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

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Table of Contents

Project Details	*Page 3*
Application of Methodology	*Page 11*
Quantification of Emissions Reductions and Removals	*Page 33*
Monitoring	*Page 45*
Environmental Impact	*Page 55*
Stakeholder Comments	*Page 55*

1 PROJECT DETAILS

1.1 Summary Description of the 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 #12 near Garvin, MN 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.

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Project Overview	
Nameplate Capacity	Facilities with a nameplate capacity of 7.5 MW and contract capacity of 5.5 MWs. On average the unit is expected to produce 5.5 MWs of energy; it has been oversized to 7.5 MW to accommodate peak generation.
Location	Garvin, MN
Commercial Operation Date	Garvin - October 21, 2009
Capacity Factor/MWh per year	50 – 70% 2010 Production resulted in 37,766 MWh total produced, representing an average of 57% based on the projects' nameplate capacity of 7.5%.
Project Area under Lease	The facility is hosted by the Northern Border Pipeline and uses roughly 1 acre of the compressor station grounds.
Project Interconnection	The Garvin facility interconnects with the East River Amiret to Russell 69 kV sub-transmission line, which in turn interconnects to the WAPA grid at the Marshall Substation.
Turbine Technology	Ormat Turbines
Turbine Warranty	1 year

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's 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 Garvin 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.

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1.5 Project Start Date

The date of first generation for the Garvin project is October 21, 2009. Please see attachment #32, which contains MV90 meter readings for supporting information.

1.6 Project Crediting Period

The project crediting period for the projects will commence January 1, 2010, and conclude December 31, 2014, for a total of 5 years

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	X
Mega-project	

Years	*Estimated GHG emission reductions* or removals (tCO2e)
2010	31.765.35
2011	31.765.35
2012	31.765.35
2013	31.765.35
2014	31.765.35
Total number of crediting years	5
Total Estimated ERs	158,826.76
Average Annual ERs	31.765.35

1.8 Description of the Project Activity

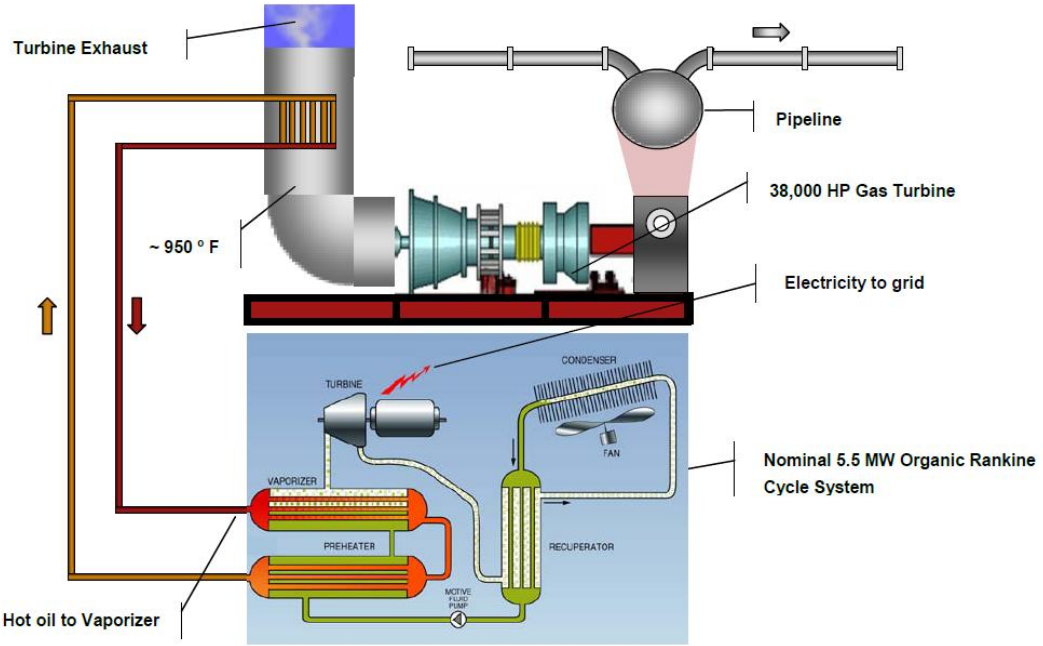
Project Structure

The OREG II projects include four identical waste heat capture installations undertaken at four separate compressor stations along the Northern Border pipeline: 1) The Zeeland project at Compressor Station # 8 (online date of December 2008); 2) the Manning project at Compressor Station # 5 (online date of January 2009); 3) the Garvin project at Compressor Station # 12 (online date of October 21, 2009, seeking VCS registration); and 4) the Culbertson project at Compressor Station #3 (also seeking VCS registration). Since the earlier projects came online over two years ago, they are not eligible for VCS. Please note that the Culbertson site is a separate VCS project and is seeking registration as well.

The Garvin project generates zero emissions energy by using waste heat generated by a compressor station along the Northern Border pipeline. This emissions-free electricity displaces Basin's use of grid connected resources to generate emission reduction credits. The project has a life of approximately 25 years.

The Technology:

This project use specially adapted geothermal technology to recover energy and generate electricity from waste heat. The REG unit uses the hot exhaust gases (the Waste Energy Carrying Medium, or WECM) from the compressor station to generate electricity. The compressor stations are driven by natural gas-fuelled turbines with a horsepower of 35,000-40,000. The exhaust temperature of the gas-fuelled turbine is between 800-900 degrees Fahrenheit and that exhaust heat is recovered using heat exchangers installed on the exhaust stack.



The Recovered Energy Generation (REG) system is a thermodynamic Rankine Cycle, and uses a non-freezing, ozone benign organic working fluid, pentane. The heat in the exhaust is used to heat an intermediate fluid, which is then used to heat the OEC working fluid in the secondary heat exchanger.

- First, the working fluid is pumped from low to high pressure.
- Then the high pressure liquid enters a boiler (vaporizer) where it is heated at the constant pressure by an external heat source to become a saturated vapor.
- The superheated vapour expands through a turbine to generate power output. This decreases the temperature and pressure of the vapour.
- The vapour then enters the condenser where it is cooled at constant pressure to become a saturated liquid. This liquid then re-enters the pump and the cycle repeats.

The nameplate capacity of the generator at the compressor station is 7.5 MWs, with average output expected to be 5.5 MWs. The generated capacity varies greatly depending on flow of gas in the pipeline (which affects the compressor station operations and the amount of waste heat generated). The ambient temperature also plays a key role, as it affects the parasitic fan loads at the compressor station, and the net amount of power provided to the grid.

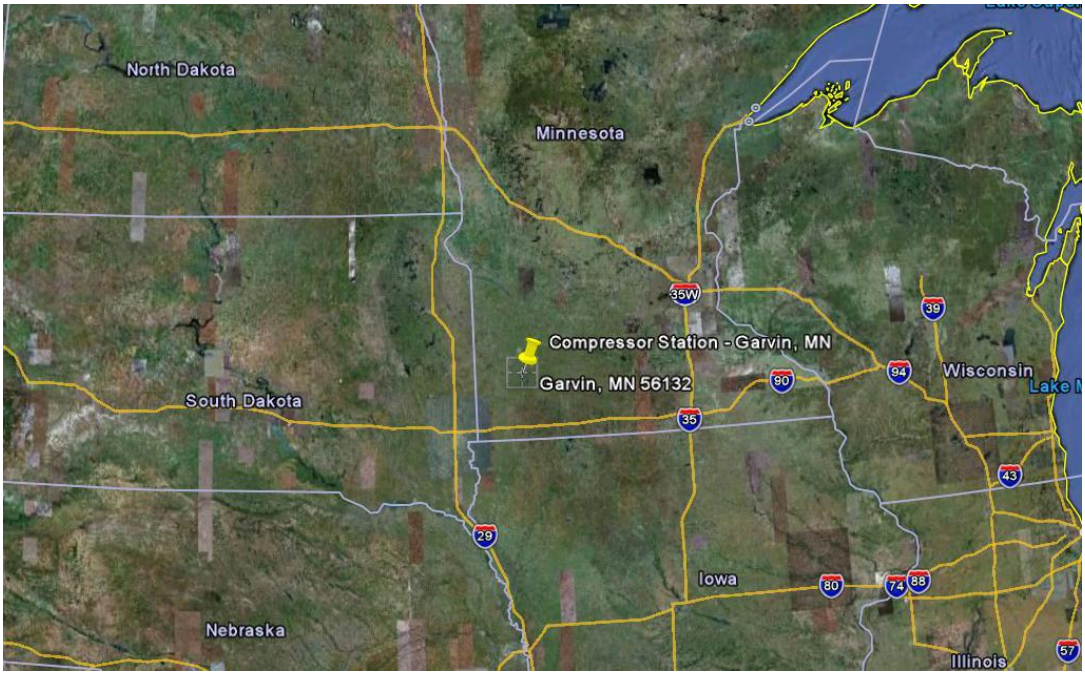
This project provides zero emissions electricity by using a waste stream and generates GHG offsets by displacing other grid connected resources.

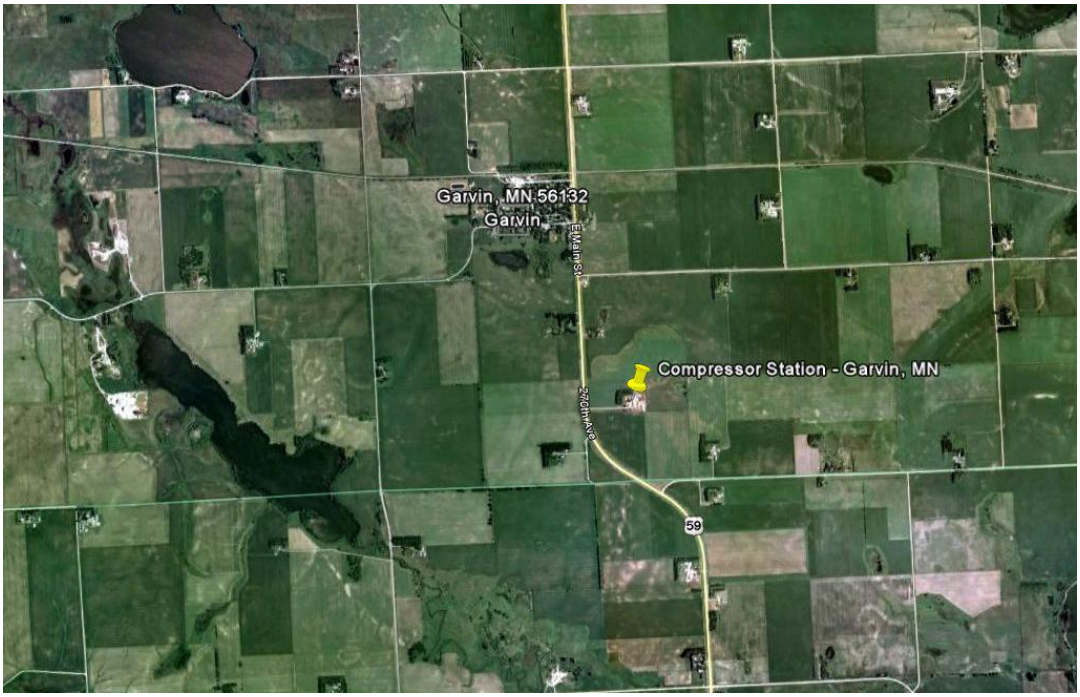
The following video provides additional information about the projects: http://www.youtube.com/watch?v=5do48iO1ZxY&feature=related.

1.9 Project Location

The compressor station is located approximately one mile southeast of Garvin, MN in Lyon County.

Garvin, MN – Latitude: 44.2° Longitude: -95.8°





1.10 Conditions Prior to Project Initiation

Prior to project initiation, the compressor station emitted exhaust heat into the atmosphere. This project uses a waste exhaust to generate power – no additional GHG emissions are being

created so as to be reduced by this project activity. GHG reductions are generated through the displacement of grid connected resources.

