CHAMISA ENERGY

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AIR PERMITS SECTION
6PD-R

October 31, 2012

Mr. Jeffrey Robinson
Chief, Air Permits Section
U.S. Environmental Protection Agency, Region 6 (6PD-R)
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Application for a Prevention of Significant Deterioration (PSD) Air Quality Permit for Greenhouse Gas Pollutants
Chamisa CAES at Tulia, LLC
Tulia, Swisher County, Texas

Dear Mr. Robinson:

Chamisa CAES at Tulia LLC (Chamisa) submits the enclosed application for a PSD permit for greenhouse gas (GHG) pollutants for a new compressed air energy storage (CAES) power plant to be located in Swisher County, Texas. CAES facilities use electrical power produced by renewable energy technologies such as wind turbines as well as conventional power generation facilities to compress and store air in underground storage caverns. As needed, the compressed air is released from storage, heated by mixing and combusting it with natural gas, and exhausted through an expansion turbine to produce electricity. The nature of this operation allows CAES facilities to achieve lower heat rates and thus lower GHG emissions than conventional power production technology. The two trains proposed for Chamisa's Tulia facility will be able to produce up to 270 MW of electrical power.

As shown in the permit application, the Chamisa CAES plant is subject to PSD review only for GHG pollutants. Other air pollutants are released below the PSD significant increase levels. These other non-GHG pollutants will be authorized by the Texas Commission on Environmental Quality (TCEQ). A permit application covering those pollutants will be submitted to TCEQ in November.

Chamisa met with Region 6 permitting staff in April of this year to discuss GHG permitting and to introduce staff to the concepts behind CAES technology. Chamisa hopes for an expeditious review of its application and is committed to working closely with your staff to answer questions and issues as they arise. Chamisa has reviewed and followed the EPA's

Chamisa Energy
2300 North Ridgetop Road
Santa Fe, New Mexico 87506
505.467.7853 Tel

guidance materials for GHG permitting in developing this permit application, but realizes that additional information may be required to enable EPA permitting staff to complete their review. Chamisa would like to meet with your permitting team shortly after they complete their initial review, to discuss additional information needs and issues that have been identified. We would like to use electronic communications and teleconferences as much as possible to facilitate the EPA's review and development of a basis for issuing a permit for our facility. Either I or our air quality consultant Pat Murin can be contacted any time to respond to questions and issues. Our contact information is included in the Administrative section of the permit application.

We look forward to working with EPA Region 6 as you review our permit application and develop a permit that meets the requirements of the PSD program for GHG pollutants.

Sincerely yours,

Alissa Oppenheimer
Managing Director
Chamisa Energy, LLC

Enclosure

cc: Mr. Mike Wilson, P.E., Director, Air Permits Division, TCEQ

Application for
Prevention of Significant Deterioration
Permit for Greenhouse Gases for
Chamisa CAES at Tulia, LLC
Tulia, Texas

Submitted to:

U.S. Environmental Protection Agency, Region 6
Dallas, TX

October 2012

CHAMISA
ENERGY

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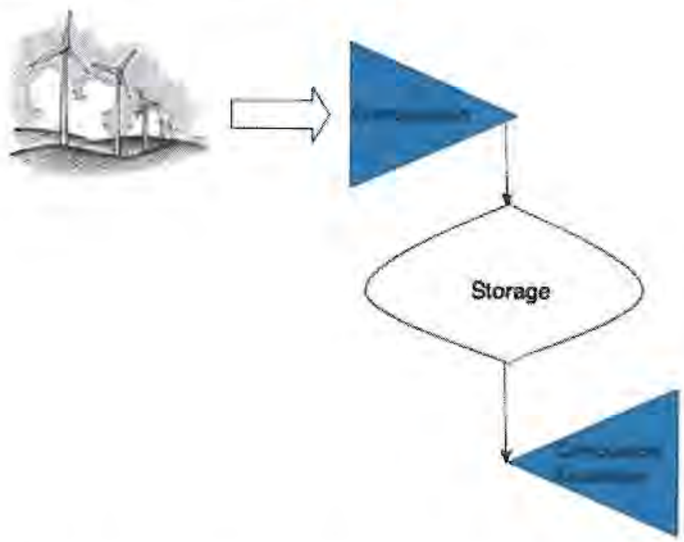
The seal appearing on this document was authorized by Patrick J. Murin, P.E. 67271 on 10/29/2012
P.E. Expiration Date: 12/31/2012

Murin Environmental Inc.
TBPE Registration No. F-7702
Firm Registration Expiration Date: 3/31/2013

1.0 INTRODUCTION AND ADMINISTRATIVE INFORMATION

The Chamisa CAES at Tulia power plant ("the Chamisa Facility") is a bulk energy storage system that will use compressed air energy storage (CAES) to produce up to 270 MW of electrical power. The Chamisa Facility will be located between Amarillo and Lubbock in the Texas Panhandle in Swisher County, Texas. As shown in the simple figure below, CAES technology can use electrical power produced by renewable energy technologies such as wind turbines and conventional power generation facilities to compress and store air in underground storage caverns. As needed, the compressed air is released from storage, heated by mixing and combusting it with natural gas, and exhausted through an expansion turbine to produce electricity.



Bulk storage technologies such as CAES and pumped hydro can hold weeks of megawatt-scale energy production capacity and provide a broad array of grid support services. A CAES facility provides valuable system and market services by storing energy when supply is plentiful and less costly and injecting it into the system when energy is scarce and more valuable, both stabilizing the system and dampening price volatility. With their ability to store energy created by wind and photovoltaic solar facilities, which have no emissions, and low water consumption, CAES provides societal benefits beyond the obvious system economic and reliability benefits.

The Chamisa Facility will use common and proven equipment and techniques - air compressors, storage caverns, and gas turbine generators - to draw electricity as needed, or desired, from grid-connected or behind the meter resources and inject that energy into the system hours or days later. Chamisa's compressors can capture renewable resources whenever they are available and save that energy until it is needed. From a technical perspective, the core equipment comprising the compression and generation functions of the Chamisa Facility are analogous to those provided by a common gas turbine power plant. Like a traditional gas-fired power plant, Chamisa's generators are fully dispatchable, fast-starting, fast-ramping resources capable of multiple starts per day. Unlike a traditional gas power plant, the Chamisa Facility will consume little water in its every day operations and use less fuel and produce fewer emissions than typical natural gas-fired generators.

The Chamisa Facility can ensure Texas's renewable energy resources are more fully utilized by electricity consumers. In 2011, wind energy made up about 13% of Texas' electric generation capacity and 8.5% of its electric usage.[1] Texas presently has approximately 10,648 MW of wind installed with more installations planned for the Texas Panhandle and far West Texas. If the air compression process is powered using electricity from a renewable but intermittent energy source such as a wind or solar power, the Chamisa project can stabilize that intermittent resource. In addition, when using wind or solar for the compression side of its process, CAES units operate with higher overall fuel efficiencies than conventional fuel combustion power systems because wind and solar use zero fuel to generate electricity.

The Chamisa Facility will comprise two 135 MW trains. Each train will use CAES technology developed by Dresser-Rand and will be equipped with selective catalytic reduction (SCR) and catalytic oxidation units to minimize emissions of nitrogen oxides, volatile organic compounds, and carbon monoxide. Exhaust emissions from the turbine trains comprise the majority of air emissions from the plant site, with smaller emissions from an associated emergency generator engine, the natural gas and ammonia supply equipment, electrical equipment, and two cooling towers. The compressed air for the project will be stored in caverns developed at the site. Using the compressed air and combusting natural gas, the CAES turbines can run at all ambient temperatures without any de-rate in production. The system can also ramp production up to full capacity in less than 10 minutes (for a warm start-up) to less than 30 minutes (for a cold start-up). This gives the Chamisa Facility the flexibility to meet a range of electrical service needs, including peaking, intermediate, base-load, tolling, and others. Electricity demand planning for West Texas indicates a regional requirement for power over the full range of services, but providing for peak power production is one of the major demand needs.

Under the U.S. Environmental Protection Agency's (EPA's) Prevention of Significant Deterioration (PSD) regulations in 40 CFR 52.21, the Chamisa Facility is a major source of greenhouse gas (GHG) emissions because its potential emissions have global warming potential equivalent to more than 100,000 tons per year of emissions of carbon dioxide (CO_2). (The emissions equivalent to CO2 are designated as CO_2-e.) As a new major source of GHG emissions, the Chamisa Facility is required to obtain a pre-construction air quality permit under the PSD rules. No other emissions released by the Chamisa Facility are subject to permitting under the PSD rules because their emission rates are less than the levels defined as significant emission increases. Those emissions, however, are subject to the State of Texas pre-construction authorization requirements, and authorizations for those associated facilities and emissions will be obtained from the Texas Commission on Environmental Quality (TCEQ).

