

Emissions Reductions from Capture of Waste Heat at the Culbertson Compressor Station

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Project Title	<i>Waste Heat Capture Project at Natural Gas Pipeline in Culbertson, Montana</i>
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Table of Contents

1	Project Details	3
2	Implementation Status	7
3	Data and Parameters	8
4	Quantification of GHG Emission Reductions and Removals	18
5	Additional Information	18

1 PROJECT DETAILS

1.1 Summary Description of Project

This project activity uses waste heat from the exhaust generated by a natural gas compressor station to produce zero emissions electricity. Verified Carbon Units (VCUs) are generated through the displacement of existing resources on the grid.

In the absence of this project, the waste heat generated at the compressor stations would dissipate into the atmosphere. With the implementation of this project, a major portion of the waste heat is recovered and used to produce an average of 5.5 MWs of electricity each year. The heat recovery generating station – referred to as a recovered energy generation (REG) unit – is located at compressor station #3 near Culbertson, MT along the Northern Border Pipeline. The recovered heat energy heats a thermal oil, which is then transferred and used to vaporize a fluid that expands to drive the turbine, which in turn drive a generator. The facility delivers electricity to Western Area Power Administration (WAPA) – Upper Great Plains East (UGPE) Integrated System (IS). This power control area is part of the Midwest Reliability Organization (MRO) NERC region.

Basin Electric Power Cooperative (BEPC) developed this project on a voluntary basis in anticipation of potential GHG and renewable legislation. This project was not required to meet any state renewable portfolio requirements. In addition, the monetization of the green attributes from this project was part of the justification of the economics of the project to BEPC as they have more cost effective alternatives to obtain energy from grid connected resources, absent the value of the green attributes.

1.2 Sectoral Scope and Project Type

As a grid-connected, zero emissions waste heat recovery project at a compressor station, the project activity is principally categorized under Sectoral Scope 4: Manufacturing industries. This project is not a grouped project.

1.3 Project Proponent

The project co-proponents are Ormat Technologies' subsidiary Ormat Recovered Energy Generation II (OREG II), and Basin Electric Power Cooperative (BEPC).

BEPC is a wholesale electric generation and transmission cooperative based in North Dakota that provides electricity to 2.8 million customers across 135 rural distribution companies in 9 states (Montana, Minnesota, Iowa, South Dakota, North Dakota, Colorado, New Mexico, Nebraska, and Wyoming). BEPC has entered a power purchase agreement (PPA) with the owner and operator of the recovered energy generation (REG) units, Ormat Technologies, through Ormat's subsidiary OREG II (used hence forth to refer to the owner / operator of the waste heat facility).

OREG II built the waste heat project and oversees facility operations. BEPC built the interconnection infrastructure and owns and operates the meter which measures the amount of energy that is provided to the grid by the Culbertson site.

Currently, BEPC buys energy generated from a total of eight waste heat recovery units along the Northern Border Pipeline (NBP), which travels in a south-easterly direction across Montana, North Dakota, South Dakota and Iowa as it carries natural gas from Canada to the Chicago area.

Contact information for BEPC and OREG II is:

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1.4 Other Entities Involved in the Project

Element Markets, LLC is a renewable energy development and environmental credit marketing company based in Houston, Texas. Element Markets has rights to the emissions reductions from this project for the project's crediting period, is undertaking the validation of this project, and will manage future verifications for the project site.

Contact information for Element Markets:

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1.5 Project Start Date

The date of first generation for the Culbertson project is December 17, 2009.