In addition, the run time for the compressor station is determined by the amount of gas scheduled and delivered by the shippers along the Northern Border pipeline. Neither BEPC, OREG II or even the owners of Northern Border pipeline can directly influence the capacity utilization of the pipeline, run time of the compressor stations, and the resulting waste exhaust. The project uses whatever waste heat is generated, with no ability to influence compressor station output.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

This project was constructed in accordance with the state laws of Minnesota. The pipeline and OREG II notified the Minnesota Pollution Control Agency and received confirmation that no permitting was required. Air dispersion modelling was required, and performed in a satisfactory manner.

OREG II acquired all necessary permits to construct the project as part of the PPA.

[redacted] the PPA between BEPC and OREG II required OREG II to complete the necessary permitting. Please refer to Attachments #1 – Garvin PPA. The specific language states: [redacted]

BEPC arranged the grid interconnection studies and obtained the necessary transmission rights.

1.12 Ownership and Other Programs

1.12.1 Proof of Title

Ormat Technologies' wholly owned subsidiary OREG II owns the project system at the Garvin site. OREG II owns rights to the waste heat from the pipeline and is using the medium to produce electricity, which is being sold to BEPC under a power purchase agreement. BEPC constructed and owns the interconnection infrastructure and owns the meter which measures the net amount of energy produced. BEPC purchases all of the power generated from OREG II. BEPC initially held the rights to the waste heat at these sites and negotiated a Power Purchase Agreement (PPA) with OREG II to develop and own this facility. BEPC assigned its rights to the waste heat to OREG II as part of the project development process. BEPC is purchasing the power from OREG II and has rights to all environmental attributes associated with the power.

[redacted] the PPA between BEPC and OREG II states (Attachment #1):

[redacted]

[redacted]

1.12.2 Emissions Trading Programs and Other Binding Limits

The facility is not subject to any emissions trading programs or binding limits. Credits from these projects will not be used to meet compliance for another emissions trading program or to meet binding limits on GHG emissions.

1.12.3 Participation under Other GHG Programs

The project is not registered in any other GHG program.

1.12.4 Other Forms of Environmental Credit

The project is eligible to receive voluntary Renewable Energy Credits (RECs). It is currently registered in MRETS (the Midwest Renewable Energy Tracking System), a tracking registry to record the generation of renewable energy MWh. BEPC does not plan to generate RECs for environmental attributes that are claimed as Voluntary Carbon Units (VCUs). The facility will remain in MRETS for reporting purposes only. RECs associated with the projects will be retired in MRETS so that VCUs may be issued in accordance with the mechanism described below.

A third party, WAPA, reports the number of MWh generated each month to MRETS, which assigns unique serial numbers for each MWh. For the creation of VCUs, the MWh for which VCUs are being claimed will be retired in the system and the reason for doing this (VCU creation) will be documented in the system. A screenshot of the retirement will be provided during the verification process. The retirement of these credits and subsequent identification of the reason will ensure that those RECs will not be double sold, and that VCUs can be created with confidence. A sample screenshot is provided below:

1.12.5 Projects Rejected by Other GHG Programs

The project has neither applied for nor been denied acceptance under any other GHG program.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

This project is expected to produce energy from the use of waste heat, with less than 60,000 metric tons of reductions expected annually. It also meets the other criteria of the AMS III.Q methodology, as discussed in greater detail in Section 2.2 below.

Leakage Management

Per the methodology, no leakage is applicable because new / original equipment was put into place at each site.

Commercially Sensitive Information

Commercially sensitive information includes:

- PPA prices, duration, terms and conditions
- Certain OREG II Operating Data and Manufacturer's Specifications
- Certain avoided cost data and long term coal prices and escalation forecasts
- Load Forecasts and Basin future Renewable Energy Requirements (all information derived from BEPC's 2007 Power Supply Analysis)
- All financial metrics

Further Information

None.

2 APPLICATION OF METHODOLOGY

2.1 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=ek58bHNwYmdifDB95nlUkZtbZMtBalZccVMF

Version: Version 4.0

2.2 Applicability of Methodology

The AMS III.Q methodology is applicable here. The chart below depicts the eligibility criteria defined by the methodology and how this project complies:

Technology / Measure	Project
The category is for project activities that utilize waste gas and/or waste heat at existing facilities as an energy source for: 1) cogeneration; 2) generation of electricity; 3) direct use as process heat; 4) generation of heat in elemental process; 5) generation of mechanical energy.	This project activity uses waste heat at an existing facility (the compressor station) as an energy source for the generation of electricity.
The recovery of waste gas / heat / pressure should be a new initiative.	The recovery of the waste heat is a new initiative and no waste heat was recovered prior to the implementation of the project activity.
Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually	The electricity production at the Garvin site will result in emissions reductions less than or equal to 60,000 metric tons of CO2e per year for each site. The Garvin site is expected to produce 31,765 metric tons in reductions. (Please See Attachment #14).
The category is applicable under the following conditions: Energy produced with the recovered waste gas / heat / pressure should be measurable Electricity generated in the project activity may be exported to the grid, or used for captive purposes. The emission reductions are claimed by the generator of energy using waste energy The waste gas/heat/pressure utilized in the project activity would have been flared or released into the atmosphere in the absence of the project activity. This shall be proved by one of the following options: Direct measurements Energy balance	This project meets all conditions required: The energy is measured via utility grade meters. The energy is exported to the grid The emissions reductions have been assigned by the owner of the generation equipment to the power purchaser via a power purchase agreement (PPA) The waste heat was previously released into the atmosphere in the absence of the project activity. Evidence of this is provided based on presentations made to members of BEPC to explain and obtain approval for the project activities, which includes schematics of the facility, and pictures (see Attachment #3 – Waste Heat Project Advantages). In addition, an energy and heat balance is attached. (See

Energy bills Process Plant manufacturer's original specifications	Attachment #4 – Heat Balance Table).

2.3 Project Boundary

AMS III.Q requires the project boundary to include:

- The industrial facility where the waste heat is generated: this includes the compressor station, which is owned and operated by Northern Border Pipeline.
- The facility where the electricity is generated (Garvin)
- The facilities where the energy is exported (in this case the MRO grid)

Therefore, the Project Electricity System includes: Compressor Station; Ormat Waste Heat Capture Equipment and 7.5 MW Generator at Garvin

The Connected Electricity System includes: all power plants in the Midwest Reliability Organization (MRO), a regional electricity grid defined by the National Electric Reliability Council (NERC).

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from Grid Connected Resources	CO_2	Yes	This represents the main emissions source for the project. In the absence of the projects, grid connected resources would provide power to BEPC (this will be shown to be the appropriate baseline in the subsequent section), and hence lead to GHG emissions.
		CH_4	No	Minor emissions source
		N_2O	No	Minor emissions source
		Other	N/A	N/A
Project	Station Resources (i.e. power purchased from the grid by each Site)	CO_2	Yes	The project uses a small amount of grid electricity for substation back up power (i.e. station services).
		CH_4	No	Minor emissions source
		N_2O	No	Minor emissions source
		Other	N/A	N/A

2.4 Baseline Scenario

The additionality section below provides justification that the appropriate baseline for BEPC in the absence of these projects is the displacement of grid connected resources as represented by the calculation of the Combined Margin. Per the protocol, the Baseline Emissions from electricity generated by waste energy are:

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(EG_{i,j,y} * EF_{Elec,i,j,y})$$

$BE_{elec,y}$ - Baseline emissions due to displacement of electricity during the year y in metric tons of CO_2.

$EG_{i,j,y}$- The quantity of electricity supplied to the recipient *j* (in this case the grid) by the generator, that in the absence of project activity would have been sourced from the *i* (MRO) grid in MWh in year y.

$EF_{elec,i,j,y}$ - The CO_2 emission factor for the grid *i* displaced due to the project activity, during the year y in metric tons CO_2/MWh.

f_{wcm} - The fraction of total electricity generated by the project activity using only waste energy (as opposed to both waste energy and fossil fuels). Since the electricity generation is purely from the use of waste energy, this fraction is equal to 1, per the protocol.

f_{cap} - Factor that determines the energy that would have been produced in year y using waste energy generated at a historical level, expressed as a fraction of total energy using the waste energy source in year y.

We propose a project specific approach to calculate the f_{cap} factor as Methods 1, 2, and 3 outlined in Section 3.2 of ACM0012 require information which is unavailable or is not pertinent for this project.

For example, Method #1 requires temperature, pressure, specific heat and other metrics over a historical 3 year period, that is not available. Method #2 and 3 rely on manufacturer's data, which is similarly unavailable or requires information which BEPC is not able to access because of security and/or other commercial issues.

More importantly, the technical feasibility of these projects was conducted by BEPC using the daily horsepower hours produced at the compressor station over a 32 month period. The facilities which historically had the highest rates of production on average were deemed suitable sites for waste heat recovery. Since this is the information which was used to develop the projects, we propose to use this information to calculate the f_{cap} ratio.

$$f_{cap} = CF_{historical} / CF_{actual}$$

Attachment #42 shows that BEPC collected 32 months of operating data at Compressor Station #12 (Garvin). Measured from July 2001 – February 2004, the data reflects the daily horsepower hours generated by the gas turbines running the compressor station. We calculate a historical capacity factor ($CF_{historical}$) as the ratio of the mean horsepower hour production on a daily basis

over the 32 months over the maximum theoretical daily horsepower hours that could be achieved at the gas turbine.

The maximum theoretical daily horsepower hours are calculated as the product of the design capacity of the gas turbine * 24 hours. Based on Attachment #17, GTI notes that gas turbines on the "Northern Border pipeline system uses thirteen simple-cycle gas-turbine-powered (each ranging in the 35,000 to 40,000 HP) compression stations to deliver natural gas to the upper Midwest". Using 40,000 HP as a conservative basis, the maximum theoretical number of daily horsepower hours is 960,000.

Mean Value – Daily Horsepower Hours Produced	[redacted]
Maximum Theoretical Daily Horsepower Hours achieved	960,000
f_{cap} numerator ($CF_{historical, Garvin}$)	[redacted]

This capacity factor will be used as the numerator of the f_{cap} ratio - it represents the percentage of waste energy which was available at a historical level.

The denominator will be based on the actual capacity factor achieved at each compressor station, multiplied by a gross generation adjustment factor. The actual capacity factor achieved each year will be based on the on the net electricity delivered to the grid, adjusted upward by the gross generation factor, divided by the total feasible generation over 8760 hours and a nameplate capacity of 7.5 MWs. The gross generation adjustment factor accounts for the total amount of power generated, including parasitic load, and allows for calculation of a "true" capacity factor since it represents the total amount of power that can feasibly be generated. The gross generation factor will be calculated on an ex-ante basis using the historical relationship between the net amount of energy delivered to the grid and the gross amount of generation produced. Based on available historical data (attachment #43) for CS12, gross generation has been [redacted]% higher than on a median basis. Hence, the factor will be:

$$\text{Gross Generation Adjustment Factor}_{Garvin} = [redacted]$$

Note that the gross adjustment factor is being fixed for the duration of the crediting period. This is because the parasitic loads that occur are a direct result of the ambient temperatures, which are expected to remain relatively stable. The GTI report (Attachment #17) further corroborates the stability of the relationship between gross and net generation, noting that the facility delivers [redacted] times more energy to the grid than it consumes, suggesting that gross generation exceeds net generation by less than [redacted]%, which is approximately what is found using historical data.

The denominator of the f_{cap} ratio, then, will be calculated as:

$$CF_{actual,Garvin} = \text{Annual } EG_{i,j,y} * [redacted] / (7.5 \text{ MW} * 8760 \text{ hours})$$

In addition, if the f_{cap} factor exceeds 1, it will be capped at 1. The f_{cap} ratio, then, which will be used for each site will be:

$$f_{cap,\ Garvin} = \min \{1\ ,\ [redacted] / CF_{actual,Garvin}\}$$

We further show (through our prevailing practice analysis, Step 3) that waste energy would not have been partially captured in the absence of this project activity; hence we do not use the $f_{practice}$ factor.

2.5 Additionality

Per the large scale Additionality Tool (version 5.2):

Step 1: Identification of alternatives to the project activity consistent with mandatory laws and regulations.

Substep 1a: Identify realistic and credible alternatives available to the project participants that provide outputs or services comparable to the proposed activity.