Sources and emissions subject to PSD permitting requirements because of their potential to release GHG emissions are only subject to some of the requirements of the PSD rules. The primary requirement of a PSD permit for GHG emissions is to require that the permitted facilities use the Best Available Control Technology (BACT) for controlling GHG emissions. The resulting PSD permit specifies emission levels reflecting the use of BACT, including emissions monitoring and other requirements to ensure that the BACT emission levels are maintained during operations.

Administrative information for the owner and operator of the Chamisa Facility, Chamisa CAES at Tulia LLC, is provided in the TCEQ Core Data Form which follows this page. Additional information is provided in the TCEQ Form PI-1S, which also follows this page. The TCEQ Form PI-1S is a basic element of the TCEQ Standard Permit registration which will be used to authorize emissions and facilities other than those related to GHG pollutants.

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[1] ERCOT Quick Facts. (July 2012) available at www.ercot.com/content/news/presentations/2012/ERCOT_Quick_Facts_July_%202012.pdf

The start of construction of the Chamisa Facility is projected for December 2013. Initial operation of the power plant is expected by March 2016.

The remaining sections of this permit application are the following: Section 2.0 provides process information and Section 3.0 provides site information for the Chamisa Facility. Section 4.0 summarizes and describes the calculation of GHG emissions from the power plant and supporting equipment. Section 5.0 summarizes the applicability of PSD permit requirements. Section 6.0 analyzes and selects the BACT, including proposed emission limits and monitoring and maintenance requirements to achieve and maintain compliance with the BACT emission limits.

Affiliated with the Federal PSD permit process are requirements to consider the impacts of the proposed power plant on cultural and historical resources in the area, and on biological resources including threatened and endangered species. These impacts will be addressed in studies separate from this PSD permit application.

TCEQ

TCEQ Use Only

TCEQ Core Data Form

For detailed instructions regarding completion of this form, please read the Core Data Form Instructions or call 512-239-5175.

SECTION I: General Information

1. Reason for Submission *(If other is checked please describe in space provided)*

☒ New Permit, Registration or Authorization *(Core Data Form should be submitted with the program application)*

☐ Renewal *(Core Data Form should be submitted with the renewal form)* ☐ Other

2. Attachments ☒Yes ☐No

Describe Any Attachments: *(ex. Title V Application, Waste Transporter Application, etc.)* Air Quality Permit Application

3. Customer Reference Number ***(if issued)*** CN

Follow this link to search for CN or RN numbers in Central Registry**

4. Regulated Entity Reference Number ***(if issued)*** RN

SECTION II: Customer Information

5. Effective Date for Customer Information Updates (mm/dd/yyyy)

6. Customer Role (Proposed or Actual) – *as it relates to the Regulated Entity listed on this form. Please check only one of the following:*

☒Owner ☒ Operator ☐ Owner & Operator
☐Occupational Licensee ☐ Responsible Party ☐ Voluntary Cleanup Applicant ☐Other:

7. General Customer Information

☒ New Customer ☐ Update to Customer Information ☐ Change in Regulated Entity Ownership
☐Change in Legal Name (Verifiable with the Texas Secretary of State) ☐ No Change**

*****If "No Change" and Section I is complete, skip to Section III – Regulated Entity Information.***

8. Type of Customer:	☒ Corporation	☐ Individual	☐ Sole Proprietorship- D.B.A
☐ City Government	☐ County Government	☐ Federal Government	☐ State Government
☐ Other Government	☐ General Partnership	☐ Limited Partnership	☐ Other:

9. Customer Legal Name *(If an individual, print last name first: ex: Doe, John)*: Chamisa CAES at Tulia, LLC

If new Customer, enter previous Customer below:

End Date:

10. Mailing Address: 2300 North Ridgetop Road

City	Santa Fe	State	NM	ZIP	87506	ZIP + 4	

11. Country Mailing Information *(if outside USA)*:

12. E-Mail Address *(if applicable)*: ao@chamisaenergy.com

13. Telephone Number	14. Extension or Code	15. Fax Number (if applicable)
(505) 467-7800		(505) 467-5239

16. Federal Tax ID (9 digits)	17. TX State Franchise Tax ID (11 digits)	18. DUNS Number (if applicable)	19. TX SOS Filing Number (if applicable)
452704481	32044752833		0801459860

20. Number of Employees
☒ 0-20 ☐ 21-100 ☐ 101-250 ☐ 251-500 ☐ 501 and higher

21. Independently Owned and Operated? ☐ Yes ☒ No

SECTION III: Regulated Entity Information

22. General Regulated Entity Information *(If 'New Regulated Entity" is selected below this form should be accompanied by a permit application)*

☒ New Regulated Entity ☐ Update to Regulated Entity Name ☐ Update to Regulated Entity Information ☐ No Change** *(See below)*

****If "NO CHANGE" is checked and Section I is complete, skip to Section IV, Preparer Information.**

23. Regulated Entity Name *(name of the site where the regulated action is taking place)*

Chamisa CAES at Tulia

24. Street Address of the Regulated Entity: *(No P.O. Boxes)*	TBD							
	City	Tulia	State	TX	ZIP	79088	ZIP + 4	
25. Mailing Address:	2300 North Ridgetop Road							
	City	Santa Fe	State	NM	ZIP	87506	ZIP + 4	
26. E-Mail Address:	ao@chamisaenergy.com							

27. Telephone Number	28. Extension or Code	29. Fax Number *(if applicable)*
(505) 467-7800		(505) 467-5239

30. Primary SIC Code (4 digits)	31. Secondary SIC Code (4 digits)	32. Primary NAICS Code (5 or 6 digits)	33. Secondary NAICS Code (5 or 6 digits)
4911		221112	

34. What is the Primary Business of this entity? *(Please do not repeat the SIC or NAICS description.)*

Electric Power Production Using Stored Compressed Air and Natural Gas

Questions 34 – 37 address geographic location. Please refer to the instructions for applicability.

35. Description to Physical Location:	Future access via State Highway 86 approximately 1000 meters west of I-27 intersection with SH 86. Plant site is southwest of SH 86 and I-27 intersection

36. Nearest City	County	State	Nearest ZIP Code
Tulia	Swisher	TX	79088

37. Latitude (N) In Decimal:			38. Longitude (W) In Decimal:		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
34	31	26	101	48	20

39. TCEQ Programs and ID Numbers Check all Programs and write in the permits/registration numbers that will be affected by the updates submitted on this form or the updates may not be made. If your Program is not listed, check other and write it in. See the Core Data Form instructions for additional guidance.

☐ Dam Safety	☐ Districts	☐ Edwards Aquifer	☐ Industrial Hazardous Waste	☐ Municipal Solid Waste
☒ New Source Review – Air	☐ OSSF	☐ Petroleum Storage Tank	☐ PWS	☐ Sludge
TBD				
☒ Stormwater	☒ Title V – Air	☐ Tires	☐ Used Oil	☐ Utilities
TBD	TBD			
☐ Voluntary Cleanup	☐ Waste Water	☐ Wastewater Agriculture	☐ Water Rights	☐ Other:

SECTION IV: Preparer Information

40. Name:	Alissa Oppenheimer	41. Title:	Managing Director

42. Telephone Number	43. Ext./Code	44. Fax Number	45. E-Mail Address
(505) 467-7800		(505) 467-5239	ao@chamisaenergy.com

SECTION V: Authorized Signature

46. By my signature below, I certify, to the best of my knowledge, that the information provided in this form is true and complete, and that I have signature authority to submit this form on behalf of the entity specified in Section II, Field 9 and/or as required for the updates to the ID numbers identified in field 39.

(See the Core Data Form instructions for more information on who should sign this form.)