1.6 Project Crediting Period

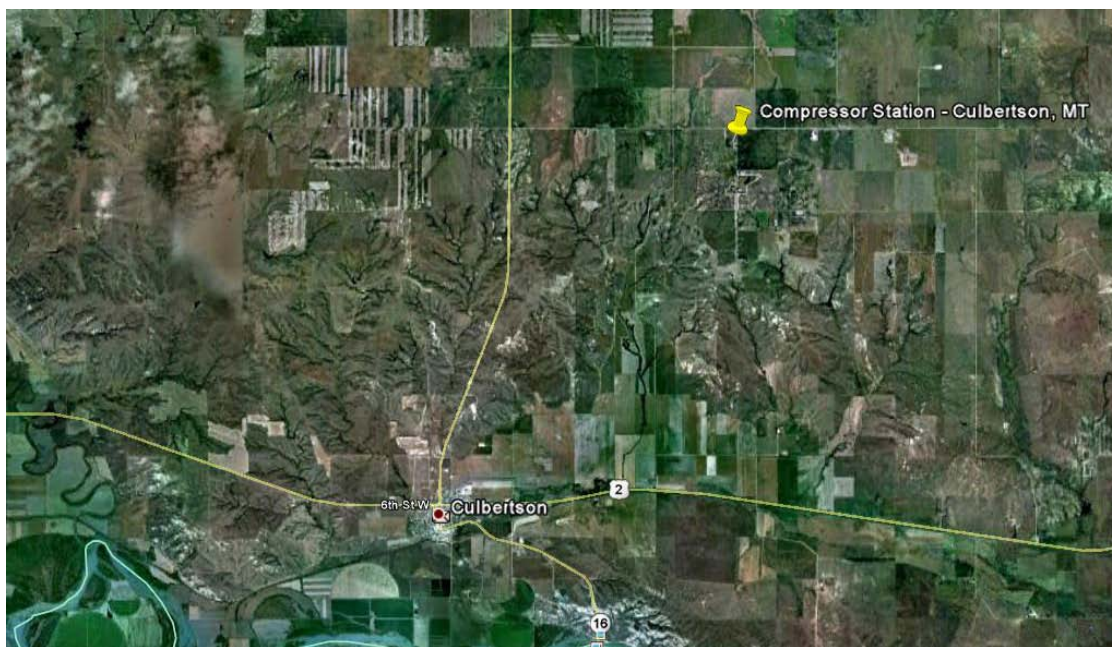
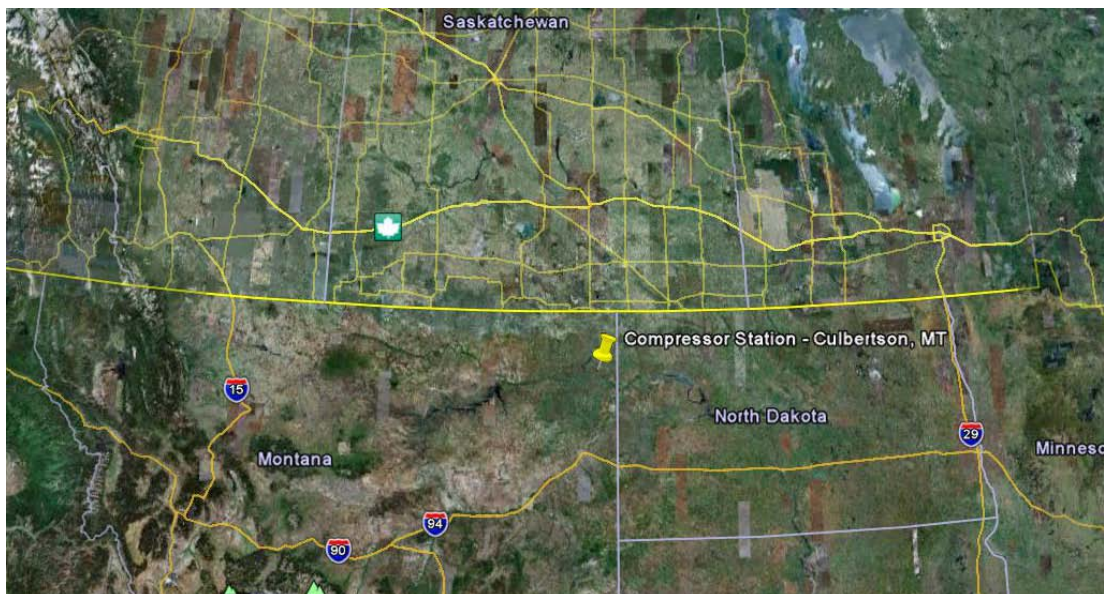
The project crediting period for the projects will commence January 1, 2010, and conclude December 31, 2019, for a total of 10 years. This verification covers the periods from January 1, 2012– December 31, 2012.