Unlike a merchant generator that is solely concerned with building generation to provide energy and managing the project economics, BEPC must balance a range of interests as it determines which assets it adds to its generation portfolio. As a generation and transmission cooperative, BEPC has a dual mission to provide both reliable and cost effective electric service to its member cooperatives. In addition, BEPC's membership of 135 cooperatives across nine states has a range of motivations to support the addition of cleaner resources to BEPC's generation, including diversifying the generation mix to address potential future environmental legislation and responding to constituents' desire for environmental stewardship.

In 2007, at the time this facility was contemplated, BEPC determined that their system had experienced significant load growth from [redacted] – [redacted], and would continue to face ongoing load growth from 2007 to 2021 (See Attachment #5), In particular, BEPC calculated that system peak demand increased on average by [redacted] MW annually from [redacted] – [redacted]. Basin noted:

> "The average increase in system peak demand required an [redacted]% capacity factor generation facility to meet load levels. This indicates that Basin Electric has been adding load at a capacity factor that is best served by base-load generation resources".

Similarly, from [redacted] – [redacted], BEPC forecasted that their peak system demand is expected to rise by [redacted] MW per year. Basin noted:

> "The average expected increase in energy sales compared to the average expected increase in peak demand requires a [redacted]% capacity factor generating facility".

This analysis implies that baseload facilities capable of achieving an [redacted]% capacity factor (which traditionally have been coal generation units in BEPC's portfolio) would be the optimal generation resource for BEPC to manage increasing load growth, not intermittent or non-dispatchable generation. In fact, BEPC is currently developing both coal and natural gas plants to meet these load growth requirements.

In this case, BEPC also chose to develop non-baseload, non-dispatchable generation (the waste heat unit) so as to displace generation from fossil fuel emitting resources connected to the grid. The waste heat unit's run-time is based on pipeline operations, and BEPC cannot call on the unit to run in order to satisfy peak demand. BEPC must take the power when it is available and

provide power from other sources when these units are not available or when their output fluctuates. . The waste heat unit, then, was added primarily because the service it provides is emissions free electricity. Hence, the appropriate alternatives to the development of this waste heat unit include the following:

- The project activity undertaken without being registered as a VCS activity
    - It will be shown (per Step 3) that this is not a feasible alternative
- Electricity delivered to the grid would have otherwise been generated by the operation of grid connected power plants and by the addition of new generation resources, as reflected in the combined margin calculations described in the "Tool to calculate the emission factor for an electricity system".
    - It will be shown (per Step 3) that this is the baseline in the absence of this project activity
- Procure other renewable emissions generation resources
    - Wind generation
        - As a load serving entity, BEPC looks to develop a diverse portfolio of generation resources (both resource type and geographies). It is significant that the profile of the waste heat project is uncorrelated with wind assets. Wind projects have a different generation profile (capacity factors between 30 – 40%) than the waste heat project (which, while non-dispatchable can potentially reach capacity factors between 50-70%). Systems can only integrate so much localized wind capacity before their reliability is severely degraded. By having non-dispatchable / intermittent resources whose generation profiles are uncorrelated and that are diversified across various geographic locations, BEPC is better able to manage the impact to the grid from a reliability perspective. Information about the Capacity Factors is provided in Attachment #39, page 74, which is an assessment of Basin's available renewable resources.
        - BEPC does not view a wind project as a substitute for a waste heat project. Wind does not provide a comparable level of service in comparison to the waste heat projects, hence this alternative is not considered.
    - Solar generation
        - Solar, while uncorrelated with wind generation, is prohibitively costly and brings a much lower capacity factor than the Waste Heat project. It does not provide a comparable level of service to the Waste Heat project, so this alternative is not considered. Please see Attachment #39, page 76, for corroboration that solar is intermittent which much lower capacity factors.
    - Biogas
        - Biogas projects are in very limited supply – for example, to date, Basin has contracted for ~ 1 MW of Biogas, as shown on this website. Hence, biogas does not provide a comparable level of service to the waste heat project, so this alternative is not considered. The much smaller size of biogas projects in addition to their limited availability provides additional evidence that this is not a comparable alternative to the waste heat unit.

Therefore, the alternatives considered (and to which subsequent steps are applied) are:

- The project activity undertaken without being registered as a VCS activity
- Electricity delivered to the grid would have otherwise been generated by the operation of grid connected power plants and by the addition of new generation resources, as reflected in the combined margin calculations described in the "Tool to calculate the emission factor for an electricity system".

Step 1b: Consistency with Mandatory Laws and Regulations

All identified alternatives are in compliance with local regulations, hence neither alternative is eliminated. In addition, this waste heat project is not specifically required under any laws or regulations in any of the nine states within which BEPC or its member cooperatives are active, nor was the waste heat project the only way for BEPC and its members to meet their renewable requirements. BEPC provides power to member cooperatives (who ultimately serve retail load) in nine states. Renewable legislation in those states varies widely in terms of the requirement it imposes on BEPC members (and BEPC).

- Colorado, Minnesota and New Mexico have enacted Renewable Portfolio Standards (RPS) that apply to electric cooperatives requiring them to procure a certain percentage of their generation from renewable resources
- North and South Dakota have enacted "Renewable Energy Objectives" creating voluntary goals for electric cooperatives to procure 10% of their generation from either renewable or recycled energy (or in the case of South Dakota energy efficiency) by 2015
- Iowa and Montana have enacted Renewable Portfolio Standards that do not apply to electric cooperatives
- Nebraska and Wyoming have no Renewable Portfolio Standard

BEPC has only one member (Tri-State Generation and Transmission Association) in Colorado and New Mexico that is responsible for its own compliance for the state RPSs. BEPC has a contractual relationship with Tri-State to sell them a fixed amount of power to meet a portion of Tri-state's Wyoming and Colorado load requirements. BEPC does not supply any power for Tri-State's New Mexico system and thus has no RPS requirement in that state; Tri-State has independently procured renewable resources for their New Mexico obligation. BEPC's sale to Tri-State requires them to offer Renewable Energy Credits in the same percentage as the Colorado RPS such that the total annual power delivery would be compliant. For point of reference, that percentage is 1% for 2010, 3% for 2011 thru 2014, 6% for 2015 thru 2019 and 10% for 2020 and beyond.

In Minnesota, BEPC has an obligation to provide RECs to meet specific percentages of the company's and their members' loads. The Minnesota RPS was originally a non-mandated, "good faith" renewable energy objective that had a target of 7% of all retail sales by 2010 being served by eligible generation resources. In 2007 this was changed to a mandate thru the passage of S.F. 4. For point of reference, that percentage is 7% thru 2011, 12% for 2012 thru 2015, 6% for 2016 thru 2019 and 20% for 2020 and beyond.

Based on the load forecast for Tri State and for the Minnesota members (see Attachment # 6 – Renewable Requirements by State), the total number of RECs Basin needed is listed below:

[redacted]

Well before the waste heat project was constructed (indeed, by the end of 2007) BEPC had acquired a portfolio of nearly 168 MW's of eligible capacity which was capable of generating over [redacted] RECs per year, through PPAs signed with merchant generators as well as their own development efforts (See Attachments # 6 and #7). The number of available RECs in (2007) far exceeded the mandatory requirements of BEPC's members through 2022. The renewable generation from the waste heat project, therefore, was not necessary for meeting these mandates, and the development of this site was not required to meet these state programs. In addition, BEPC's supply of RECs far exceeds their voluntary needs through 2014. These RECs are not required, nor will they be retired, to meet these goals.

North and South Dakota have both enacted Renewable Energy Objectives that apply to all retail providers of electricity in those states. However, as a voluntary objective (as opposed to a mandatory standard), there are no penalties or sanctions for failing to meet these goals. While each retail provider is required to file an annual report to the states' public service commissions detailing the amount of renewable energy they generated for that year and their planned renewable capacity additions going forward, there is no "ramp-up" to the 15% target. Consequently, there is no need to retire or even procure any credits prior to 2015.

Finally, in 2010 the North Dakota Public Utilities Division recommended in PU-10-19 (see Attachment #8, Page 5):

- Electric utilities with RECs allocated to ND should be encouraged not to retire RECs in the years leading up to 2015.
- Electric utilities with RECs allocated to ND should be encouraged to sell all these RECs in the years leading up to 2015. It is understood that the mechanism to credit ND rate payers will differ between investor-owned utilities vs. generation & transmission cooperatives and municipal joint action agencies.
- By the year 2015 and after, if the electric utility has shown compliance with the REO, the PUD recommends that the Commission consider allowing electric utilities to continue to sell all of their RECs attributable to ND rather than retiring them to show compliance, given that the objective is voluntary.

In addition, the North Dakota Public Service Commission did rule (see Attachment #9, Page 2):

> "All allocated RECs must be considered excess and no RECs may be considered needed for compliance until 2015."

Thus BEPC is under no obligation in either of these states to procure renewable generation; if it does procure renewable generation, it is under no obligation to retire its credits towards those objectives.

With respect to federal mandates, there was much discussion regarding a potential federal Renewable or Clean Energy Standard or a Greenhouse Gas Cap and Trade program from 2007 - 2009. However, under the proposed 4,000,000 MWh annual threshold for inclusion detailed in the most recent proposed federal legislation, namely Bingaman's Renewable Portfolio Standard and Waxman and Markey's American Clean Energy and Security Act, not a single one of BEPC's members would have been subject to an obligation given their system loads. Indeed, BEPC's move to add renewable generation took place long before the proposed legislation merited.

In 2005, BEPC's Board of Directors authorized a *voluntary* resolution (Resolution D-5: Renewable Energy Goal – see Attachment # 10) that directed the company to:

> "... seek to obtain renewable or environmentally benign resources equal to 10 percent of the MW capacity needed to meet its member demand by 2010."

This same resolution also directed BEPC to:

- "... actively market "green credits" for the benefit of cooperative members"

BEPC's 2007 Power Supply Analysis noted about BEPC's voluntary resolution that

> "a fundamental component underlying this policy is the marketing of the Green Tags (aka renewable energy credits) resulting from these resources. The revenue from the marketing of the credits is integral to achieving the economics of the goal." (Attachment #11)

Basin's internal target was developed to show support to renewable resources and respond to member and community interest in renewable generation. Basin had no obligation to meet the target nor was there any internal requirement to do so. Indeed, the resolution was voluntary in nature in the first place (and was not treated internally as a "binding requirement".) Second, the resolution noted that BEPC would try to sell the green tags from its projects to benefit the economics of relatively higher priced green resources and for the benefit of their members. Green Tag revenue was contemplated and a key consideration in reaching the target in the first place. Finally, at the time the waste heat project was completed, Basin had exceeded its target (to obtain renewable resources equal to 10% of the MW capacity needed to meet member demand) – this resource was not necessary to meet the internal resolution.

In summary:

- BEPC's mandated obligation of approximately of up to [redacted] RECs through 2020 was met in 2006, well before the waste heat project was constructed. In addition, their obligation for 2020 and beyond can actively be met with other resources in BEPC's portfolio.
- BEPC did establish a renewable capacity goal and was proactively monitoring any potential renewable obligation, no matter how remote, far in advance of any mandate.
- BEPC's Board (as well as the Public Service Commission of the state of North Dakota) has encouraged the company to monetize the Renewable Energy Credits generated by their renewable project portfolio, in part to recover the costs associated with adding more expensive, greener generation, so as to compensate their electric customers.

Outcome of Step 1b: Therefore, the following scenarios continue to to be consistent with mandatory laws and regulations:

- The project activity undertaken without being registered as a VCS activity
- Electricity delivered to the grid would have otherwise been generated by the operation of grid connected power plants and by the addition of new generation resources, as reflected in the combined margin calculations described in the "Tool to calculate the emission factor for an electricity system".

Step 2 - Investment Analysis:

Substep 2a – Determine Appropriate Analysis Method

Since the project activity derives benefit from energy and VCUs, we apply Option III, using Benchmark Analysis. BEPC's generation resources provide two separate sets of services to electrical consumers.

- Energy – reflects the amount of electricity supplied throughout the year during each interval (measured in MWhs)
- Capacity – Capacity reflects the potential ability of generating resources to be available to meet peak demand. Capacity demand is determined by calculating the system requirements to meet the peak demand period, and the unit must be available during that period. Hence, capacity value is generally attributed to resources which can be dispatched with an adequate degree of reliability.