Company:	Chamisa Energy, LLC	Job Title:	Managing Director
Name*(In Print)*:	Alissa Oppenheimer	Phone:	(505) 467-7800
Signature:	[signature]	Date:	10/31/12

Texas Commission on Environmental Quality
Form PI-1S
Registrations for Air Standard Permit
(Page 1)

I. Registrant Information			
A. Is a TCEQ Core Data Form (TCEQ Form No. 10400) attached? Core Data Form required for Standard Permits 6004, 6006, 6007, 6008, and 6013.			☒ YES ☐ NO
Customer Reference Number (CN): TBD			
Regulated Entity Number (RN): TBD			
B. Company or Other Legal Customer Name (must be same as Core Data "Customer"): Chamisa CAES at Tulia, LLC			
Company Official Contact Name: Alissa Oppenheimer			
Title: Managing Director			
Mailing Address: 2300 North Ridgetop Road			
City: Santa Fe	State: New Mexico	ZIP Code: 87506	
Phone No.: (505) 467-7800	Fax No.: (505) 467-5239	E-mail Address: ao@chamisaenergy.com	
C. Technical Contact Name: Patrick Murin, P.E.			
Title: Principal, Murin Environmental Inc.			
Mailing Address: 979 Via Puebla			
City: Rio Rico	State: Arizona	ZIP Code: 85648	
Phone No.: (713) 819-6115	Fax No.: (520) 281-4229	E-mail Address: pmurin@murinenv.com	
D. Facility Location Information (Street Address): TBD			
If no street address, provide clear driving directions to the site in writing:			
Future access via State Highway 86 approximately 1000 meters west of I-27 intersection with SH86. Plant site is southwest of SH 86 and I-27 intersection, SW of Tulia			
City: Tulia	County: Swisher	ZIP Code: 79088	
Latitude (nearest second): 34°31'26" N		Longitude (nearest second): 101°48'20" W	
II. Facility and Site Information			
A. Name and Type of Facility: Chamisa CAES at Tulia - Power production using compressed air and natural gas			☒ Permanent ☐ Portable
B. Type of Action:	☒ Initial Application	☐ Renewal	☐ Change to Registration
	Registration No.:		☐ Expiration Date:
C. List the Standard Permit Claimed: 6005			
Description: Electric Generating Unit			
D. Concrete Batch Plant Standard Permit *(Check one)*			
☐ Central Mix ☐ Ready Mix ☐ Specialty Mix ☐ Enhanced Controls for Concrete Batch Plants			

Texas Commission on Environmental Quality
Registrations for Air Standard Permit
PI-1S
(Page 2)

II. Facility and Site Information *(continued)*		
E. Proposed Start of Construction: 8/15/2013	Length of Time at the Site: Permanent	
F. Is there a previous Standard Exemption or Permit by Rule for the facilities in this registration? *(Attach details regarding changes)*		☐ YES ☒ NO
If "YES," list Permit No.:		
G. Are there any other facilities at this site which are authorized by an air Standard Permit?		☐ YES ☒ NO
If "YES," list Permit No.:		
H. Are there any other air preconstruction permits at this site?		☒ YES ☐ NO
If "YES," list Permit No.: TBD - GHG PSD Permit to be issued by U.S. EPA		
Are there any other air preconstruction permits at this site that would be directly associated with this project?		☒ YES ☐ NO
If "YES," list Permit No.: TBD - GHG PSD Permit to be issued by U.S. EPA		
I. TCEQ Account Identification Number (if known): N/A		
J. Is this facility located at a site which is required to obtain a federal operating permit pursuant to 30 TAC Chapter 122?		☒ YES ☐ NO ☐ To Be Determined
K. Identify the requirements of 30 TAC Chapter 122 that will be triggered if this Form PI-1S application is approved.		
☒ Application for an FOP	☐ FOP Significant Revision	☐ FOP Minor
☐ Operational Flexibility/Off-Permit Notification	☐ Streamlined Revision for GOP	
☐ To Be Determined	☐ None	
L. Identify the type(s) issued and/or FOP application(s) submitted/pending for the site. *(check all that apply)*		
☒ SOP	☐ GOP	☐ GOP Application/Revision Application: Submitted or Under APD Review
☐ SOP Application Review Application: Submitted or Under APD Review		☐ N/A
III. Fee Information		
A. Is a copy of the check or money order attached?		☐ YES ☐ NO
Check/Money Order/Transaction Number:		
Company name on Check:		
Fee Amount: $900		

Texas Commission on Environmental Quality
Registrations for Air Standard Permit
PI-1S
(Page 3)

IV.	**Public Notice *(If Applicable) - N/A***			
A.	Is the plant located at a site contiguous or adjacent to the public works project?			☐ YES ☐ NO
B.	Name of Public Place:			
Physical Address:				
City:		County:		
C.	Small Business Classification:			☐ YES ☐ NO
D.	Concrete batch plants with enhanced controls, permanent rock crushers, and animal carcass incinerators shall place a copy of the technically complete application at the appropriate TCEQ regional office only.			
E.	Please furnish the names of the state legislators who represent the area where the facility site is located:			
State Senator:				
State Representative:				
F.	For Concrete Batch Plants, name of the County Judge for this facility site:			
County Judge:				
Mailing Address:				
City:		State:	ZIP Code:	
G.	For Concrete Batch Plants, is the facility located in a municipality and/or extraterritorial jurisdiction of a municipality?			☐ YES ☐ NO
If "YES," list the name(s) of the Presiding Officer(s) for the municipality and/or extraterritorial jurisdiction:				
Title:				
Mailing Address:				
City:		State:	ZIP Code:	
V.	**Technical Information Including State and Federal Regulatory Requirements** ***Registrants must be in compliance with all applicable state and federal regulations and standards to claim a Standard Permit.***			
A.	Is confidential information submitted and properly marked with this registration?			☐ YES ☑ NO
B.	Is a process flow diagram and a process description attached?			☑ YES ☐ NO
C.	Is a plot plan attached?			☑ YES ☐ NO
D.	Are emissions data and calculations for this claim attached?			☑ YES ☐ NO
E.	Is information attached showing how the general requirements and applicability (30 TAC § 116.610 and 116.615) are met?			☑ YES ☐ NO
F.	Is information attached showing how the specific requirements are met?			☑ YES ☐ NO

Texas Commission on Environmental Quality
Form PI-1S
General Application for Air Permit Renewals
(Page 4)

The signature below indicates that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge and belief. I further state that to the best of my knowledge and belief, the project for which application is made will not in any way violate any provision of the Texas Water Code (TWC), Chapter 7, Texas Clean Air Act (TCAA), as amended, or any of the air quality rules and regulations of the Texas Commission on Environmental Quality or any local governmental ordinance or resolution enacted pursuant to the TCAA. I further state that I have read and understand TWC §§ 7.177 7.183, which defines ***Criminal Offenses*** for certain violations, including intentionally or knowingly making or causing to be made false material statements or representations in this application, and TWC §§ 7.187, pertaining to ***Criminal Penalties***.

Name: Alissa Oppenheimer
Print Full Name

Signature: [signature]
Original Signature Required

Date: 10/31/12

Texas Commission on Environmental Quality
Form PI-1S
General Application for Air Permit Renewals
(Page 5)

VII. Copies of the Registration		
Copies must be sent as listed below. Processing delays will occur if copies are not sent as noted.		
Air Permits Initial Review Team (APIRT)	Regular, Certified, Priority Mail Mail Code 161, P.O. Box 13087, Austin, Texas 78711-3087 OR Hand Delivery, Overnight Mail Mail Code 161, 12100 Park 35 Circle, Building C, Third Floor, Room 300 W, Austin, Texas 78753 **Note: The official application cannot be faxed to the TCEQ**	Copy of Money Order or Check , original Form PI-1S and Core Data Form; all attachments
Revenue Section TCEQ	Regular, Certified, Priority Mail Mail Code 214, P.O. Box 13088, Austin, Texas 78711-3088 OR Hand Delivery, Overnight Mail Mail Code 214, 12100 Park 35 Circle, Building A, Third Floor, Austin, Texas 78753	Original Money Order or Check, a Copy of Form PI-1S, Core Date Form
Appropriate TCEQ Regional Office	To find your regional office address go to www.tceq.texas.gov/about/directory/region/reglist.html or call (512) 239-1250	Copy of Form PI-1S, Core Data Form, and all attachments
Appropriate Local Air Pollution Control Program(s)	To find your local air pollution control programs go to www.tceq.texas.gov/nav/permits/air_permits.html or call (512) 239-1250	Copy of Form PI-1S, Core Data Form, and all attachments

2.0 PROCESS DESCRIPTION AND PROCESS FLOW DIAGRAM

The process flow diagram illustrates the process steps in the proposed Chamisa Facility.