1.7 Project Location

The project is located at approximately six miles northeast of Culbertson, MT in Roosevelt County.



Culbertson, MT – Latitude: 48.144° Longitude: -104.516°



1.8 Title and Reference of Methodology

Title: AMS III.Q: Waste Energy Recovery (Gas / Heat / Pressure) projects

Reference: http://cdm.unfccc.int/filestorage/R/W/8/RW84DSJ1MY7KQZBLECHV2603IFXTP5/EB60_repan22_%20AMS-III%20Q_ver04.pdf?t=ek58bHNwYmdifDB95nIUkZtbZMtBaIZccVMF

Version: Version 4.0

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The Culbertson waste heat project has been operating since December 17, 2009. The project experienced normal operations in 2012. There were no disruptions to normal operations experienced at the compressor station.

A JemStar revenue meter measures the amount of power generated on a continuous basis; data is aggregated hourly and is reported in a MV90 report with 8760 separate data points for the number of kWh generated each hour. The Western Area Power Administration (WAPA) reads this meter on a monthly basis and reports the number of megawatt hours (MWh) generated to the Midwest Renewable Energy Tracking System (MRETS), which then issues Renewable Energy Credits (RECs) to the project's account. As noted in the project description, the project's registration in MRETS is being used for reporting purposes only – all certificates for which VCUs are being generated will be retired and screenshots will be provided to the verifiers to ensure no double counting can take place.

Per the project description, both the MV90 data and the corresponding MRETS generation records are being provided to corroborate the number of MWh generated. Please note that at times, there can be a small difference between the value reported in the MV90 report and the value in MRETS. For the period between January 1 – December 31, 2012, the average difference between the MRETS value and the MV90 value is extremely small - 0.62%.

The small difference between the MV90 data and M-RETS occurs due to the way WAPA reads the meters for the projects. WAPA's standard procedure is to use the Stop meter reading and subtract the Start meter reading to come up with the monthly reading. This reading is then multiplied by the meter's multiplier to come up with monthly kWh. The Start and Stop times occur at midnight of the beginning of each month. The MV90 hourly data is a reading for each hour multiplied by the meter multiplier. Therefore when summing up the hourly meter reads and comparing to a start and stop time meter read a variance will occur to sampling.

The project generated a total of 36,607 MWh in the period from January 1 – December 31, 2012.

2.2 Project Description Deviations

There are no deviations from the monitoring plan defined in the project description document.

2.3 Grouped Project

This is not a grouped project

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Monitoring consists of:

- o Metering the net amount of electrical energy produced – this is provided by a revenue grade meter (JemStar Serial No. 05 50 06045, Model Number JS-09R6120-43) owned by Western Area Power Administration (WAPA), a federal agency that serves as the control area operator for the UPGE. The data is acquired on a continuous basis, and is aggregated at hourly intervals. WAPA reads the meters on a monthly basis as the qualified reporting entity for BEPC and reports the information to the Midwest Renewable Energy Tracking System (MRETS). The data is reporting to MRETS for reporting purposes only. All renewable energy generation reported to MRETS will be retired so that VCUs can be issued.
- o Data Acquisition – continuous metering
- o Data Recording (Aggregation) Frequency – while the metering is continuous, the data is aggregated in HOURLY increments so BEPC has an 8760 shape of the MWhs generated every year. This information is provided in MV90 data.
- o Data Monitoring – WAPA reads the meters monthly and uploads the information into the MRETS as BEPC's qualified reporting entity. This data will be used to calculate baseline emissions. Hence, the QA / QC process is MONTHLY. By relying on data submitted by an objective third party, BEPC is allowing for further rigor on the data collection process – there is a third party entity making sure the meters are read appropriately.
- o Metering the amount of waste gas or the amount of energy contained in the waste heat
 - o We do not monitor the gross amount of energy contained in the waste heat. Since emissions reductions are calculated based on net energy delivered to grid, and an ex-ante gross generation adjustment factor is used, the gross value is not pertinent to the calculations performed.