The appropriate metric for BEPC varies based on the technology under consideration and the value to the system that the facility provides. Non-dispatchable generation such as wind, solar, and the waste heat project provide energy value to the system but little or no dispatchable capacity value; hence, the primary value to the system is the reduced fuel consumption and avoided variable cost of generation which can be dispatched.

As a result, the appropriate measure assesses the PPA price of waste heat generation in comparison to its system value, which is the reduction of fuel consumption and variable costs of the generation it backs down, as captured by BEPC's published avoided cost / PURPA rate (additional information provided below). Please note that BEPC expended significant expenses to interconnect this projects to the grid – to be conservative we do not include these expenses in the final value which is compared to the avoided cost benchmark.

Substep 2b – Option III – Benchmark Analysis

The rate which captures the fuel displacement value of the energy from the waste heat project is the annual avoided cost which is published by BEPC. The avoided cost rate is defined under Public Utilities Regulatory Policy Act (PURPA) as "the incremental costs of electric energy, capacity, or both, which, but for the purchase from the qualified facility, such utility would generate itself or purchase from another source." Basin's interpretation of this definition is to identify the cost of marginal generation which would provide power on their system in the absence of the project activity. This method conforms to the "Component/Peaker Method" as identified by the Edison Electric Institute (Attachment #38), which assumes that the facility "displaces the marginal, or most expensive, generation source in the utility's system at any given time." BEPC utilizes this method to calculate its system wide avoided costs, and, in keeping with the "standard offer" approach outlined in the EEI publication, submits it for approval to the Federal Rural Utilities Service (RUS) and publishes it for the benefit of its members. While this method can be used to estimate both the avoided costs associated with capacity and with energy, since the waste heat projects provide no capacity benefit, only the avoided costs associated with energy are considered here.

The avoided cost rate calculated by BEPC is equal to BEPC's reduced power production costs and reduced transmission and distribution line losses associated with delivering the generation to load. It reflects the cost of energy that BEPC is able to avoid by purchasing power from the PURPA resource. On BEPC's eastern system, where the Waste Heat units are located, this marginal unit is currently identified to be [redacted], a coal unit.

The avoided cost metric fits option e (any other indicators) among the allowable indicators, since the other allowable indicators are not pertinent for BEPC.

Potential Benchmark	Reason benchmark is not appropriate
a) Government bond rates, increased by a suitable risk premium	As a non-profit rural electric cooperative, BEPC does not build projects based on rates of return in the same way a private developer would seek to do. As a generation and transmission cooperative, BEPC's mission is to serve reliable, low cost power to its member cooperatives, which in turn provide it on a retail basis to residential, commercial, and industrial customers. If BEPC's members have load or experience load growth, BEPC is required to build or procure energy. The primary measure for the cooperative on whether to build is the cost of the project and the end result – delivered cost of generated electricity. BEPC seeks the most cost effective resources which can be used to serve member load. BEPC does not seek to build projects on the basis of an IRR. Therefore, this is not a pertinent benchmark.
b) Estimates of cost of financing and required return on capital	BEPC does not build projects based on IRRs. As a generation and transmission cooperative, BEPC's mission is to serve reliable, low cost power to its member cooperatives, which in turn provide it on a retail basis to residential, commercial, and industrial customers. If BEPC's members have load or experience load growth, BEPC is required to build or procure energy. The primary measure for the cooperative on whether to build is the cost of the project and the end result – delivered cost of generated electricity. BEPC seeks the most cost effective resources which can be used to serve member load. BEPC does not seek to build projects on the basis of an IRR. Therefore, this is not a pertinent benchmark.
c) A company internal benchmark that has been used to assess similar activities in the past	The avoided cost figure is not an internal benchmark that is used to make specific investment decisions. The avoided cost rate is used under the PURPA regulation, such that entities seeking to provide power to BEPC on an unsolicited basis are entitled to paid BEPC's avoided cost. However, since investment decisions are not made based on avoided cost, this benchmark would not fit under this category.
d) Government / official approved benchmark that is used for investment decisions	While the avoided cost benchmark is published by BEPC and submitted to the RUS under PURPA, BEPC does not make specific investment decisions based on avoided cost. The avoided cost rate is used

	under the PURPA regulation, such that entities seeking to provided power to BEPC on an unsolicited basis are entitled to paid BEPC's avoided cost. However, since investment decisions are not made based on avoided cost, this benchmark would not fit under this category.
e) Any other indicator, if the project participant can demonstrate that the above options are not applicable and their indicator is appropriately justified	As stated above, the avoided cost metric does not fit into the other four options of allowable benchmarks, and is eminently suitable for the analysis of this project as being additional to BEPC. This metric is suitable because: 1) Waste heat projects cannot be dispatched, and therefore cannot provide true capacity value to BEPC. Their benefit to the system is to displace the variable costs of other facilities which are not run due to the operation of this site. In other words, the waste heat project has "fuel displacement value". 2) For this same reason, a traditional levelized cost measure (that includes all-in fixed and variable costs for various technology types) is not appropriate to use here. A coal unit or a natural gas unit which has capacity value to BEPC cannot be compared on a strict cost basis to a waste heat unit which does not. 3) The avoided cost metric published by BEPC for PURPA is specifically designed to capture the fuel displacement value of the marginal unit which is no longer run because these facilities are operating. 4) While no investment decision is made on an avoided cost basis, it does capture the value to the system that is provided by a non-dispatchable resource.

Substep 2c – Calculation and comparison of financial indicators

The avoided costs of not using power from [redacted] is comprised of [redacted], and the [redacted] tax. These rates represent the avoided costs of whole sale power supply component of the cooperative system and are computed at BEPC's point of delivery to its members. The avoided costs for BEPC have historically ranged from $10 / MWh - $20 / MWh. For example, the average avoided cost to Basin for the period between 2005 – 2011 is $14.57 /MWh. Hence, the system value BEPC derives per MWh of waste heat power it receives is captured by this metric. The historical avoided cost values from 2005 – 2011 is provided below in units of $ / MWh.

	Avoided Cost (System Value to Basin)
2005	$ 10.00
2006	$ 12.70
2007	$ 14.20
2008	$ 15.90
2009	$ 15.10
2010	$ 16.80
2011	$ 17.30

On the other hand, the cost to BEPC for each MWh is determined by three factors: 1) PPA price that it will pay OREG II in its long term PPA, which starts in [redacted] (note that the project came online in 2009, at which points the payments began) and ends in [redacted]; 2) any interconnection costs; 3) any integration costs.

The PPA price for the contracted output of the waste heat resource (5.5 MW) starts at $[redacted] / MWh in [redacted] and increases by [redacted]% each year until [redacted]. The average cost of the PPA to BEPC for the contracted output from the facility is $[redacted] / MWh. In addition to the PPA price for these projects, BEPC also incurred interconnection costs above the PPA price of $[redacted] million at Garvin (please see Attachment #13). The expected production over 25 years from this site is expected to exceed 690,000 MWh. Amortizing the interconnection costs over this time period results in a $[redacted]/MWh incremental cost to the PPA price which BEPC incurs (please see Attachment # 14).

Finally, the intermittent / non-dispatchable nature of this generation also imposes real costs to BEPC from a load shaping perspective. A number of utilities attempting to integrate wind have attempted to quantify the burden these intermittent resources put on system operators who must integrate renewable onto the grid. Most recently, Southern California Edison proposed a $15 / MWh integration cost for wind to be integrated into its grid (see Attachment #15). Although the waste heat projects are substantially different from wind in their generation profile they too have a non-dispatchable component, and while the estimate provided by SoCalEd is not applicable in this instance, it does illustrate the substantial costs of integrating such resources.

To adequately compare the system value to BEPC (as determined by the avoided cost) to the cost (as determined by the PPA), we forecast the potential avoided cost value for BEPC until [redacted]. The primary and most volatile determinant of the avoided cost calculation is based on the cost of combusting coal at [redacted]. Using BEPC's proprietary long term coal price forecast, the coal price is expected to increase by an average of [redacted]% per year for the next [redacted] years at [redacted] (Attachment #16, Tab 2). Similarly, the long term coal price is expected to increase by an average of [redacted]% at BEPC's other coal unit on the eastern system, [redacted]. To be conservative, we apply the average of these 2 values ([redacted]%) to the 2011 published avoided cost rate (to date the highest value) and forecast BEPC's avoided cost rate to 2034. Note this is conservative, since other components of the avoided cost are not expected to increase as much as the coal cost.

We are also conservative in that for the purposes of comparing the system benefit to BEPC versus the costs incurred, we exclude the substantial interconnection costs and the integration costs for intermittent resources.

[redacted]

Comparing the PPA price to the forecasted avoided cost rate, it becomes apparent that the waste heat project cost far exceeds its value, unless the GHG or renewable value is taken into account. Indeed, the average benefit to BEPC on a per MWh basis between [redacted] - [redacted] is $[redacted] while the average PPA cost is $[redacted] (please see Attachment #16).

The "green value" of BEPC's renewable generation was a key consideration for them in moving forward with these relatively less economic projects. In their 2007 Power Supply Analysis (Attachment #11), BEPC modelled a number of potential carbon costs in considering which resources to add to their generation portfolio. The graph below illustrates their 3 cost curves for GHG allowances which BEPC considered viable ($[redacted] / ton in 2012 with a [redacted]% escalator; $[redacted]/ ton in 2012 with a [redacted]% escalator; $[redacted] / ton in 2012 with a [redacted]% escalator).

[redacted]

Indeed, the expected revenue from the environmental attributes was presented to the board as a mitigating factor to help address the difference between the project's value to the system and the project's cost. "Green tag" revenue and the possible CO2 benefits were an important consideration for the BEPC board when these projects were being approved. Attachment #3

references the presentation made to BEPC's Board members with respect to green tag revenue being a key consideration for the approval of this project. The importance of green tag revenue to Basin is also underscored on its website, which notes that

> "We are selling the green tags from our green and renewable resources to benefit the economics of those resources."

In summary, as a generation and transmission cooperative, BEPC signed a PPA at a higher cost than a feasible alternative to take into account the potential GHG and renewable benefits from the generation, when there were no existing state or federal laws compelling them to do so at that time. The potential VCU revenue compensates them for taking such a risk ahead of time, and helps to mitigate the difference between the cost BEPC is bearing for these resources and its true system benefit as a fuel displacer.

Substep 2d: Sensitivity Analysis

In the base case, the escalator used for the avoided cost is [redacted]%. We increase this escalator by 10%, and use a [redacted]% escalator to project forward the avoided cost. Similarly, we decrease the escalator by 10% and use [redacted]% to project the long term avoided cost escalator.

The results of this analysis are presented below. Again, taking into account the sensitivities, the average cost of the Waste Heat PPA is higher than their relative benefit to the system. The revenue from the green tags is critical to closing the gap.

[redacted]

Hence, the alternative of "undertaking this project without VCU revenues" is not feasible, and the appropriate alternative is for BEPC to obtain power from grid connected resources.

(Optional) Step 3: Barrier Analysis -Technology Barrier

Impact of unstable pipeline flow and compressor station reliability:

Pipeline flow risk (Production Risk) – The waste heat is generated entirely as a result of gas flows on the Northern Border pipeline. When flows are low, production is low; when flows are high, production is high. There are various reasons for this outcome such as no/low pipeline flow due to low natural gas sales, compressor station failure, upstream pipeline interruptions, or frozen components.

BEPC is required to take the power, whether they need it or not, as it is produced, with no ability to dispatch it. This exposes BEPC to a unique risk: at peak power prices and low pipeline flows, BEPC is required to cover its demand needs on the market. At low power prices and high pipeline flows, BEPC is required to pay for (and take) higher priced power than it is able to obtain on the market. Pipeline flows are entirely contingent on supplier demand on the Northern Border Pipeline (neither BEPC, nor OREG II, nor even the pipeline can truly affect supply / demand, which is affected by producers moving their product to market.) Indeed, as specified in Attachment #3, the pipeline does not own the natural gas it transports, but derives its revenues from fees paid by each shipper to move their gas.

As an example, the Gas Technology Institute (please see Attachment #17) did a test of the average MWh delivered by another OREG plant owned by BEPC on the pipeline to show the impact of pipeline flows.