Power from the utility grid will operate multi-stage electric compressors to compress ambient air to pressures as high as 1838 psia. The electricity to run the compressors will be generated by renewable energy sources or conventional power sources during non-peak operation. The compressed air will be stored in one of several caverns at the site.[2] The electrical motors driving the air compressors will be operated independently of the electrical generators harnessed to the expansion gas turbines. Cooling water will be used to cool both the electrical motors and the two air compressor trains.

Compressed air withdrawn from the storage caverns will first be preheated in a recuperator with hot exhaust gases from the process. Natural gas will be combusted with the pre-heated air in high-pressure combustors before entering a high-pressure expanding turbine stage. Water will be injected into the turbine stages at higher production capacities to maximize power production and help to reduce the formation of nitrogen oxides. After expansion in the turbine, the turbine gases will be cooler and at lower pressure. The exhaust gases will enter low-pressure combustors, where additional natural gas will be combusted. The gases will then enter a low-pressure expanding turbine stage. Exhaust gases from that turbine will exchange heat with the incoming cavern air in a recuperator, and pass through a catalytic oxidation unit (for reduction of carbon monoxide and volatile organic compounds) and a selective catalytic reduction (SCR) unit (for reduction of nitrogen oxides) before exhausting to the atmosphere through two stacks. The catalytic oxidation and SCR units will be integrated with the recuperative heat exchangers. The electrical generators driven by the expansion turbines are rated to produce nominally 135 MW per turbine train, with a peak gross production of 140 MW. Cooling water will be used to cool the electric generator sets. Annually, the Chamisa Facility will combust up to 6,270,000 MM Btu of natural gas in the two CAES power trains to produce up to 1,425,000 MWh of electricity at the turbine generator.[3]

Heated cooling water from each compressor train and generator set will be cooled in mechanical draft cooling towers equipped with high-efficiency mist eliminators to minimize drift emissions.

A natural gas-fired generator with a capacity of 1400 ekW will provide emergency power when necessary. This generator will be equivalent to a Caterpillar SR4B-DM5498 generator set equipped with a G3516B LE (Low Emission) engine. The generator will operate in non-emergency operations less than 100 hours per year.

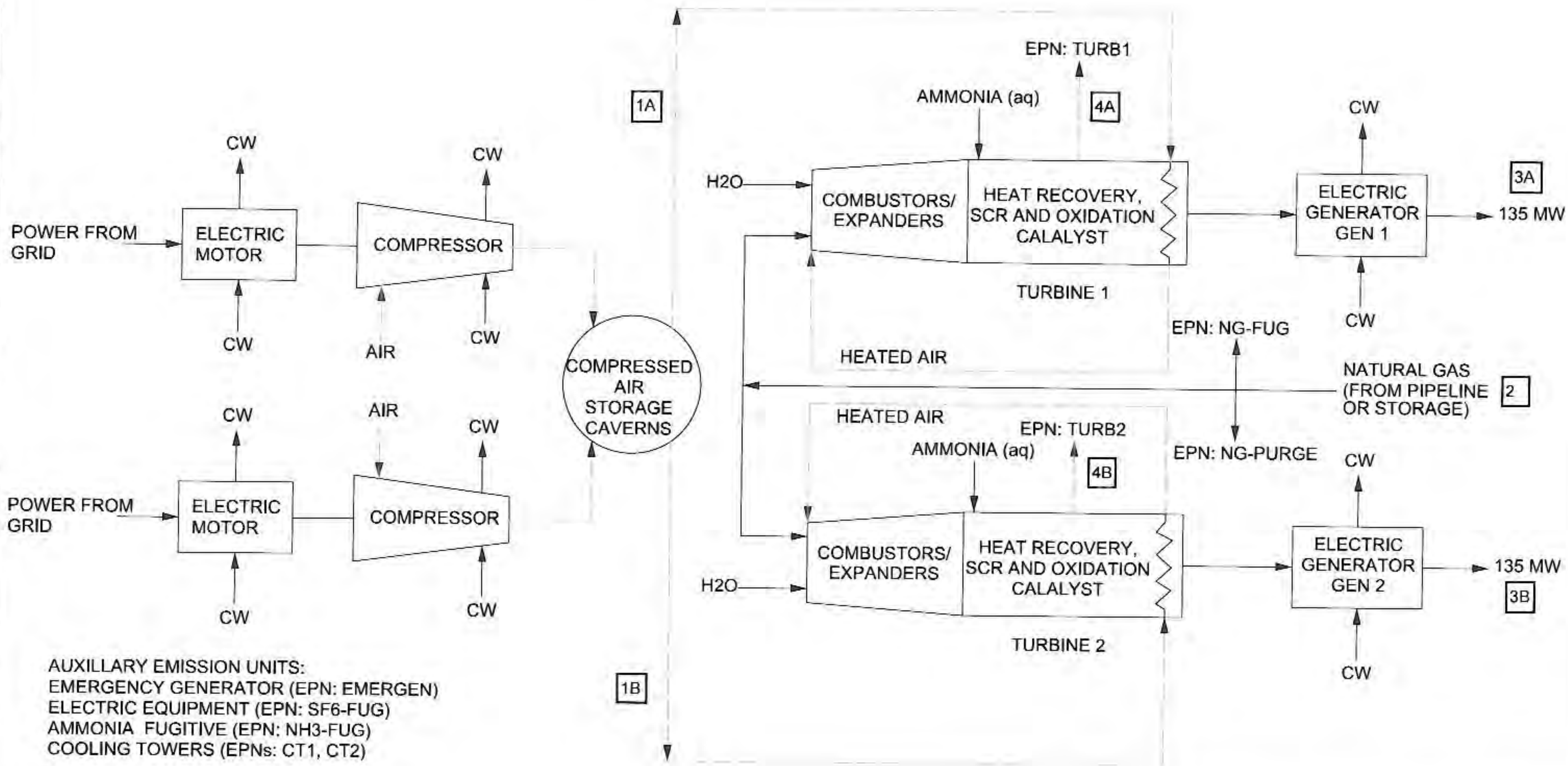
The two expansion turbine trains will exhaust through stacks [Emission Point Numbers (EPNs) TURB1 and TURB2], and the emergency generator will exhaust through stack EPN EMERGEN. These emission sources will release both GHG and non-GHG air pollutants. The GHG pollutant sulfur hexafluoride (SF_6) will be released in low-volume leaks from circuit breakers as EPN SF_6-FUG. Leaks from the natural gas supply equipment (EPN NG-FUG) and periodic maintenance purges of natural gas (EPN NG-PURGE) will release mostly GHG emissions but a small amount of non-GHG emissions. GHG emissions from these sources will be considered further in this permit application. Particulate matter emissions from the cooling towers (EPNs CT1 and CT2) and ammonia emissions from the ammonia supply system (EPNs

[2] The caverns will be formed by leaching salt from underground salt deposits. The cavern forming process will use only electrical driven equipment and will not generate any GHG emissions.
[3] Based on a combined 10,000 hours of yearly operation of the two turbine trains at the maximum production level, and fuel usage and power production during startup and shutdown periods at half the maximum production level.

NH3-STOR and NH3-FUG) do not comprise GHG emissions and will not be considered further in this permit application. Non-GHG emissions will also not be covered in this permit.

Other process equipment and systems at the site support either the cavern development or the power plant. However, these equipment and systems are not sources of GHG emissions. They include: 1) the air storage caverns; 2) equipment for the development and maintenance of the caverns; 3) electrically-driven equipment including the air compressors, water and wastewater pumps, and instrument air compressors; and 4) water and wastewater treatment and handling systems.

