{fuel\ oil,PJ,y} - EG_{BL,y}$$

Where:

FC<sub>fuel oil, PJ,y</sub> Estimated energy potential of fossil fuel consumed in project scenario in year “y”  
 EG<sub>BL,y</sub> Energy potential of the electricity produced by the facility in baseline scenario in year “y”

### Equation 3: Estimated Fossil Fuel Consumption

$$FC_{fuel\ oil,PJ,y} = EG_{BL,y} / \eta_{PJ,y}$$

Where:

η<sub>PJ,y</sub> Estimated energy conversion efficiency in project scenario for year “y”

### Equation 4: Estimated Project Energy Conversion Efficiency

$$\eta_{PJ,y} = \eta_{BL,y} * HR_{increase,y}$$

Where:

η<sub>BL,y</sub> Energy conversion efficiency in baseline scenario in year “y”  
 HR<sub>increase,y</sub> Estimated percentage increase in heat rate as a result of project activity in year “y”

#### Equation 5: Estimated Percentage Increase in Heat Rate

$$HR_{\text{increase},y} = HR_{\text{BL},y} / HR_{\text{PJ},y}$$

Where:

HR<sub>BL,y</sub> Heat rate of generating unit in baseline scenario for year “y”  
HR<sub>PJ,y</sub> Estimated heat rate of generating unit in project scenario for year “y”

#### Equation 6: Estimated Project Emission Reductions

$$ER_y = BE_y - PE_y$$

Where:

ER<sub>y</sub> Emission reductions for year “y” (tCO<sub>2</sub>)  
BE<sub>y</sub> Baseline emission for year “y” (tCO<sub>2</sub>)  
PE<sub>y</sub> Emissions after implementation of project for year “y” (tCO<sub>2</sub>)

Project Emissions appended below;

<b>Project Emission:</b>			
Energy Potential of project Energy Produced:		TJ	12,211.2
Energy Potential of Project Fuel Oil Consumed efficiency increase:		TJ	33,255.0
Technical losses:			<b>21,043.8</b>
CO2 Emission	t CO2		1,628,792.5

#### **E.3. Leakage calculation**

>>

In accordance with AMS II.B, Ver. 9, leakage calculations are not required since the technology being employed in this project is not transferred from or to another activity.

#### **E.4. Emission reductions calculation / table**

>>

Following formulae used to calculate the emission reductions and summary in table given of all baseline and actual emission reduction calculations;

#### Equation 1: Emissions after Project Implementation

$$PE_y = TL_{\text{PJ},y} * EF_{\text{CO}_2, \text{fuel oil}}$$

Where:

PE<sub>y</sub> Emissions after implementation of project for year “y” (tCO<sub>2</sub>)  
TL<sub>PJ,y</sub> Technical losses in project scenario in year “y”  
EF<sub>CO<sub>2</sub>,fuel oil</sub> Emission coefficient for fuel used by the generating unit; IPCC default value

#### Equation 2: Technical Losses in Project Scenario

$$TL_{\text{PJ},y} = FC_{\text{fuel oil}, \text{PJ},y} - EG_{\text{BL},y}$$

Where:

FC<sub>fuel oil, PJ,y</sub> Energy potential of fossil fuel consumed in project scenario in year “y”  
EG<sub>BL,y</sub> Energy potential of the electricity produced by the facility in baseline scenario in year “y”

Equation 3: Fossil Fuel Consumption

$$FC_{\text{fuel oil,PJ,y}} = EG_{\text{BL,y}} / \eta_{\text{PJ,y}}$$

*Where:*

$\eta_{\text{PJ,y}}$  Energy conversion efficiency in project scenario for year “y”

Equation 4: Project Energy Conversion Efficiency

$$\eta_{\text{PJ,y}} = \eta_{\text{BL,y}} * HR_{\text{increase,y}}$$

*Where:*

$\eta_{\text{BL,y}}$  Energy conversion efficiency in baseline scenario in year “y”

$HR_{\text{increase,y}}$  Estimated percentage increase in heat rate as a result of project activity in year “y”

Equation 5: Baseline Energy Conversion Efficiency

$$\eta_{\text{BL,y}} = EG_{\text{BL,y}} / FC_{\text{fuel oil,BL,y}}$$

Equation 6: Percentage Increase in Heat Rate

$$HR_{\text{increase,y}} = HR_{\text{BL,y}} / HR_{\text{PJ,y}}$$

*Where:*

$HR_{\text{BL,y}}$  Heat rate of generating unit in baseline scenario for year “y”

$HR_{\text{PJ,y}}$  Heat rate of generating unit in project scenario for year “y”

Equation 7: Emission Reductions

$$ER_y = BE_y - PE_y$$

*Where:*

$ER_y$  Emission reductions for year “y” (tCO<sub>2</sub>)

$BE_y$  Baseline emission for year “y” (tCO<sub>2</sub>)

$PE_y$  Emissions after implementation of project for year “y” (tCO<sub>2</sub>)