The variability is depicted below:

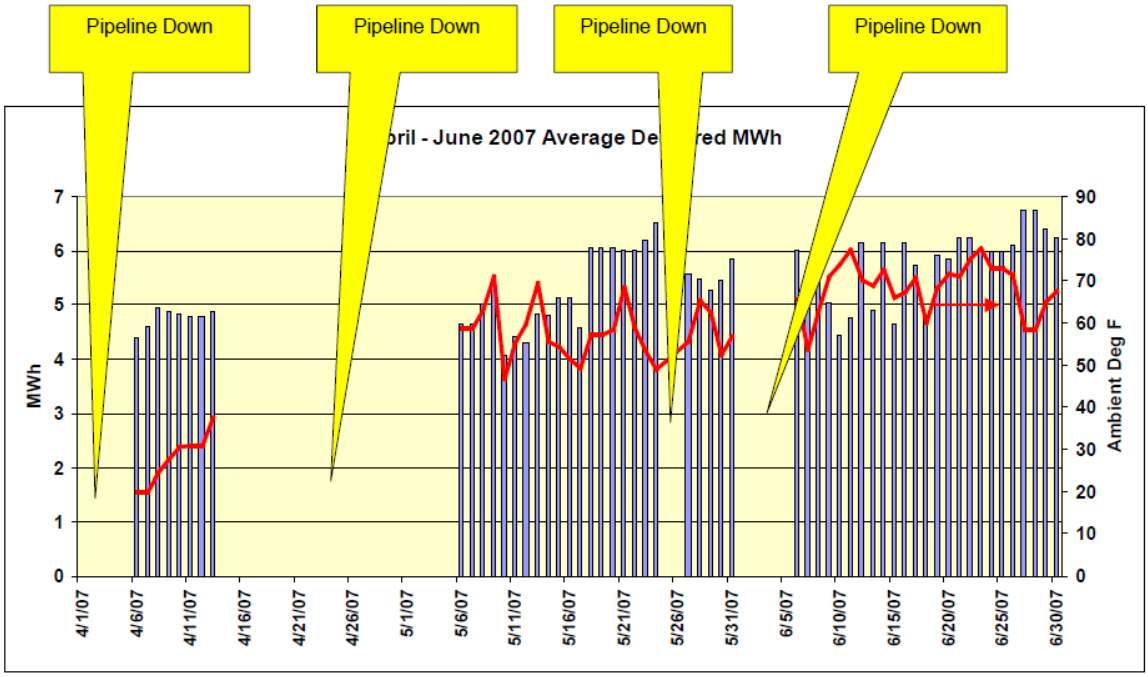


Figure 8. Second Quarter 2007 Hourly Average Delivered Power vs. Ambient

This added variability increases economic and reliability risk to BEPC. The benefit from VCU revenue will be crucial to help BEPC to mitigate this added risk.

Step 4: Common Practice Analysis:

Step 4a: Analyze other activities similar to the proposed project activity

The Department of Energy (DOE) Energy Information Administration (EIA) sites that there are over 1,400 compression stations at 305,000 miles of natural gas transmission pipeline in the United States. According to ICF International's whitepaper Waste Energy Recovery Opportunities for Interstate Natural Gas Pipelines, Feb. 2008 (Attachment #18), "Waste heat recovery to power systems are economically viable in areas where there are certain renewable incentives or subsidies or where compressor capacity and load factor are both above certain minimums." The economic viability of the compressor station depends on the following:

- Total station capacity of exceeds 15,000 horsepower.
- The compressor station must be operational for a minimum of 5250 hours (at least 60%) of the year.

ICF concludes that 90 – 100 existing compressor stations that meet these criteria representing 500 to 600 megawatts (MW). ICF acknowledges that the viability of its market prediction relies upon the assumption that clean energy incentives – including sales of carbon reductions -- would be available to support this deployment. The market threshold itself is a function, in part of limited access to transmission interconnection where many of the compressor stations are located. ICF reports in a separate supplemental analysis ("Status of Waste Heat to Power Projects on Natural Gas Pipelines, November,2009, Attachment #19) that viability depends on the availability of clean energy incentives (in BEPC's case where there are effectively no RPS benefits, the VCU revenues serve this purpose):

"The 2008 report verified that waste heat recovery to power systems are economically viable in areas where power purchase prices include some incentive for clean energy (e.g., states where heat recovery qualifies as an option under a renewable portfolio standard), and where compressor capacity and load factor both are above certain minimums. In addition, ICT notes "The [2008] report concluded that project feasibility is determined primarily by the price paid for the power generated. Project financial margins are narrow and systems were installed only in states or provinces where waste heat recovery qualified for some level of incentive in a renewable portfolio standard (RPS) or as a green power resource."

Step 4b: Discuss any similar options that are occurring

The 2009 ICF publication (Attachment #19) also outlines operational and planned Waste Heat to Power systems in the United States. BEPC in particular is purchasing power from a total of eight projects, four of which were constructed between 2005-2006 by OREG I, another wholly owned subsidiary of Ormat Technologies. BEPC's OREG I projects were registered as eligible GHG offset projects in the Massachusetts state program. Since they relied on GHG revenue (see Attachment #36), these projects are not included below in the list of similar projects per the methodology's guidance that consideration of projects which are registered to receive GHG offsets is not required. BEPC's two other waste heat projects, owned and operated by OREG II, are not eligible to register under VCS because of their online date, but BEPC is attempting to monetize the credits from environmental attributes for those earlier projects in the voluntary

renewable energy credit (REC) markets. The Garvin project and the Culbertson project are being registered to generate VCUs instead of being monetized in REC markets because their VCU value is expected to be higher and therefore better close the gap between their cost to BEPC and their system value as measured by avoided cost.

Project	Gas Turbine	Turbine Horsepower (hp)	MW	Power Buyer	Yr	Developer	Essential Distinctions
Neptune Gas Processing, Centerville, Louisiana	Solar Mars 100 (2)	12000 (each)	4.6	Internal Use	2004	Ormat	Neptune Gas Processing is owned by Enterprise Pipeline Company, which is an investor owned (publicly traded) company. In addition, the gas processing facility is using the power onsite, where it is partially displacing its own retail electricity cost. This is a very different economic model than the BEPC/OREG II relationship. Please see http://www.ormat.com/research/papers/utilization-turbine-waste-heat-generate-electric-powerat-neptune-plant for more information.
Trailblazer Pipeline, Peetz Station, Colorado	Solar Mars 100 (2)	10000 (each)	4	Highline Electric Coop	2009	Ormat	This project received support from Tri-State's "Member Local Renewable Program" – which provides additional financial incentives http://www.nreca.org/press/CoopStories/Pages/2010HighlineElectricAssociation.aspx
Northern Border Pipeline, Manning, North Dakota	Rolls Royce, RB211	38000	5.5	BEPC	2008	Ormat	This project is part of BEPC's OREG II projects. This project is not eligible for VCS registration because it is passed the start date. Green tags revenues are important to this project and BEPC is attempting to monetize environmental attributes.
Northern Border Pipeline, Zeeland, North Dakota	Rolls Royce, RB211	38000	4	BEPC	2009	Ormat	This project is part of BEPC's OREG II projects. This project is not eligible for VCS registration because it is passed the start date. Green tags revenues are important to this project and BEPC is attempting to monetize environmental attributes.
Northern Border Pipeline, CS6, North Dakota	Rolls Royce, RB211	38000	5.5	Montana Dakota Utilities (MDU)	2009	MDU/Ormat	Montana Dakota Utilities is an Investor Owned Utility with direct RPS obligations in Montana and renewable objectives in the Dakotas. The utility is actively seeking use its waste heat and wind projects to meet these requirements and objectives, as identified in their 2009 filing with the North Dakota Public Service Commission (http://www.psc.nd.gov/database/documents/09-0547/001-010.pdf, page 31, page 2)

Project	Gas Turbine	Turbine Horsepower (hp)	MW	Power Buyer	Yr	Developer	Essential Distinctions
Northern Border Pipeline, Culbertson, Montana	Rolls Royce, RB211	38000	5.5	BEPC	2009	Ormat	One of the projects trying to register with VCS
Northern Border Pipeline, Garvin, Minnesota	Rolls Royce, RB211	38000	5.5	BEPC	2009	Ormat	One of the projects trying to register with VCS
Northern Border Pipeline, CS 13, Minnesota	Rolls Royce, RB211	38000	5.5	Great River Energy	2010	Ormat	As a Minnesota based G&T cooperative, Great River Energy is subject to various renewable energy standards and energy conservation goals within the state of MN. The cooperative has stated in its blog that it believes the energy from this project will count towards its requirements under the MN energy conservation goal. (http://blog.greatriverenergy.com/2010/08/12/ormat-declares-commercial-operation-of-its-oreg3-pipeline-compressor-station-heat-recovery-generator/) More information about MN's energy conservation program can be found here: http://www.mnenergysmart.com/resources/energy-saving-opportunities/cip/
Kern River Pipeline, Goodsprings, Nevada	Solar Mars 100 (3)	3X15000	6	NV Energies	2010	NV Energies	NV has an RPS which NV energy is required to meet. This project is identified as a renewable resource within their generation portfolio, and it appears it is being claimed towards the RPS: http://www.nvenergy.com/renewablesenvironment/renewables/other.cfm.

The tables above show that there are 9 similar waste heat to Power facilities (<10% of feasible capacity) currently operational in the United States (including Garvin and Culbertson) that must be considered under the common practice section. Moreover, aside from BEPC affiliated generation, there were only 5 other sites in the United States as of 2009 that were similar to the Culbertson and Garvin projects. Indeed, this represents a market penetration of less than 6% for non-BEPC projects.

The number of similar project activities is even smaller compared to the potential opportunity, especially given the growth in pipeline capacity which is transpiring as a result of shale gas production. The EIA, in its white paper *Additions to Capacity on the U.S. Natural Gas Pipeline Network: 2007,* summarizes that the proposed pipeline capacity additions from 2008-2010 will total 10,057 miles representing an increased pipeline capacity of more than 103 billion cubic feet per day (Attachment #20).

In addition, the study reveals that by the end of 2007, the interstate and intrastate pipeline grid consisted of more than 187 Bcf/d of capacity carried through approximately 288,000 miles of pipeline. The difference in capacity-to-pipeline ratio is likely due to the increased pipeline diameter of recent pipeline additions. Therefore, the proposed pipeline capacity addition represents a 3.5% increase in pipeline miles and a 55% increase in pipeline capacity. The resulting conclusion is that there is very significant growth both in the number of compressor stations and the number of compressor station remodels since 2008, allowing for a significantly larger pool of compressor stations to be considered as possible waste heat to power facilities.

As shown, there are few projects in existence similar to the project activity at Garvin in comparison to the number of possible projects available in the United States. In addition, Ormat Technologies is the owner and developer of all but two of the projects, all of which are located in a small geographical area in northern United States, suggesting that the technology for waste energy recovery is not widely implemented both within the industry as well as geographically.

We therefore conclude that this project is additional, and that the continuation of this project without revenue from the environmental attributes can be eliminated as an alternative. Hence, of the 2 alternatives remaining after Step 2, the only remaining alternative is for BEPC to obtain power from existing grid connected resources, which is the baseline project for these projects.

2.6 Methodology Deviations

- We do not monitor certain parameters which are not pertinent to the calculation of emissions reductions. These include:
    - The gross amount of energy contained in the waste heat or the amount of waste heat. Since emissions reductions are calculated based on net energy delivered to grid, the gross value is not pertinent to the calculations performed. In addition, the gross adjustment factor is being calculated on an ex-ante basis, hence it is not necessary to monitor the gross generation on a forward basis
    - Temperature and Pressure

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

Per AMS III.Q, in the absence of the project, BEPC derives its power from the grid. Therefore, the baseline emissions are:

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(EG_{i,j,y} * EF_{Elec,i,j,y})$$

$BE_{elec,y}$ - Baseline emissions due to displacement of electricity during the year y in metric tons of CO_2.

$EG_{i,j,y}$ - The quantity of electricity supplied to the recipient *j* (in this case the grid) by the generator, that in the absence of project activity would have been sourced from the *i* (MRO) grid in MWh in year y.