Chamisa CAES at Tulia
PROCESS FLOW DIAGRAM



AUXILLARY EMISSION UNITS:
EMERGENCY GENERATOR (EPN: EMERGEN)
ELECTRIC EQUIPMENT (EPN: SF6-FUG)
AMMONIA FUGITIVE (EPN: NH3-FUG)
COOLING TOWERS (EPNs: CT1, CT2)

NOTE:
EPN - EMISSION POINT NUMBER
CW - COOLING WATER
—— AIR FLOW

CHAMISA ENERGY

DWW	10/1/12	10/10/12	FLOW	4

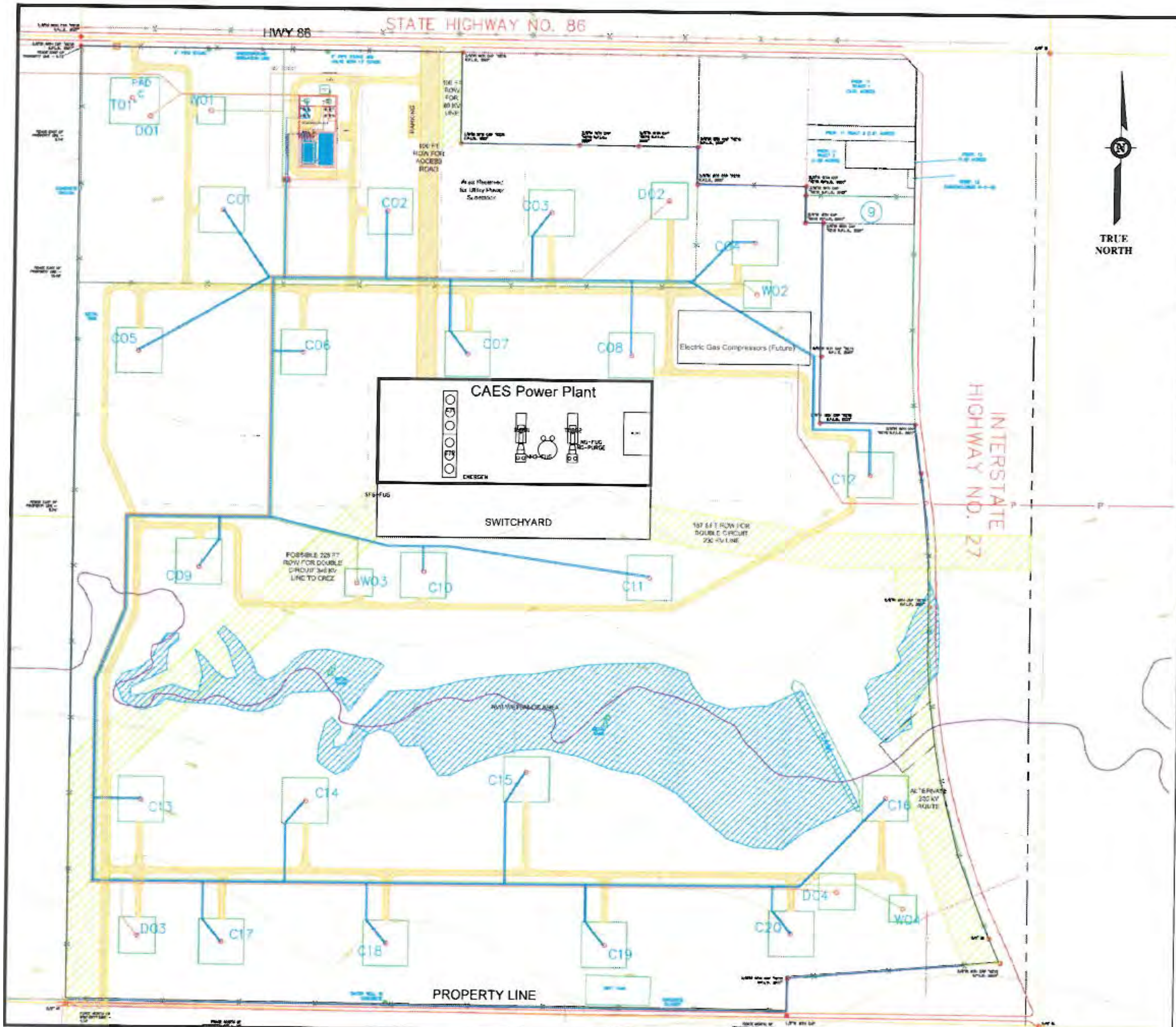
H:\CLIENTS\MURIN ENVIR\MUR4615\CHAMISA\ACAD

3.0 SITE INFORMATION

As shown in the Area Map, the Chamisa Facility will be located southwest of the Intersection of Interstate Highway 27 and State Highway 86, in Swisher County, Texas, just southwest of the City of Tulia.

The preliminary plot plan shows the location of Chamisa Facility on the Chamisa property, and the general locations of the planned storage cavern developments.


34°, 31', 26" N 101°,48', 20" W WGS84
1 MILE RADIUS
3,000 FEET RADIUS
HWY 86
TULIA
INTERSTATE 27
US HWY 87
TRUE
NORTH
© 2012 Google
4101 ft
1/2
0
1 MILE
Imagery Date 3/31/2012
14 S 241672.34 m E 3823629.10 m N elev 3503 ft
Google earth
Eye alt 21217 ft
Annotations by Weld Environmental
CHAMISA
ENERGY



Emission Point Number	Name	Location Easting, Northing (meters)
CT1	COOLING TOWER 1	242540, 3823795
CT2	COOLING TOWER 2	242540, 3823722
EMERGEN	EMERGENCY GENERATOR	242584, 3823682
NG-FUG	NG FUGITIVES	242742, 3823745
NG-PURGE	NG PURGE	242742, 3823745
NH3-FUG	AMMONIA FUGITIVES	242664, 3823726
SF6-FUG	SF6 FUGITIVES	242420, 3823651
TURB1	TURBINE 1	242660, 3823762
TURB2	TURBINE 2	242746, 3823762

0 100 200 400

SCALE IN METERS

LEGEND

- IRON ROD FOUND (IRF)/SPIKE NAIL (SNF)
- PLANNED WELLHEAD LOCATION
- PLANNED WELL PAD LOCATION
- PIPE STAND
- FOREST PULL
- EXISTING OVERHEAD ELEC. LINE
- WIRE FENCE
- PROJECT PROPERTY BOUNDARY
- EXISTING ROAD BOUNDARIES
- SURVEY SECTION BOUNDARIES
- CREEK LINE
- PROPOSED ELEC. SUPPLY LINE
- PROPOSED FUEL GAS SUPPLY LINE
- PLANNED ROW FOR ACCESS ROADS
- PLANNED ROW FOR ELECTRICAL TRANSMISSION
- WETLANDS AREA (NATIONAL WETLANDS INVENTORY)
- USGS ELEVATION CONTOURS (5 FT CONTOUR INTERVAL)
- PIPELINE – RAW WATER
- PIPELINE – SOLUTION MINING WATER IN
- PIPELINE – SOLUTION MINING WATER OUT
- PIPELINE – DISPOSAL BRINE

Annotations for CAES Power Plant by Murin Environmental Inc.

LONQUIST & CO. LLC

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DWW	10/1/12	10/15/12	PLOT	5

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4.0 GHG EMISSIONS

As noted in the Process Description, sources of GHG emissions on the site will include the following:

- Two gas expansion turbine trains
- An emergency generator
- Natural gas line equipment fugitive releases
- Natural gas maintenance purge releases
- SF_6 leaks from circuit breakers

GHG emissions from these sources are summarized in Table 1. The bases for and calculations of these emissions are further discussed below and in Tables 2 through 6. The Chamisa Facility will not emit two of the six pollutant categories which comprise GHG pollutants, namely hydrofluorocarbons or perfluorocarbons. The plant will emit some amount of each of the remaining four categories of GHG pollutants (CO_2, CH_4, N_2O, and SF_6), but emissions of CO_2 comprise 99% of the total annual tons of GHG pollutants as CO_2-e, and nearly 99.99% of the mass emissions of GHG pollutants.

4.1 Gas Expansion Turbine Trains

GHG emissions from the turbine trains comprise CO_2, CH_4, and N_2O. Emissions of CO_2 during normal operations are those estimated by the turbine manufacturer. Emissions of CH_4 and N_2O are estimated from the EPA's Compilation of Air Pollutant Emission Factors (AP-42, 5th Edition) and the maximum fuel usage rates. (Vendor data for CH_4 emissions were much lower than those based on AP-42 emission factors; the values from AP-42 were used to be conservative.) GHG emissions during startup and shutdown operations were conservatively estimated to be the same as those in normal operations. Actual GHG emissions in these operations will be less, based on the lower firing rate of natural gas. Table 2 provides the emission calculation bases and example calculations.

4.2 Emergency Generator

GHG emissions from the emergency generator are based on the vendor maximum fuel usage rates and emission factors from AP-42. Table 3 provides emission calculation bases and example calculations.

4.3 Natural Gas Line Fugitives and Maintenance Purges

Natural gas line fugitive emissions are determined from the number of pipeline components such as control and relief valves, flanges, and sampling connections, and emission factors in 40 CFR 98 Table W-1A. The speciation of the fugitive releases uses data on the maximum composition of GHG components in the natural gas supply. Table 4 provides the emission calculation bases and example calculations.

The number and extent of maintenance purges are estimated from one maintenance purge per quarter for each expansion turbine train. The amount of natural gas lost in each purge is conservatively estimated as 1000 acf/purge at 950 psig. Again, the speciation of the natural gas emissions is based on the maximum composition of GHG components in the natural gas supply. Table 5 provides the emission calculation bases and example calculations.