- o Please note that certain other parameters defined in the methodology, namely temperature, pressure as well as the amount of waste heat, will not be monitored since they are not pertinent to calculating the emissions reductions.

Data Unit / Parameter:	f_{WCM}
Data unit:	Ratio
Description:	Fraction of total electricity generated by the project activity using only waste energy (as opposed to waste energy and fossil fuels).
Source of data:	Default Factors
Value applied:	1
Purpose of Data:	This factor is a default amount. Since the electricity generation is purely from the generation of waste energy, this fraction is 1.
Any comment:	N/A

Data Unit / Parameter:	$EF_{grid,CM,y}$
Data unit:	Metric tons / MWhr
Description:	The CO ₂ emissions factor for the grid displaced due to the project activity, during the year y in metric tons CO ₂ /MWh, as calculated by the combined operating margin (CM), which is a weighted average of the Simple Operating Margin and Build Margin.
Source of data:	Calculated based on Tool for calculating emissions intensity of the grid; Sources include EIA 923/860 databases, EIA fuel emissions factors
Value applied:	0.8422
Purpose of Data	Used to calculate the metric tons displaced when 1 MWhr of renewable power is placed on the grid
Any comment:	The ex-ante option is chosen

Data Unit / Parameter:	EF _{grid,OMsimple,y}
Data unit:	Metric tons / MWh
Description:	Simple Operating Margin CO2 emissions factor in year y
Source of data:	Calculated based on Tool for calculating emissions intensity of the grid; Sources include EIA 923/860 databases, EIA fuel emissions factors
Value applied:	0.98542
Purpose of Data	Used to determine the simple operating margin. The combined intensity is a weighted average of the simple operating margin and the build margin
Any comment:	The ex-ante option is chosen

Data Unit / Parameter:	EG _{m,y}
Data unit:	MWh
Description:	Net quantity of electricity generated by power unit m in year y (m includes all power units except low cost must run power units)
Source of data:	EIA 923/860 databases
Value applied:	Varies by unit
Purpose of Data:	Used to calculate the simple operating margin
Any comment:	N/A

Data Unit / Parameter:	For simple operating margin - EF _{EL,m,y}
Data unit:	Metric tons / MWh
Description:	CO2 emissions factor of power unit m in year y (tCO2 / MWh)
Source of data:	EIA 923/860 databases
Value applied:	Varies by unit
Purpose of Data	Used to calculate the simple operating margin
Any comment:	N/A

Data Unit / Parameter:	FC _{i,m,y} and NCV _{i,y}
Data unit:	MMBtus

Description:	Amount of fossil fuel type i consumed by power unit m in year y (mass or unit volume) and the Net Calorific Value (energy content) of fossil fuel type i in year y
Source of data:	EIA 923/860 databases and EIA Fuel Emissions Factors
Value applied:	Varies by unit
Purpose of Data	Used to calculate the simple operating margin
Any comment:	N/A

Data Unit / Parameter:	$EF_{CO_2,i,y}$
Data unit:	Kg CO ₂ e/MMBtu
Description:	CO ₂ emissions factor of fossil fuel type i in year y
Source of data:	EIA 923/860 databases and EIA Fuel Emissions Factors
Value applied:	Varies by fuel type
Purpose of Data	EIA fuel emissions factors are default values that have been used to prepare GHG inventories. These values are used to calculate the operating margins.
Any comment:	N/A