$EF_{elec,i,j,y}$ - The CO_2 emission factor for the grid *i* displaced due to the project activity, during the year y in metric tons CO_2 / MWh.

f_{wcm} - The fraction of total electricity generated by the project activity using only waste energy (as opposed to both waste energy and fossil fuels). Since the electricity generation is purely from the use of waste energy, this fraction is equal to 1, per the protocol.

f_{cap} - Factor that determines the energy that would have been produced in year y using waste energy generated at a historical level, expressed as a fraction of total energy using the waste energy source in year y.

Per the "Tool to calculate the emission factor for an electricity system, version 5.2," the following steps were implemented in determining the emission factor. Please see attachment #24 in the dataroom.

Step 1: Identify the relevant electricity systems.

For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints. The protocol requires that if electricity systems are well defined in the country in question, then those official designations be used.

The United States has a well defined electricity system, with eight regional electric systems defined by the North American Electric Reliability Council (NERC). The BEPC facilities are interconnected to the WAPA Integrated System for the Upper Great Plains region, which is part of the MRO NERC region. Since this presents a clear grid boundary for the projects, MRO is defined as the appropriate electricity system in which all the calculations are done.

Project Electricity System: Compressor Stations; Ormat Waste Heat Capture Equipment and 7.5 MW Generators at Garvin

Connected Electricity System: all power plants in the Midwest Reliability Organization (MRO), a regional electricity grid defined by the National Electric Reliability Council (NERC).

Step 2: Choose whether to include off grid power plants

We choose not to include off grid power plants, as this is optional in the methodology, and we do not have access to that data. Hence, we follow Option 1, only grid connected power plants are included in the calculation.

Step 3: Select a method to determine the operating margin (OM).

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on the Simple Operating Margin (Simple OM, Step 3, option a). In addition, the ex-ante option is chosen for the Simple OM. The Simple OM is allowed to be used if low cost must run resources (LCMR) constitute less than 50% of the total grid generation based on 5 most recent years of historical data.

We define low cost must run resources as nuclear, hydro, wind, solar units and *any other unit with a capacity factor over 80%.* This follows the precedent that EPA used in developing their eGRID database, where base-load units were defined as those with a capacity factor over 80% (EPA eGRID Technical Support Document, Attachment #21). Where coal units meet or exceed this capacity factor, they are considered base-load.

Indeed, it is important to note that coal is not always the most frequently run unit in MRO. On a weighted average basis, coal units in MRO have capacity factors ranging from 63 – 70%. This calculation is based on EIA 860 data for units that use bituminous, sub-bituminous, or lignite coal as a primary fuel.

	Coal Unit Wtd Capacity Factor
2005	69.7%
2006	67.8%
2007	64.02%
2008	66.9%
2009	63.3%

These capacity factors suggest that coal units on average are often *intermediate units which are displaced* as opposed to *base-load, low cost must run* units in MRO. In other words, if other, cheaper generation is available, it is feasible that the coal units could be backed down to accommodate those resources. For example, the summer of 2011 has seen significant availability of hydro resources in the WAPA's Upper Great Plains region (which comprises a significant portion of MRO). These hydro resources are comprised of large dams built on the Missouri River by the federal government and managed by WAPA, a federal agency. This year's hydro availability has been so significant that certain coal units have been shut off or backed down to accommodate this power. For example, in late August, Basin's Antelope Valley Station and Leland Olds Station (AVS and LOS, both coal) had capacity factors between 40-70% (see charts below) because they were backed down to accommodate hydro. Laramie River Station (LRS, a coal unit) is running over 90%, as is the Duane Arnold nuclear unit – these are clearly low cost must run / base-load units. Therefore, it is not automatic that every coal unit, regardless of its run time, should be considered base-load (i.e. low cost, must run). Hence, we use the EPA's

eGRID precedent and identify any unit with a capacity factor greater than or equal to 80% as a LCMR unit.

[redacted]

The EIA 923/906 and 860 datasets are used to calculate the Simple OM. The EIA database is widely recognized in the United States as a high quality survey of all power plants and generators. The EIA 923 database is an annual survey that provides information on the amount and type of fuel used (in MMBtus) at each plant and the total MWh generated at each plant by fuel type. The EIA 860 database provides information on units available at each plant, the fuel types used, the online date of each unit, and the unit's nameplate capacities. Unit level generation and fuel usage, is not available in EIA 860, and therefore the combination of the 2 databases is necessary to get unit level information, as called for in the protocol. At the time this analysis was conducted, EIA data was complete through calendar year 2009 (2010 data was partially available, but not yet complete.) Hence 2009 is regarded as the most recent year of completely available data where EIA data is used, and all calculations are done at a unit level. The LCMR assessment is based on a five year historical average, hence the calculation is done from 2005-2009.

We calculate the proportion of total generation from LCMR resources using the following process:

1) The EIA 860 Data for each year surveys units by fuel types used and operating status. We focus our analysis only on operating units at the plant (retired, stand by, and out of service units are not included unless the unit is expected to return to service.) We then calculate the plant's total nameplate capacity. Next, we calculate each unit's proportion of the plant's total name plate capacity. This is the Unit Scaling factor (See sample below)

PLNTCODE	NAMEPLATE	Total Plant Size	Unit Scaling Factor	Fuel 1	Fuel 2
55135	186.6	373.2	50.0%	NG	DFO
55135	186.6	373.2	50.0%	NG	DFO
55038	1.2	3.6	33.3%	NG	DFO
55038	1.2	3.6	33.3%	NG	DFO
55038	1.2	3.6	33.3%	NG	DFO
55035	0.8	1.6	50.0%	OBG	NG
55035	0.8	1.6	50.0%	OBG	NG
55033	1	3	33.3%	OBG	NG
55033	1	3	33.3%	OBG	NG
55033	1	3	33.3%	OBG	NG
55027	0.5	1	50.0%	OBG	NG
55027	0.5	1	50.0%	OBG	NG
55010	177.3	283.5	62.5%	NG	DFO

2) We use this factor to get the unit's MWh generated and the emissions, since the EIA 923 database only provides data at a total plant level for each individual fuel type used at the plant. Specifically, the EIA 923 database for the MRO region is then used to build a separate table: total MWh produced at the plant arranged by fuel type

Example – EIA 923 Data

Plant ID	Plant Name	Operator Name	Reported	ELEC FUEL CONSUMPTION MMBTUS	NET GENERATION (megawatthours)
30	Madelia	City of Madelia	DFO	99	-207
30	Madelia	City of Madelia	NG	0	0
59	Platte	Grand Island City of	SUB	6,772,698	609,970
60	Whelan Energy Center	Hastings City of	DFO	8,102	485
60	Whelan Energy Center	Hastings City of	SUB	5,667,098	496,857
785	Kingsley	Central Nebraska Pub P&I Dist	WAT	142,852	14,453
1046	Dubuque	Interstate Power and Light Co	DFO	556	-76
1046	Dubuque	Interstate Power and Light Co	BIT	1,225,032	93,056
1046	Dubuque	Interstate Power and Light Co	NG	59,811	4,423
1046	Dubuque	Interstate Power and Light Co	SUB	2,868,237	215,206
1047	Lansing	Interstate Power and Light Co	DFO	220	19
1047	Lansing	Interstate Power and Light Co	BIT	2,320,931	210,640
1047	Lansing	Interstate Power and Light Co	DFO	37,175	3,132

Example – Total MWh by Fuel Type

Sum of NET GENERATION (megawatthours)	Fuel Type								
Plant ID	AB	BIT	BLQ	DFO	KER	LFG	LIG	MSW	NG
30				118.998					492
59									
60				141.999					
378									
785									
1046		155411		-32					
1047		0		2602					
1048									3908
1052				6.001					
1058		0		0					34084
1060									
1067									
1068				46947					
1073		0		105		13679			4002
1077		113149							4660.999

3) The EIA 860 database also identifies all the fuel types used at each unit. The first fuel type is generally the primary fuel; the other fuel types are often starter fuels and therefore used in significantly smaller quantities. For each fuel type (of which there are up to 6), the MWh and electric MMBtus for that plant and for that fuel type are queried using the MWh by Plant and

Fuel Type table. The unit level MWh and electric MMBtus produced at that unit for the particular fuel type is determined by multiplying the plant level number by the unit scaling factor. The unit's capacity factor is then calculated using the unit's nameplate capacity and the Total MWh produced at the unit for all fuel types. Note that unit level scaling provides the most objective measure available to conduct these calculations at a unit level as required in the protocol. The unit level scaling measure assumes that each unit's contribution to the total MWh generated is based on its name plate capacity.

4) LCMR Units are identified using the following process:

   a. All nuclear, hydro and wind units are considered LCMR Units

   b. All units with capacity factors >= 80% are considered LCMR

5) Total LCMR Unit MWh are then calculated as a percentage of the total MWh generated by all units in MRO

6) For the simple OM, the percentage of LCMR hours needs to be less than 50% over 5 years. Each year's LCMR unit hours and total MWh generated and the percentage is calculated in the Summary – Unit Level OM Calculation spreadsheet.

PLNTCODE	NAMEPLATE	Total Plant Size	Unit Scaling Factor	Fuel 1	Fuel 2	MWH from Fuel 1 at Unit	MWH from Fuel 2 at Unit	Total MWhrs at Unit	Unit Capacity Factor	LCMR Unit?
10223	8.5	8.5	100%	SUB		45605.52	#N/A	45,606	61.25%	0
1956	2	2	100%	DFO		34	#N/A	34	0.19%	0
1958	1.2	9.2	13%	DFO		7.557521739	#N/A	8	0.07%	0
1958	4	9.2	43%	DFO	NG	25.19173913	29.15652174	54	0.16%	0
1958	4	9.2	43%	DFO	NG	25.19173913	29.15652174	54	0.16%	0
7966	2.3	2.3	100%	WND		5038.999	#N/A	5,039	25.01%	LCMR Unit
54710	1.5	1.5	100%	DFO		19.001	#N/A	19	0.14%	0
54210	13.3	13.3	100%	SUB		81375.22	#N/A	81,375	69.85%	0
54211	3	5	60%	SUB		22518.744	#N/A	22,519	85.69%	LCMR Unit
54211	2	5	40%	SUB		15012.496	#N/A	15,012	85.69%	LCMR Unit
54212	3.5	6.5	54%	SUB		20609.73869	#N/A	20,610	67.22%	0

Over a 5 year basis, this results in LCMR resources being 41.99% of total generation on a weighted average basis.

	2005	2006	2007	2008	2009
MWhrs from LCMR Units	78,893,736	88,880,056	94,297,504	89,121,139	83,617,242
Total MWhrs in MRO	183,871,190	217,902,933	209,332,455	212,248,071	212,131,844
LCMR Units as % of Total MWhrs	42.91%	40.79%	45.05%	41.99%	39.42%
5 Year Wtd Average	41.99%				

Hence, we can use the Simple OM.

Step 4: Calculate the operating margin emissions factor according to the selected method

The Simple OM is calculated using Option A1, based on the net electricity generation and the CO2 emission factor of each power unit.

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

where

$EF_{grid, OM simple y}$ - Simple operating margin CO2 emissions factor in year y

$EG_{m,y}$ - Net quantity of electricity generated by power unit m in year y

$EF_{EL, m,y}$ - CO2 emission factor of power unit m in year y (tCO2 / MWh)

M - All power units serving the grid except low cost must run units

Y - Relevant year

$EF_{EL, m,y}$ is further determined by:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where

$FC_{i,m,y}$ - Amount of fossil fuel type i consumed by power unit m in year y (Mass or Unit Volume)

$NCV_{i,y}$ - Net Calorific value (energy content) of fossil fuel type i in year y (GJ/mass or unit volume)

$EF_{CO2,i,y}$ - CO2 Emissions Factor of Fossil Fuel type i in year y (tCOe2/GJ)

$EG_{m,y}$ - Net quantity of electricity degenerated by power unit m in year y (MWh)

M - All power units serving the grid except low cost must run units

Y - Relevant year

I - Fossil fuel types combusted in power unit m in year y.

The emissions for each unit are then calculated using the following process:

1. For each fuel type used at the unit, we look up the EIA's GHG combustion factor by fuel type. This combustion factor is provided by EIA for each fuel type and is used for the preparation of GHG inventories. A sample is provided below.