4.4 SF_6 Leaks from Circuit Breakers

Leaks of SF_6 are based on the amount of SF_6 in circuit breakers at the power plant and a standard leak rate of 0.5% per year, which corresponds to the use of modern design circuit breakers and a comprehensive leak monitoring program. Table 6 provides the emission calculation bases and example calculations.

	Turbine 1			Turbine 2			Emergency Gen		NG-Purge		NG-Fugitives		SF_6 Fug	TOTAL	
	Normal, lb/hr	SSM, lb/hr	Total*, tons/yr	Normal, lb/hr	SSM, lb/hr	Total*, tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	tons/yr	tons/yr	PSD Significant Increase Levels, tons/yr
CO_2	74,455	74,455	200,601	74,455	74,455	200,601	1,729	86.45	29.1	0.116	0.01	0.044		401,288	N/A
CH_4	5.29	5.29	14.25	5.29	5.29	14.25	16.88	0.84	2592.4	10.37	0.92	4.03		43.74	N/A
N_2O	1.84	1.84	4.96	1.84	1.84	4.96								9.92	N/A
SF_6													0.0073	0.0073	N/A
GHG	74,462	74,462	200,620	74,462	74,462	200,620	1,746	87.29	2,622	10.49	0.93	4.07	0.0073	401,342	100,000
CO_2-e	75,137	75,137	202,438	75,137	75,137	202,438	2,083	104	54,470	217.89	19.3	84.67	174.47	405,457	100,000

*Total GHG emissions reflect normal operation of each turbine train for an average of 5000 hours operation at maximum production per year, and startup and shutdown operations, but each train could actually operate at greater hours at lower producton levels or at maximum production if the other train was operated less, to keep emissions below the total for the two turbines.

Bases for Calculations

- Total Annual Operating Hours, Normal Maximum Operation, Per Turbine*	5000
*Not proposed as a limit for each unit, but as a basis for development of an operations and emissions cap.	
- Total Number of Startups Per Year, Per Turbine	700
- Maximum Duration of Startup, min	30
- Maximum Annual Startup Hours, Per Turbine	350
- Total Number of Shutdowns Per Year, Per Turbine	700
- Maximum Duration of Shutdown, min	3.3
- Maximum Annual Shutdown Hours, Per Turbine	38.5
- Basis of Turbine Emission Rates	Vendor data except as noted
- Maximum Turbine Firing Duty, MM Btu/hr (HHV), Per Turbine	614.854

Maximum Emission Rates

	Turbine 1						Turbine 2					
	Normal, lb/hr	Startup, lbs/start-up	Startup, lbs/hr (incl. normal operation)	Shutdown, lbs/shutdown	Shutdown, lbs/hr (incl. normal operation)	Annual, tons/yr	Normal, lb/hr	Startup, lbs/start-up	Startup, lbs/hr (incl. normal operation)	Shutdown, lbs/shutdown	Shutdown, lbs/hr (incl. normal operation)	Annual, tons/yr
CO_2	74,455	N/A	74,455	N/A	74,455	200,601	74,455	N/A	74,455	N/A	74,455	200,601
CH_4	5.29	N/A	5.29	N/A	5.29	14.25	5.29	N/A	5.29	N/A	5.29	14.25
N_2O	1.84	N/A	1.84	N/A	1.84	4.96	1.84	N/A	1.84	N/A	1.84	4.96
CO_2-e	75,137	N/A	75,137	N/A	75,137	202,438	75,137	N/A	75,137	N/A	75,137	202,438

Tabulation of HAPs, CH_4, and N_2O Emission Factors from AP-42, Tables 3.1-2a and 3.1-3

CH_4	0.0086 lbs/MM Btu
N_2O	0.003 lbs/MM Btu

Calculation of CO_2 Hourly Emissions

(20.682 lb/sec CO2) X (3600 sec/1 hour) = 74455 lbs/hr

Tabulation of GHG Warming Potential Equivalency Factors (40 CFR Part 98 Subpart A, Table A-1)

CO_2	1 kg CO_2-e/kg CO_2
CH_4	21 kg CO_2-e/kg CH_4
N_2O	310 kg CO_2-e/kg N_2O

Calculation of CO_2-e Hourly Emissions

(74,455 lb CO2/hr) X (1lb CO2-e/lb CO2) + (5.29 lbs CH4/hr) X (21 lb CO2-e/lb CH4) + (1.84 lbs N2O/hr) X (310 lb CO2-e/lb N2O) =
75,137 lbs CO_2-e/hr

Note: AP-42 is the U.S. EPA's *Compilation of Air Pollutant Emission Factors*, 5th Edition.

Gas-Fired Generator - Caterpillar G3516B - DM5498 (Lean Burn)

Maximum Gross Generator Output , kW	1400
Maximum Heat Duty, MM Btu/hr (LHV)	14.15
Maximum Heat Duty, MM Btu/hr (HHV)[1]	15.72
Annual Hours of Non-Emergency Operation	100
Calculated ghp[4]	1877

Criteria and GHG Pollutants [2]

	NOx	CO	VOC	PM10	SO_2	CH_4	CO_2	HAPs	CO_2-e
Emission Factor, g/ghp-hr (Vendor)	0.5	2.4	0.72	N/A	N/A	4.08	N/A	N/A	N/A
Emission Factor, lbs/MM Btu (HHV) (AP-42 Table 3.2-2)	N/A	N/A	N/A	0.01	0.0014	N/A	110	0.072	N/A
Hourly emissions, lbs/hr	2.07	9.93	2.98	0.16	0.022	16.88	1729	1.13	2083
Annual emissions, tons/yr	0.10	0.50	0.15	0.0080	0.0011	0.84	86.45	0.057	104

Tabulation of GHG Warming Potential Equivalency Factors (40 CFR Part 98 Subpart A, Table A-1)

CO_2	1 kg CO_2-e/kg CO_2
CH_4	21 kg CO_2-e/kg CH_4

Example Calculation of GHG_e Hourly Emissions

(1,729 lb CO2/hr) X (1lb CO2-e/lb CO2) + (16.88 lbs CH4/hr) X (21 lb CO2-e/lb CH4) = 2,083 lbs CO_2-e/hr

Example Calculation of Hourly Emissions

Vendor Data: (1877 ghp) X (0.5 g NOx/ghp-hr) X (1 lb/453.6 g) = 2.07 lbs NOx/hr

AP-42 Data: (15.72 MM Btu (HHV)/hr) X [0.072 lbs HAPs/MM Btu (HHV)] = 1.13 lbs HAPs/hr

Example Calculation of Annual Emissions

(9.93 lbs CO/hr) X (100 hours/yr) X (1 ton/2000 lbs) = 0.50 tons CO/yr

Emission Bases and Calculations

Emission Source Characteristics	
- No. of Gas Valves:	120
- No. of Gas Flanges:	300
- No. of Gas Relief Valves:	8
- No. of Sampling Connections:	18
Emission Factor, scf/hr/component	
- Gas Valve:	0.123
- Gas Flange:	0.017
- Gas Relief Valve:	0.196
- Gas Sampling Connection*:	0.123
*Used factor for gas valves since no factor is provided in Table W-1A of 40 CFR 98.	
Source of Emission Factors:	Table W-1A of 40 CFR 98
Annual Hours of Operation:	8760
Maximum Component Compositon, % Vol	
- CH_4:	91.517
- CO_2:	0.374
Molecular Weights	
- CH_4:	16.04
- CO_2:	44.01
Calculated Fugitive Release, scf/hr = ∑ (no. of components) X (emission factor, scf/hr/component) = 23.642 scf/hr	
GHG Equivalency Factors, lb CO_2-e/lb:	
- CH_4:	21
- CO_2:	1

Calculated Emission Rates

	lbs/hr	tons/yr
CH_4	0.92	4.03
CO_2	0.010	0.044
CO_2-e	19.33	84.67

Example Calculation of Hourly Emissions (CH_4):

(23.642 scf/hr) * (91.517 scf CH4/100 scf gas) X (1-lb-mol/379 scf) X (16.04 lbs CH4/lb-mol) =
0.92 lbs CH_4/hr

Example Calculation of Annual Emissions (CH4)

(0.92 lbs/hr) X (8760 hrs/yr) X (1 ton/2000 lbs) = 4.03 tons CH_4/yr

Example Calculation of CO_2-e Hourly Emissions

(0.010 lb CO2/hr) X (1lb CO2-e/lb CO2) + (0.92 lbs CH4/hr) X (21 lb CO2-e/lb CH4) =
19.33 lbs CO_2-e/hr