Data Unit / Parameter:	$EF_{grid,BM,y}$
Data unit:	Metric Tons / MWh
Description:	CO ₂ emissions factor of fossil fuel type i in year y
Source of data:	Calculated using Option A2 for simple OM, but including all units as defined in the methodology. EIA 923/860 databases and EIA Fuel Emissions Factors
Value applied:	0.4126
Purpose of Data	This factor is the build margin. The combined margin is a weighted average of the build and operating margin.
Any comment:	N/A

Data Unit / Parameter:	For Build Margin - $EF_{EL,m,y}$
Data unit:	Metric tons / MWh
Description:	CO2 emissions factor of power unit m in year y (tCO2 / MWh)
Source of data:	EIA 923/860 databases
Value applied:	Varies by unit
Purpose of Data	Used to calculate the build margin factor. Calculated using EIA 923 / EIA 860 databases and EIA Fuel emissions factors, based on Option A2 as described under the Simple OM.
Any comment:	This factor uses the power generation efficiency factor and the CO2 emissions factor of fossil fuel type l in year y.

Data Unit / Parameter:	For Build Margin - $n_{m,y}$
Data unit:	MMBtus / MWh
Description:	Average net energy conversion efficiency of power unit m in year y
Source of data:	Default table, Annex 1
Value applied:	Varies by unit
Purpose of Data	Used to calculate the build margin factor. This is required by the Tool for the option chosen.
Any comment:	N/A

Data Unit / Parameter:	$TDL_{j,y}$
Data unit:	Default Factor
Description:	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data:	Tool to calculate baseline, project and/or leakage emissions
Value applied:	20%
Purpose of Data	This is a default factor used to account for the line losses associated with consuming grid connected power
Any comment:	N/A

Data Unit / Parameter:	CF _{historical, Culbertson}
Data unit:	Percentage
Description:	Ratio of mean daily horsepower hours generated over maximum theoretical horsepower hours feasible at the Culbertson compressor station
Source of data:	Mean daily horsepower hours are based on BEPC's historical data collected over 32 months at the compressor station. Maximum theoretical horsepower hours is based on the conservative assumption that the Northern Border Pipeline has a 40,000 hp turbine in place at Culbertson. This information is derived from the Gas Technology Institute's report about the BEPC and OREG waste heat projects.
Value applied:	0.678462
Purpose of data	This measure captures the historical capacity factor that measures how much energy was available at each compressor station. It is based on data which was used to assess the technical feasibility of the project at the Culbertson Site. It is used to calculate the f_{cap} factor.
Any comment:	N/A

Data Unit / Parameter:	Gross Adjustment Factor
Data unit:	Percentage
Description:	Median of historical monthly data of percentage by which gross generation exceeds net generation at Compressor Station #3.
Source of data:	OREG II readings at CS3 since its start date – historical data. OREG II data includes gross generation, net generation and parasitic load.
Value applied:	15.53%
Purpose of Data	This measure captures the historical capacity factor that measures how much energy was available at each compressor station. It is based on data which was used to assess the technical feasibility of the project at the Culbertson Site. It is used to calculate the f_{cap} factor.
Any comment:	N/A

3.2 Data and Parameters Monitored

Data Unit / Parameter:	EG _{i,j,2012}
Data unit:	MWh
Description:	The quantity of electricity supplied to the recipient (in this case the grid) by the generator that in the absence of project activity would have been sourced from i (MRO) grid in MWh in year y (2012 in this case).
Source of data:	Project activity revenue meters at the Culbertson substation
Description of measurement methods and procedures to be applied:	A project activity revenue meter at the Culbertson substation.
Frequency of monitoring/recording:	Monthly
Value Monitored:	EG _{i,j,2012} : 36,607 MWh
Monitoring equipment:	The project has a revenue quality meter (JemStar Serial No. 05 50 06045, Model Number JS-09R6120-43) which provides information for all test, measurement, and project operating equipment on or before the start of project operations. WAPA installed this meter on 12-9-2009.
QA/QC procedures to be applied:	A meter test was conducted May 4, 2010. Per the interconnection agreement, and the WAPA PGPR Meter policies, WAPA conducts subsequent tests and calibrations every 3-5 years, hence no test was conducted for calendar years 2011 and 2012 (An attestation for 2012 is provided stating that no meter calibrations were conducted during CY 2012). The meter is deemed to be functioning within acceptable parameters.
Calculation method:	Meter readings
Any comment:	N/A