Code	***Meaning***	***Emissions Factors (kg / MMBtu)***
AB	Agricultural Crop Byproduct	0
BIT	Anthracite Coal and Bituminous Coal	93.46
BLQ	Black Liquor	0
DFO	Distillate Fuel Oil (Diesel, No. 1, No. 2,	73.15
JF	Jet Fuel	70.88
KER	Kerosene	72.31
LFG	Landfill Gas	0
LIG	Lignite	96.43
MSB	Municipal Solid Waste – Biogenic comp	0
MSN	Municipal Solid Waste – Non-biogenic	41.14
NG	Natural Gas	53.06
NUC	Nuclear	0
OBG	Other Biomass Gas (includes digester g	0
OBL	Other Biomass Liquids (specify in Com	0
OBS	Other Biomass Solids	0

2. The product of NCV $_{i,y}$ and FC $_{i,m,y}$ is given by the Elec Fuel Consumption factor (in MMBtus) in the EIA 923 database. A separate table is built arranging the MMBtus from each fuel type by plant, which is then scaled to a unit level using the unit scaling factor calculated earlier.

Example – Elec Fuel Consumption in MMBtus by Fuel Type

Sum of ELEC FUEL CONSUMPTION MMBTUS	Fuel Type										
Plant ID	AB	BIT	BLQ	DFO	JF	KER	LFG	LIG	MSB	MSN	NG
30				99							0
59											
60				8102							
785											
1046		1225032		556							59811
1047		2320931		37395							
1048											12540
1058		0		0							664121
1060											
1067											
1068				749797							
1073		1404530		1880			143352				120829
1077		0		0							179082
1079											15131

3. Then the electricity generated by that fuel type (in MMBtus) at that unit is multiplied by the EIA's GHG combustion factor (this factor is in kg CO2 / MMBtu) for that fuel type. The total emissions for that unit is the SUM of emissions from each fuel type divided by 1000 to convert it into Metric Tons. The total MWh generated by the unit was calculated and is explained above under the LCMR analysis section.

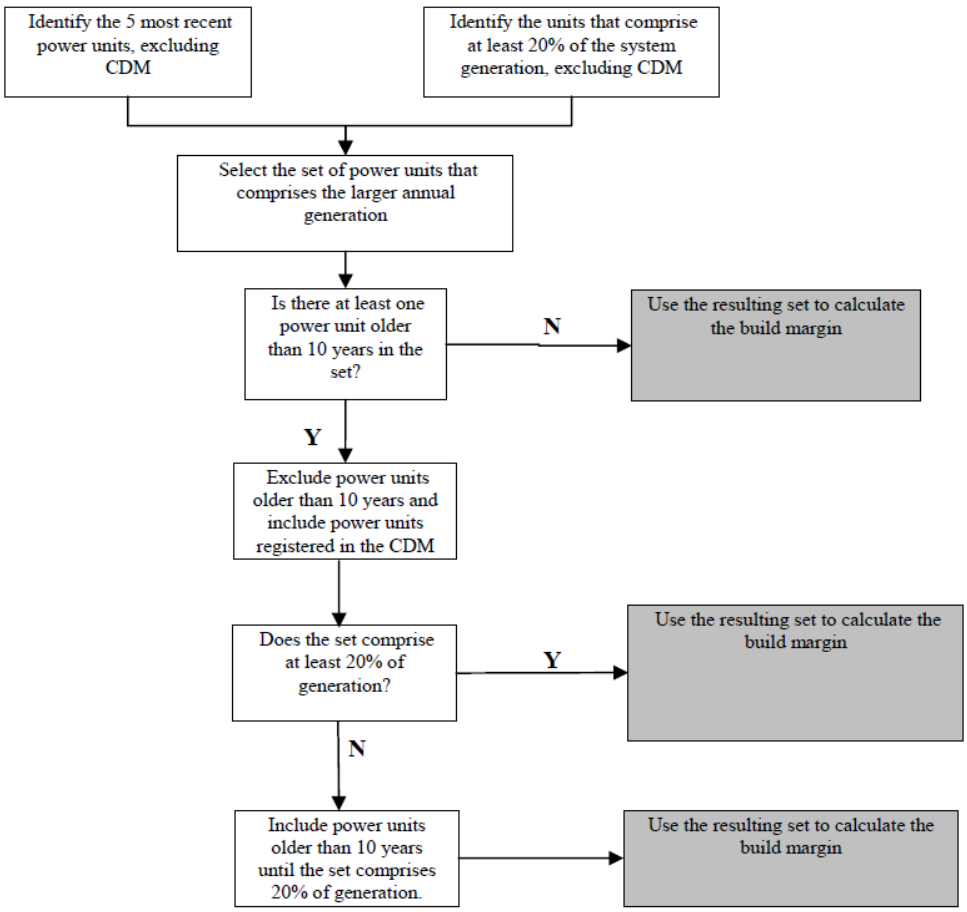
Metric Tons and MWh are calculated only for non-LCMR units, per the protocol, for 3 most recent years for which data is available.

	2007	**2008**	**2009**
Non-LCMR Unit Emissions (Metric Tons)	112,612,426	121,874,545	126,842,217
Non-LCMR Unit MWhrs	115,034,951	123,126,932	128,514,602
Intensity Factor (Metric Tons / MWh)	0.979	0.990	0.987
3 Yr Historcal Wtd Average	0.98542		

Hence, the Simple OM is 0.98542.

Step 5: Calculate the Build Margin Emission Factor (BM)

The build margin is calculated using both EIA using Option 1 (See attachment #15) using EIA 860 and 923 data from 2009. The build margin uses the following procedure:



Hence, using this Unit Generation in MWhs factor, the above procedure is implemented to identify the set of plants for the Build Margin. Ultimately, the set of power plants used is power units older than 10 years that comprise 20% of the generation. The outcome for each of the sub-steps for Step 5 is given below:

Step 5a: Identify the set of five power units, excluding power units registered as CDM (VCS) project activities, that started to supply electricity to the grid most recently and determine their annual electricity generation (AEG).

$AEG_{Set5Units}$ = 45,533 MWh

Step 5b: Determine the annual electricity generation of the project electricity system and identify the set of power units that started to supply electricity to the grid and comprise 20% of the total

AEG $_{Set>20\%}$ = 43,971,662 MWh

Step 5c: Since the number is step 5b is larger, the Set_{sample} is the set which comprises 20% of the total generation.

Step 5d: The set of plants that comprises 20% of the generation includes units over 10 years old, so we include projects seeking VCS registration and exclude units that came online over 10 years ago. The generation in MWh from this new set is:

AEG $_{SetSampleVCS}$ = 35,383,819 MWh

20% of the total AEG (AEG_{total}) is 42,424,699 MWh

Since AEG $_{SetSampleVCS}$ < $AEG_{total,}$ we go to Step 5e

Step 5e: Include units seeking VCS registration and units over 10 years old until 20% of total generation is reached. This is called $Set_{SampleVCS>10yrs}$ and is the sample group of units used for the BM.

The build margin is calculated using the following:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Since the group of units for calculating the BM includes units over 10 years old, Option A2 from the Simple Operating Margin calculation is used to calculate the Build Margin.

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}}$$

As before, a combination of the EIA 860 and 923 data is used for this calculation. Only Operating Units are considered and are sorted based on the online date of the unit. Total MWh at each unit are calculated as with the Simple OM above using the unit scaling factor and the EIA 923 database.

Here, $n_{m,y}$ is the conversion efficiency of the power unit in year y, and the conversion efficiency is found in the default factors provided in Annex A of the methodology. The prime mover column and the corresponding EIA fuel combustion factors are used for this calculation. A sample spreadsheet is given below.

PLANT_CODE	OPERATING_YEAR	Fuel 1	Total MWhrs at Unit ($Eg_{m,y}$)	$EF_{CO2,m,I,y}$ (FUEL 1 ONLY) kg CO2 / MMBtu	$n_{m,y}$ (DEFAULT TABLE VALUES)	$EF_{EL,m,y}$ (Tons CO2 / MWh)	$EG_{m,y}$ * $EF_{EL,m,y}$ (METRIC TONS)
1172	**2009**	WND	-	-	1	-	-
55995	**2009**	WND	3,444	-	1	-	-
56607	**2009**	WND	711	-	1	-	-
56831	**2009**	WND	17,845	-	1	-	-
56880	**2009**	WH	7,691	-	1	-	-
57097	**2009**	WND	-	-	1	-	-
57111	**2009**	WND	24,244	-	1	-	-
57045	**2009**	WND	7,354	-	1	-	-
57120	**2009**	WND	36,900	-	1	-	-
50413	**2009**	DFO	-	73.15	40.0%	0.624	-
56355	**2009**	WND	40,919	-	1	-	-

Step 5f: Calculate the build margin emission factor.

The build margin is calculated to be the following:

Numerator (Metric Tons CO2)	18,145,405
Demonimator (MWh)	43,980,064
Build Margin	0.4126

Step 6: Calculate the combined margin (CM) emissions factor.

The weighting of the projects is based on the intermittent nature of the availability of the waste heat from the Northern Border Pipeline. The availability of the waste heat is dependent entirely on the shippers along the Northern Border Pipeline. Neither Ormat nor Basin can impact or control this activity. The Tool for Calculating the Emissions Intensity identifies the intermittent nature of a project as a reason for increasing the weight given to the operating margin over the build margin (page 19 in the Tool). Given the high degree of unpredictability in pipeline gas flows, we regard this project as similar to a wind or solar project, and use 75% for the operating margin and 25% for the build margin.

The Combined Margin is this calculated as 75%*0.98542 + 25% *0.4126 = 0.8422 metric tons / MWh.

The baseline emissions for this project are based thus the following for each project:

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(EG_{i,j,y} * EF_{Elec,i,j,y})$$

$BE_{elec,y}$ - Baseline emissions due to displacement of electricity during the year y in metric tons of CO_2.

$EG_{i,j,y}$ - The quantity of electricity supplied to the recipient *j* (in this case the grid) by the generator, that in the absence of project activity would have been sourced from the *i* (MRO) grid in MWh in year y.

$EF_{elec,i,j,y}$ - The CO_2 emission factor for the grid *i* displaced due to the project activity, during the year y in metric tons CO_2/MWh. Based on the calculations above, this is calculated to be 0.8422.

f_{wcm} - The fraction of total electricity generated by the project activity using only waste energy (as opposed to both waste energy and fossil fuels). Since the electricity generation is purely from the use of waste energy, this fraction is equal to 1, per the protocol.

f_{cap} - Factor that determines the energy that would have been produced in year y using waste energy generated at a historical level, expressed as a fraction of total energy using the waste energy source in year y.

Using available data, the baseline emissions for the Garvin site is:

	Garvin
Nameplate Capacity	7.5
CF (based on 2010 generation)	57.48%
fcap numerator	[redacted]
Gross Adjustment Factor	[redacted]
fcap denominator	[redacted]
fcap ratio	100.00%
Emissions Intensity Factor	0.8422
fWCM	1
Annual Production (MWh)	37,766
Baseline Reductions (Metric Tons)	***31,806.67***

Please see Attachment #14 for additional information. Total Baseline Emissions is expected to be 31,806.67 metric tons per year at Garvin.

3.2 Project Emissions

Project and/or leakage emissions from electricity consumption are calculated based on scenario A: Electricity Consumption from the Grid is applicable here. The electricity is purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any on-site captive power plant exits, it is not operating or it can physically not provide electricity to the source of electricity consumption.

In this case, the Waste heat projects use a small amount of grid connected electricity for station services, hence this tool is applicable.