Emission Bases and Calculations

Fuel Gas Volume Lost in Purge, acf/purge:	1000
Maximum Fuel Gas Pressire, psig:	950
Minimum Fuel Gas Temperature, °F:	50
Maximum Purges per Hour:	1
Maximum Purges, per year:	8
Calculated Volume per Purge, scf/purge:	66915
Calculated Lb-Moles per Purge, lb-mol/purge:	176.6
Calculated Lb-Moles per Year, lb-mols/year:	1412.8

	Gas Comp., % vol	**Molecular Weight**	**lbs/hr, lbs/purge**	**tons/yr**	**CO_2-e Factor, ton/ton***	**CO_2-e, lbs/hr**	**CO_2-e, tons/yr**
Carbon Dioxide	0.374	44.01	29.1	0.116	1	29.1	0.116
Methane	91.517	16.04	2592.4	10.37	21	54440	217.77
Total						54470	217.89

Note: Highest values from representative sampling used for each gas component, so total composition exceed 100%.
*GHG Warming Potential Equivalency Factor from 40 CFR Part 98, Subpart A, Table A-1.

Calculation Formulae:
Calculated Volume per Purge [=] (acf/purge) X [(950 + 14.7) psia / 14.7 psia] X [(60 + 460) deg R / (50 + 460) deg R]
Calculated Lb-Moles per Purge [=] (scf/purge) X (1 lb-mole /379 scf)
Calculated Lb-Moles per Year [=] (lb-moles/purge) X (purges/year)
Calculated Lbs/Day or Hour [=] (lb-moles/purge) X (purges/day or hour) X (% Vol / 100 %) X (MW lbs / lb-mole)
Calculated Tons/Year [=] (lbs/day, hour, or purge) X (purges/year) X (1 ton / 2000 lbs)

Emission Bases and Calculations

No. of Circuit Breakers:	8
Amount of SF_6 in each Circuit Breaker, lbs:	365
Estimated annual leak rate, wt. %:	0.5
Estimated annual SF6 emissions = (8 breakers) X (365 lbs/breaker) X (0.5 % lost/yr) X (1 ton/2000 lbs) = 0.0073 tons SF_6/yr	
GHG Equivalency Factor, ton CO_2-e/ton SF_6:	23900
Estimated annual CO_2-e emissions = (0.0073 tons SF6/yr) X (23900 tons CO2-e/ton SF6) = 174.47 tons CO_2-e/yr	

5.0 PSD APPLICABILITY SUMMARY

As shown in Table 1, the Chamisa Facility will emit 401,342 tons/yr of GHG pollutants, and 405,457 tons/yr of CO_2-e pollutants. As shown in Table 1F, the Chamisa Facility is not subject to PSD for non-GHG pollutants because the emissions of non-GHG are less than the significant increase levels defined for those pollutants in the PSD rules.

Sources and emissions subject to PSD permitting requirements because of their potential to release GHG emissions are subject only to some of the requirements of the PSD rules. The primary requirement of a PSD permit for GHG emissions is to require that the permitted facilities use the Best Available Control Technology (BACT) for controlling GHG emissions. The resulting PSD permit specifies emission levels reflecting the use of BACT, including emissions monitoring and other requirements to ensure that the BACT emission levels are maintained during operations. An analysis of and rationale for BACT for the GHG sources at the Chamisa Facility are provided in Section 6.0.

The Chamisa Facility is not subject to other PSD permit requirements. It is not subject to an analysis of ambient air impacts because there are no National Ambient Air Quality Standards or PSD Ambient Air Increments for GHG emissions. It is not subject to preconstruction ambient air monitoring because of the nature of GHG emissions and their potential global impact; there is no benefit for the gathering of local ambient air monitoring data on GHG pollutants. EPA's permitting guidance for GHG also indicates there is no need to conduct analyses of additional impacts on Class I areas, soils and vegetation because quantifying the impacts attributable to a single source is not feasible with current climate change models.[4]

[4] U.S. EPA, PSD and Title V Permitting Guidance for Greenhouse Gases, EPA-457/B-11-001, March 2011.

TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.: **TBD**	Application Submittal Date: **October, 2012**
Company: **Chamisa CAES at Tulia, LLC**	
RN: **TBD**	Facility Location: **Plant site is SW of Intersection of I-27 and State Highway 86, SW of Tulia**
City: **Tulia**	County: **Swisher**
Permit Unit I.D.: **Chamisa CAES at Tulia**	Permit Name: **Chamisa CAES at Tulia**
Permit Activity: ☒ New Source ☐ Modification	

Complete for all Pollutants with a Project Emission Increase.	**POLLUTANTS**							
	Ozone							
	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO_2-e
Nonattainment?	No	No	No	No	No	No	No	No
PSD?	No	No	No	No	No	No	No	Yes
Existing site PTE (tpy)?	0	0	0	0	0	0	0	0
Proposed project emission increases[1]?	6.27	37.44	39.42	8.07	7.39	37.44	4.64	405,457
Is the existing site a major source?	No	No	No	No	No	No	No	No
If not, is the project a major source by itself?	No	No	No	No	No	No	No	Yes
If site is major source, is project increase significant? **N/A**								
If netting required, estimated start of construction: **N/A since a new grassroots plant is proposed**								
5 years prior to start of construction **N/A**							contemporaneous	
Estimated start of operation **N/A**							period	
Net contemporaneous change, including proposed project (tpy)	6.27	37.44	39.42	8.07	7.39	37.44	4.64	405,457
Major NSR Applicable?	No	No	No	No	No	No	No	Yes

[signature] — *Signature*; Managing Director — *Title*; 10/31/12 — *Date*

[1] Sum of proposed emissions minus baseline emissions, increases only.

The representations made above and on the accompanying tables are true and correct to the best of my knowledge.

6.0 BEST AVAILABLE CONTROL TECHNOLOGY (BACT)

EPA's PSD rules require that any emissions emitted above the significant increase level, and thus subject to the PSD permitting process, be subject to the BACT analysis. Title 40 CFR 52.21(b)(12) reads in part:

> *Best available control technology* means an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under [this] Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61.

BACT is established in a top-down analysis where the most effective control technology is selected if it is technically feasible and has "reasonable" energy, environmental, and economic/cost impacts. As described in EPA's PSD and Title V Permitting Guidance for Greenhouse Gases (EPA, 2011) the steps to be followed in establishing BACT are the following:

1) Identify all available control technologies
2) Eliminate technically infeasible options
3) Rank remaining control technologies
4) Evaluate most effective controls and document results
5) Select the BACT

These steps are used below to evaluate and select BACT for the gas expansion turbine trains that will be utilized at the Chamisa Facility.

6.1 Gas Expansion Turbine Trains

6.1.1 Step 1 - Identify all available control technologies.

There are two fundamental control technology options for the gas expansion turbine trains. The first is carbon capture and storage (CCS). CCS is an add-on technology that captures GHG emissions resulting from natural gas combustion before they enter the atmosphere. In this instance the captured CO_2 would be compressed and transported via pipeline to a site where the CO_2 could either be stored or used (for example, for enhanced oil recovery). The second option is the baseline option of using efficient CAES gas turbine trains and maintaining and operating each CAES train component properly.

6.1.2 Step 2 - Eliminate technically infeasible options.

According to EPA GHG Permitting Guidance document a technology is technically feasible if it (1) has been demonstrated and operated successfully on the same type of source under review or, (2) is available and applicable to the type of source under review.[5] In the United States, there are presently <u>no</u> existing demonstrations of CCS systems used in the removal of CO_2 from natural-gas turbines, from turbines fired

[5] Ibid, page 33.

with other fuels, or from gas-fired, liquid-fired, or solid-fired boilers and furnaces.[6] One project, the Kemper County Integrated Gasification Combined Cycle Project, is under construction in Mississippi.[7] This project features the removal of CO_2 from a syngas produced from coal gasification; the syngas is then used in a conventional combined cycle power unit. A similar demonstration project, the Texas Clean Energy IGC project, has been planned for Penwell, Texas but construction has not begun.[8] Both of these projects will use technology in a pre-combustion application similar to gas processing conducted in petroleum refineries and natural gas treatment facilities, and do not demonstrate CCS on post-combustion equipment exhausts. Combustion exhausts are at low pressure while gasifier streams are at medium to high pressure: the low pressure in turbine exhausts limits the availability, viability, and practicability of technologies for the removal of CO_2 since some technologies are viable only at medium or high pressure. In addition, the concentration of CO_2 in combustion exhausts is much lower than in gasifier streams. Overall, the lack of utilization of the CO_2 capture/compression/transport/storage as BACT reflects the emerging nature of the CCS technology and the fact that it is not deployed even in demonstration projects on combustion sources.