Data Unit / Parameter:	CF _{actual, Culbertson} for 2012
Data unit:	Percentage
Description:	Total Generation in MWh * 1.1553 / (7.5 * 8760)
Source of data:	Project activity revenue meter at the Culbertson and the gross adjustment factor calculated above.
Description of measurement	A project activity revenue meter at the Culbertson

methods and procedures to be applied:	substation.
Frequency of monitoring/recording:	An annual calculation will be made based on total electricity generated at the site
Value applied:	$CF_{\text{actual, Culbertson}}$ for 2012: 64.37%
Monitoring equipment:	The project has a revenue quality meter (JemStar Serial No. 05 50 06045, Model Number JS-09R6120-43) device which provides information for all test, measurement, and project operating equipment on or before the start of project operations. WAPA installed this meter on 12-9-2009.
QA/QC procedures to be applied:	A meter test was conducted May 4, 2010. Per the interconnection agreement and the WAPA PGPR Meter policies, WAPA conducts subsequent tests and calibrations every 3-5 years, hence no test was conducted for calendar years 2011 and 2012 (An attestation for 2012 is provided stating that no meter calibrations were conducted during CY 2012). The meter is deemed to be functioning within acceptable parameters.
Calculation method:	Meter readings and formula above
Any comment:	N/A

Data Unit / Parameter:	$f_{\text{cap, Culbertson,2012}}$
Data unit:	Ratio
Description:	$f_{\text{cap, Culbertson,2012}} = \min \{1, 0.678462 / CF_{\text{actual,Culbertson,2012}}\}$
Source of data:	$CF_{\text{historical,Culbertson}}$ is calculated to be 0.678462 based on the average versus theoretical maximum daily horsepower hours at the compressor station. $CF_{\text{actual,Culbertson}}$ will be based on the gross amount of electricity generated and delivered to the grid in 2012, which is calculated as the net amount of electricity delivered to the grid times the gross generation adjustment factor.
Description of measurement methods and procedures to be applied:	A project activity revenue meter at the Culbertson substation.
Frequency of monitoring/recording:	An annual calculation will be made based on total electricity generated at the site
Value applied:	$f_{\text{cap, Culbertson,2012}} = 1$
Monitoring equipment:	The project has a revenue quality meter (JemStar Serial

	No. 05 50 06045, Model Number JS-09R6120-43) device which provides information for all test, measurement, and project operating equipment on or before the start of project operations. WAPA installed this meter on 12-9-2009.
QA/QC procedures to be applied:	A meter test was conducted May 4, 2010. Per the interconnection agreement, and the WAPA PGPR Meter policies, WAPA conducts subsequent tests and calibrations every 3-5 years, hence no test was conducted for calendar years 2011 and 2012 (An attestation for 2012 is provided stating that no meter calibrations were conducted during CY 2012). The meter is deemed to be functioning within acceptable parameters.
Calculation method:	Meter readings and formula above
Any comment:	N/A

Data Unit / Parameter:	$EC_{PJ,j,2012}$
Data unit:	MWh
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr), 2012 in this case
Source of data:	Project activity revenue meters at the Culbertson substation
Description of measurement methods and procedures to be applied:	Station services consumption will be derived from billing statements provided monthly by Sheridan Electric Cooperative in whose service territory this project is located, and to whose distribution lines the project interconnects
Frequency of monitoring/recording:	Monthly
Value applied:	$EC_{PJ,j,2012} = 12.036$ MWh
Monitoring equipment:	Sheridan Electric Cooperative invoices
QA/QC procedures to be applied:	Copies of Monthly Invoices submitted by Sheridan Electric Cooperative
Calculation method:	Not calculated, provided in meter data
Any comment:	N/A