The generic approach defines project emissions as:

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

Where

$PE_{EC,y}$ = Project emissions from electricity consumtion in year y (tCO2 / yr)
$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EL,j,y}$= Emission factor for electricity generation for source j in year y (tCO2 / MWh)
$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

Under Option A1, the combined margin emission factor can be used, so that $EF_{EL,j,y} = EF_{grid,CM,y}$

In addition, if accurate transmission and distribution loss data is not available, $TDL_{j,y}$ can take a default value of 20%, which is what we chose here. The project emissions (in metric tons) are:

	Garvin
Project Emissions	
MWh Consumed for Station Services	40.88
Transmission Distribution Losses	0.20
Emissions Intensity Factor	0.8422
Total Project Emissions	***41.32***

Please see Attachment #14 for additional information. Please note that the compressor station uses a gas turbine which does emit NOx, Carbon Monoxide, CO2, and to a lesser extent, volatile organic compounds (these are standard emissions for any gas turbine application). In addition, the compressor station itself uses a portion of the natural gas extracted from the pipeline to maintain pipeline pressures, and as the host facility, emits GHGs into the atmosphere as part of its operation. These emissions would be there whether a waste heat capture to electricity project were in place or not – they are not added to, exacerbated by, or resulting from the project at hand and therefore not relevant to the project emissions calculation. The “fuel” for the project is waste heat from an existing process, and no additional combustion is involved in the generation of electricity. In particular, no waste gas is being combusted for the production of electricity in this project activity. Therefore, we only consider station services for calculating project emissions.

3.3 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.

3.4 Summary of GHG Emission Reductions and Removals

Total Emissions Reductions = Baseline Emissions – Project Emissions

Total Emissions Reductions (Garvin) = 31,806.67 metric tons – 41.32 metric tons = 31,765.35 metric tons

Garvin Emissions Reductions

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2010	31,806.67	41.32	0	31.765.35
2011	31,806.67	41.32	0	31.765.35
2012	31,806.67	41.32	0	31.765.35
2013	31,806.67	41.32	0	31.765.35
2014	31,806.67	41.32	0	31.765.35
Total	159,033.342	206.58	0	158,826.76

4 MONITORING

4.1 Data and Parameters Available at Validation

Monitoring will consist of:

- Metering the net amount of electrical energy produced – this is provided by a revenue grade meter. 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 MRETS.
    - Data Acquisition – continuous metering
    - 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
    - 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.
- Metering the amount of waste gas or the amount of energy contained in the waste heat
    - 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.

- 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.

All records will be retained for 7 years by Element Markets, which is 2 years beyond the project crediting period of 5 years.

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
Justification of choice of data or description of measurement methods and procedures applied:	Since the electricity generation is purely from the generation of waste energy, this fraction is 1.
Any comment:	N/A

Data Unit / Parameter:	$EF_{elec,i.j.y}$
Data unit:	Metric tons / MWh
Description:	The CO_2 emissions factor for the grid i 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
Justification of choice of data or description of measurement methods and procedures applied:	w1 * Simple OM + w2 * Build Margin, where w1 = 0.75 and w2 = 0.25.
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
Justification of choice of data or description of measurement methods and procedures applied:	Calculated based on the tool for calculating emissions intensity of the grid.
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
Justification of choice of data or description of measurement methods and procedures applied:	N/A
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
Justification of choice of data or description of measurement methods and procedures applied:	Calculated using EIA 923 / EIA 860 databases and EIA Fuel emissions factors
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
Justification of choice of data or description of measurement methods and procedures applied:	The EIA 923 database provides the product of these two factors and provides the MMBtus consumed for electricity generation for each plant in the grid
Any comment:	N/A

Data Unit / Parameter:	$EF_{CO2,i,y}$
Data unit:	Kg CO2e/MMBtu
Description:	CO2 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
Justification of choice of data or description of measurement methods and procedures applied:	EIA fuel emissions factors are default values that have been used to prepare GHG inventories.
Any comment:	N/A

Data Unit / Parameter:	$EF_{grid,BM,y}$
Data unit:	Metric Tons / MWh
Description:	CO2 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
Justification of choice of data or description of measurement methods and procedures applied:	Calculation described in Section #3.
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
Justification of choice of data or description of measurement methods and procedures applied:	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 I in year y.

Data Unit / Parameter:	For build margin - $n_{m,y}$
Data unit:	Percentage
Description:	Average net energy conversion efficiency of power unit m in year y
Source of data:	EIA 923/860 databases
Value applied:	Varies by unit, use default factors provided in methodology
Justification of choice of data or description of measurement methods and procedures applied:	Methodology allows the use of default values for the options chosen here.
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%
Justification of choice of data or description of measurement methods and procedures applied:	Default Factor
Any comment:	N/A

Data Unit / Parameter:	$CF_{historical, Garvin}$
Data unit:	Percentage
Description:	Ratio of mean daily horsepower hours generated over maximum theoretical horsepower hours feasible at the Garvin 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 Garvin. This information is derived from the Gas Technology Institute's report about the BEPC and OREG waste heat projects.
Value applied:	[redacted]
Justification of choice of data or description of measurement methods and procedures applied:	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 Garvin Site.
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 #12.
Source of data:	OREG II readings at CS12 since its start date – historical data. OREG II data includes gross generation, net generation and parasitic load.
Value applied:	[redacted]%
Justification of choice of data or description of measurement methods and procedures applied:	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 Garvin Site.
Any comment:	N/A

4.2 Data and Parameters Monitored

Data Unit / Parameter:	$EG_{i,j,y}$
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.

Source of data:	Project activity revenue meters at the Garvin substation
Description of measurement methods and procedures to be applied:	Generation data will be archived electronically. Electricity generation will be measured continuously and recorded monthly. WAPA provides meter readings to the Midwest Renewable Energy Tracking System (MRETS) monthly.
Frequency of monitoring/recording:	Monthly
Value applied:	Varies based on meter output
Monitoring equipment:	The project has a revenue quality metering device which provides information for all test, measurement, and project operating equipment on or before the start of project operations. This information will be updated over the life of the project as devices are replaced. The device record will include a basic specification sheet for each metering device used to measure the waste heat energy output to the grid.
QA/QC procedures to be applied:	Calibrations will be performed as required in the Interconnection Agreement. An annual report detailing the calibration activities associated with the project activity will be provided, if applicable. A copy of each calibration report will be included in the calibration log. The calibration log will also include initial factory calibration records and field test documents showing the calibration upon installation.
Calculation method:	Meter readings
Any comment:	N/A

Data Unit / Parameter:	$CF_{actual, Garvin}$
Data unit:	Percentage
Description:	Sum of $EG_{i,j,y}$ each month * [redacted] / (7.5 * 8760).
Source of data:	Project activity revenue meters at the Garvin and the gross adjustment factor calculated anove.
Description of measurement methods and procedures to be applied:	Data Management and Archiving: Generation data will be archived electronically. Electricity generation will be measured continuously and recorded monthly. WAPA will provides meter readings to the Midwest Renewable Energy Tracking System (MRETS) as BEPC's qualified reporting entity.
Frequency of monitoring/recording:	An annual calculation will be made based on total electricity generated at the site

Value applied:	Varies based on meter output
Monitoring equipment:	The project has a revenue quality metering device which provides information for all test, measurement, and project operating equipment on or before the start of project operations. This information will be updated over the life of the project as devices are replaced. The device record will include a basic specification sheet for each metering device used to measure the waste heat energy output to the grid.
QA/QC procedures to be applied:	Calibrations will be performed as required in the Interconnection Agreement. An annual report detailing the calibration activities associated with the project activity will be provided, if applicable. A copy of each calibration report will be included in the calibration log. The calibration log will also include initial factory calibration records and field test documents showing the calibration upon installation.
Calculation method:	Meter readings and formula above
Any comment:	N/A

Data Unit / Parameter:	$f_{cap,\ Garvin}$
Data unit:	Ratio
Description:	$f_{cap,\ Garvin}$ = min {1 , [redacted] / $CF_{actual,Garvin}$}
Source of data:	$CF_{historical,Garvin}$ is calculated to be [redacted] based on the average versus theoretical maximum daily horsepower hours at the compressor station. $CF_{actual,\ Garvin}$ will be based on the gross amount of electricity generated and delivered to the grid, 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:	Data Management and Archiving: Generation data will be archived electronically. Electricity generation will be measured continuously and recorded monthly. WAPA will provide meter readings to the Midwest Renewable Energy Tracking System (MRETS) as BEPC's qualified reporting entity.
Frequency of monitoring/recording:	An annual calculation will be made based on total electricity generated at the site
Value applied:	Varies based on meter output

Monitoring equipment:	The project has a revenue quality metering device which provides information for all test, measurement, and project operating equipment on or before the start of project operations. This information will be updated over the life of the project as devices are replaced. The device record will include a basic specification sheet for each metering device used to measure the waste heat energy output to the grid.
QA/QC procedures to be applied:	Calibrations will be performed as required in the Interconnection Agreement. An annual report detailing the calibration activities associated with the project activity will be provided, if applicable. A copy of each calibration report will be included in the calibration log. The calibration log will also include initial factory calibration records and field test documents showing the calibration upon installation.
Calculation method:	Meter readings and formula above
Any comment:	N/A

Data Unit / Parameter:	$EC_{PJ,j,y}$
Data unit:	MWh
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
Source of data:	Project activity revenue meters at the Garvin substation
Description of measurement methods and procedures to be applied:	Station services consumption will be derived from billing statements provided monthly by BEPC's member cooperative in whose service territory this project is located, and to whose distribution lines the project interconnects
Frequency of monitoring/recording:	Monthly
Value applied:	Varies based on meter output.
Monitoring equipment:	Revenue Grade meters
QA/QC procedures to be applied:	Projects will use monthly billing invoices from the local cooperative
Calculation method:	Meter readings as detailed on the invoice
Any comment:	N/A

Data Unit / Parameter:	$PE_{EC,y}$

Data unit:	Metric Tons
Description:	Project emissions from electricity consumption in year y (tCO2 / yr)
Source of data:	Project activity revenue meters at the Garvin substation
Description of measurement methods and procedures to be applied:	Station services consumption will be derived from billing statements provided monthly by BEPC's member cooperatives 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:	Varies based on meter output.
Monitoring equipment:	Revenue Grade meters and the above formula
QA/QC procedures to be applied:	Projects will use monthly billing invoices the local cooperative
Calculation method:	Formula and Meter readings
Any comment:	N/A

4.3 Description of the Monitoring Plan

The monitoring plan will include 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 4.2 above will be monitored and the associated data will be aggregated and reported according to the following procedures.

- Data Management and Archiving: Generation data will be archived electronically. Electricity generation will be measured continuously and managed by BEPC data analyst personnel, aggregated on a hourly basis, and will be monitored monthly. This information will also be provided to the Energy Information Agency and will serve as a check on the internally reported generation information. WAPA, as the qualified reporting entity, and the entity to whom the power is delivered, will provide meter readings to the Midwest Renewable Energy Tracking System (MRETS) on a monthly basis. By ensuring data is provided by a third party reporting agency, BEPC is able to ensure objectivity in the meter readings and ensure greater accuracy. Please note that the information in MRETS will be used for calculating emissions reductions. (See Attachment #29)

- Metering Devices: The project has a revenue quality metering device which provides information for all test, measurement, and project operating equipment on or before the start

of project operations. This information will be updated over the life of the project as devices are replaced. The device record will include a basic specification sheet for each metering device used to measure the waste heat energy output to the grid.

- Calibration Log: Calibrations will be performed as required in the Interconnection Agreement. An annual report detailing the calibration activities associated with the project activity will be provided, if applicable. A copy of each calibration report will be included in the calibration log. The calibration log will also include initial factory calibration records and field test documents showing the calibration upon installation. (See Attachment #30)

- Extraordinary Events: OREG II will report any extraordinary and significant unscheduled maintenance or repair activities to BEPC that cause system downtime and would therefore prevent the production of emission reductions from the power generation source.

5 ENVIRONMENTAL IMPACT

This project is a zero emissions project that uses a waste stream. It has a positive environmental impact as it displaces electricity on the grid. This project is also being undertaken at an existing brownfield site (the compressor station). No NEPA review was triggered for this site, so no environmental impact studies were carried out.

6 STAKEHOLDER COMMENTS

There are currently a variety of public documents that report, publicize, and praise the novel methods used to generate renewable energy from compressor stations. Examples include:

http://www.ect.coop/power-supply/renewable-energy/gt-expands-waste-heat-project/4109 - this article notes that OREG II projects have been successfully implemented and that the Culbertson and Garvin projects would be implemented by the end of 2009. There is no negative commentary in this article.

The Ormat and BEPC OREG Projects have also been lauded by the public power industry. The original OREG projects (Garvin site is in the second batch of projects developed by BEPC) received the 2007 Pacesetter Plant Award for the innovation they pioneered. Again, the response to this project was very positive. (Please see attachment #44).