<b>Table Project Emission Calculations (01/05/2009 to 30/04/2010)</b>				
<b>1- Baseline Emission:</b>				
			<b>Baseline</b>	<b>Actual for 01/05/2009 to 30/04/2010</b>
Energy Potential of Baseline Energy Produced:	MWh to TJ	TJ	12,211.2	15,559.2
Energy Potential of Baseline Fuel Oil Consumed:	ton to TJ	TJ	33,399.5	42,556.6
Technical losses:		TJ	<b>21,188.3</b>	<b>26,997.5</b>
Current efficiency	%		36.56%	36.56%
Emission Coefficient	t CO2/TJ		77.4	77.4
CO2 Emission	t CO2		1,639,971.4	2,089,602.8
<b>2- Project Emission:</b>				
Energy Potential of project Energy Produced:		TJ	12,211.2	15,559.2
Energy Potential of Project Fuel Oil Consumed efficiency increase:		TJ	33,255.0	42,200.5
Technical losses:			<b>21,043.8</b>	<b>26,641.3</b>
Project efficiency			36.72%	36.87%
CO2 Emission	t CO2		1,628,792.5	2,062,040.0
<b>Emission Reduction:</b>	<b>tCO2/yr</b>		<b>11,179</b>	<b>27,563</b>
<b>Improvement in project efficiency expected:</b>				
Expected Heat Rate improvement:	BTU/kWh		40	78
Baseline Heat rate due to efficiency:	BTU/kWh		9,334	9,256
<b>Efficiency Increase (after project activity):</b>			<b>0.43%</b>	<b>0.84%</b>

Table. Project Emission Calculations (01/05/2010 to 30/04/2011)				
<b>1- Baseline Emission:</b>				
			<b>Baseline</b>	<b>Actual for 01/05/2010 to 30/04/2011</b>
Energy Potential of Baseline Energy Produced:	MWh to TJ	TJ	12,211.2	9,138.7
Energy Potential of Baseline Fuel Oil Consumed:	ton to TJ	TJ	33,399.5	24,995.8
Technical losses:		TJ	<b>21,188.3</b>	<b>15,857.1</b>
Current efficiency	%		36.56%	36.56%
Emission Coefficient	t CO2/TJ		77.4	77.4
CO2 Emission	t CO2		1,639,971.4	1,227,338.0
<b>2- Project Emission:</b>				
Energy Potential of project Energy Produced:		TJ	12,211.2	9,138.7
Energy Potential of Project Fuel Oil Consumed efficiency increase:		TJ	33,255.0	24,821.2
Technical losses:			<b>21,043.8</b>	<b>15,682.4</b>
Project efficiency			36.72%	36.82%
CO2 Emission	t CO2		1,628,792.5	1,213,820.3
<b>Emission Reduction:</b>	<b>tCO2/yr</b>		<b>11,179</b>	<b>13,518</b>
<b>Improvement in project efficiency expected:</b>				
Expected Heat Rate improvement:	BTU/kWh		40	65
Baseline Heat rate due to efficiency :	BTU/kWh		9,334	9,268
<b>Efficiency Increase (after project activity):</b>			<b>0.43%</b>	<b>0.70%</b>

Total baseline emissions (01/05/2009 to 30/04/2010): 2,089,602.8 tCO2/yr.

Total project emissions (01/05/2009 to 30/04/2010): 2,062,040.0 tCO2/yr.

Total leakage: Nil

**Total emission reductions (01/05/2009 to 30/04/2010): 27,563 tCO2/yr.**

Total baseline emissions (01/05/2010 to 30/04/2011): 1,227,338.0 tCO2/yr.

Total project emissions (01/05/2010 to 30/04/2011): 1,213,820.3 tCO2/yr.

Total leakage: Nil

**Total emission reductions (01/05/2010 to 30/04/2011): 13,518 tCO2/yr.**

**E.5. Comparison of actual emission reductions with estimates in the CDM-PDD**

&gt;&gt;

This section includes a comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
<b>Emission reductions (tCO<sub>2</sub>e)</b> (01/05/2009 to 30/04/2010)	11,179	27,563
<b>Emission reductions (tCO<sub>2</sub>e)</b> (01/05/2010 to 30/04/2011)	11,179	13,518
<b>Total Emission reductions (tCO<sub>2</sub>e)</b>	<b>22,358</b>	<b>41,081</b>

**E.6. Remarks on difference from estimated value in the PDD**

&gt;&gt;

During the PDD registration, it was estimated that from this project activity total heat rate savings would be around 40 Btu/Kwh which was approximation. Because, in power plant heat rate plays very significant role in order to get the desired efficiency which is linked with capacity factor. Due to this improvement in heat rate project emission increased from estimated. In actual after project activity operation, savings in heat rate were 78 & 65 Btu/Kwh in above mentioned two monitoring periods respectively.

In second crediting period wherein 65 Btu/kwh saving achieved is less than 78 btu because in year 2010 plant was shutdown due to flood affect for almost two months and load factor remained lower.

-----



## History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
<b>Decision Class:</b> Regulatory <b>Document Type:</b> Guideline, Form <b>Business Function:</b> Issuance		