Data Unit / Parameter:	$PE_{EC,2012}$
Data unit:	Metric Tons

Description:	Project emissions from electricity consumption in year y (tCO ₂ / yr)
Source of data:	Project activity revenue meters at the Culbertson substation
Description of measurement methods and procedures to be applied:	Station services consumption will be derived from billing statements provided monthly by Sheridan Electric Cooperative in whose service territory this project is located, and to whose distribution lines the project interconnects. After MWh consumed is obtained, the parameter will be calculated using the following formula: $PE_{EC,y} = \sum EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y})$
Frequency of monitoring/recording:	Monthly
Value applied:	$PE_{EC,2012} = 12.2$
Monitoring equipment:	Sheridan Electric Cooperative invoices
QA/QC procedures to be applied:	Copies of Monthly Invoices submitted by Sheridan Electric Cooperative
Calculation method:	The total number of MWhrs consumed at each site * 0.8422 metric tons /MWh * (1+20% transmission losses)
Any comment:	N/A

3.3 Description of the Monitoring Plan

The monitoring plan includes data monitoring, regular equipment maintenance and calibrations, and data management/archiving. Overall responsibility for the accurate measurement and archival of generation information is managed by BEPC. The parameters laid out in section 3.1 above will be monitored and the associated data will be aggregated and reported according to the following procedures.

- o Data Management and Archiving: Generation data is archived electronically. Electricity generation is measured continuously, aggregated hourly, and recorded monthly.
- o Metering Devices: The project has a revenue grade meter, (JemStar Serial No. 05 50 06045, Model Number JS-09R6120-43). This meter generated MV90 data on an hourly basis. The MV90 data is the basis of all invoicing and is used to measure baseline emissions. Note that this meter is read by WAPA on a monthly basis and data is submitted to the MRETS registry, where the MWhrs are considered “renewable energy credits”. An MRETS report with monthly generation is provided. In order to avoid double counting of environmental attributes, all MWhrs generated in MRETS have been retired to avoid double counting.
- o Calibration Log: As outlined in the Interconnection Agreement, WAPA owns the revenue meter and is responsible for all testing and calibration of the meter. A meter test was

conducted May 5, 2010. Per the interconnection agreement, and the WAPA PGPR Meter policies, WAPA conducts subsequent tests and calibrations every 3-5 years, hence no test was conducted for calendar years 2011 and 2012 (An attestation for 2012 is provided stating that no meter calibrations were conducted during CY 2012). The meter is deemed to be functioning within acceptable parameters.

- o Extraordinary Events: No extraordinary events or unscheduled outages took place this year.

Monitoring records will be retained for 12 years (two years past the project's crediting period of 10 years).

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

$$BE_{elec,2012} = f_{cap,2012} * f_{WCM} * EG_{i,j,2012} * EF_{Elec,i,j,2012}$$

$$BE_{elec,2012} = 1 * 1 * 36,607 * 0.8422 = 30,830 \text{ metric tons}$$

4.2 Project Emissions

$$PE_{EC,2012} = EC_{PJ,j,2012} * EF_{EL,j,2012} * (1 + TDL_{j,2012})$$

$$PE_{EC,2012} = 12.04 * 0.8422 * (1+0.2) = 12.2 \text{ metric tons}$$

4.3 Leakage

No leakage is considered as the equipment being utilized in the project activity is not transferred from outside the boundary to the project activity. Ormat, the project developer, installed new, original equipment at this site to generate the emissions reductions, and has provided an attestation for the validation process to that effect. Hence, we do not consider leakage here.

4.4 Summary of GHG Emission Reductions and Removals

Emissions Reductions (2012) = Baseline Emissions – Project Emissions = 30,830 – 12.2 = 30,818 metric tons.

5 ADDITIONAL INFORMATION

None