Just two years ago, the President's Interagency Task Force on Carbon Capture and Storage 2010 report found,

> Current technologies …are not ready for widespread implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application. Since the CO_2 capture capacities used in current industrial processes are generally much smaller than the capacity required for the purposes of GHG emissions at a typical power plant, there is considerable uncertainty associated with capacities at volumes necessary for commercial deployment.[9]

CCS systems comprise three key systems: capture, transport and storage.

<u>*Capture*</u>

The CO_2 capture system uses one of several absorption processes to absorb CO_2 from the combustion exhaust gas into a liquid such as monoethanolamine. The absorbed CO_2 is then released by changing the temperature and/or pressure of the absorbing liquid. The enriched CO_2 stream must then be compressed for transport to storage or an end-use. The absorption and compression processes increase the internal energy use for the power plant by 10-40%.[10]

<u>*Transport*</u>

The availability of transportation to move the captured CO_2 presents a second critical issue to the technical viability of the CCS option.

CO_2 pipelines in the Permian Basin are shown in the figure below. There are presently no existing pipelines that could transport the CO_2 stream from the Chamisa Facility to a storage facility or an

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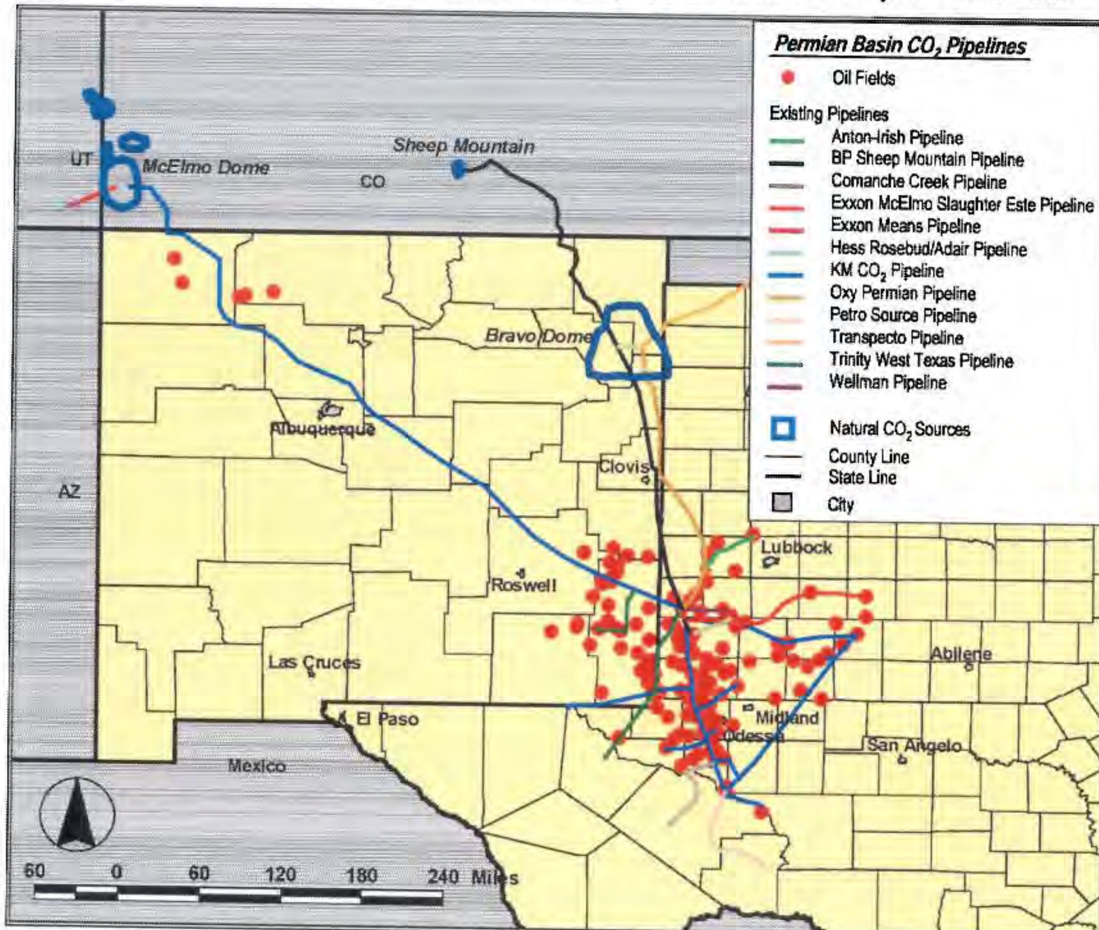
[6] Search of EPA's RACT/BACT/LAER Clearinghouse, EPA Clean Air Technology Center, 10/8/2012, and literature survey.
[7] Whether Mississippi Power can recover the costs of building the Kemper facility is currently pending before the Sixth Chancery Court District of Mississippi.
[8] According to the Penwell project website, as of September 14, 2012 construction of this project had not begun. http://www.texascleanenergyproject.com/news-room/
[9] *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.
[10] Intergovernmental Panel on Climate Change, Special Report on Carbon Dioxide Capture and Storage, (Bert Metz et al. eds., 2005)

enhanced oil recovery ("EOR") field. The closest existing CO_2 pipeline – the Anton-Irish Pipeline - is located about sixty miles (97 km) south, southwest of the proposed Chamisa Facility. The Anton-Irish



CO_2 Pipelines in the Permian Basin[11]

Pipeline is privately owned by Oxy Permian and the line's capacity is dedicated to Oxy's operations.[12] Because this is a private line, Chamisa cannot demand access to the line and even if Oxy were amenable to Chamisa using its line, whether the pipeline or the site it delivers to have any available capacity is unknown to Chamisa. In addition the Anton-Irish line may not be suitable for the transportation of anthropogenic CO_2. In its 2012 report The Global CCS Institute noted:

> [T]here are significant differences between the US experience with CO_2 EOR pipelines (mainly dealing with naturally occurring CO_2), and the expertise needed to design transport systems for anthropogenic CO_2. The composition of CO_2 that is captured from power plants, for instance, will influence the hydraulics calculations that are needed to design these pipelines. Impurities or by-products such as nitrogen, argon, methane, and

[11] Advanced Resources International, *Basin-Oriented Strategies for CO2 EOR: Permian Basin*, prepared for U.S. Department of Energy, February 2006.

[12] A Policy, Legal and Regulatory Evaluation of the Feasibility of a National Pipeline Infrastructure for the Transport and Storage of Carbon Dioxide, page 38 (September 2010).

> hydrogen lower the density of a CO_2 stream, resulting in a higher pressure drop…Moreover, combinations of impurities (e.g. from different sources) could together raise the critical pressure more than that from one component in isolation. The characteristics of CO_2 with impurities are therefore vitally important to know in order to properly engineer a CO_2 transport system. Detailed thermodynamics of CO_2 with impurities has been modeled, but the available models need to be **further** validated.[13]

Aside from the costs related to the building of a new CO_2 line, there are other adverse factors. Private right of way would need to be obtained from likely hundreds of landowners. The sensitivity of and impact on wildlife of such a pipeline would need to considered along with the time delays inherent in obtaining all of the required permits and approvals from State and possibly Federal agencies.

Storage

Finally, the availability of a geologic storage site for the storage of the captured CO2 or for use in EOR operations presents many technical challenges. After a search of publicly available information, Chamisa was unable to find any geologic sites in the immediate vicinity of the Chamisa facility that are viable for large-scale, long-term CO_2 storage. Even if there were a storage site with available capacity, any geologic site to be used for CO_2 injection and storage would need to be extensively characterized and studied which would take several years and would cost several million dollars.[14] The viability of a potential storage site depends on the trapping mechanisms and capacity of the geological formations, and the risks for environmental effects on subsurface and surface waters resulting from pipeline and storage facility leaks. In addition the quality of the CO_2 produced from the Chamisa facility would impact the suite of storage options available to it. While EOR sites exist in the Permian Basin, the Chamisa Facility is approximately 60 miles away from the nearest pipeline terminus and the transportation challenges noted above would apply. In addition, whether the captured CO_2 would be suitable for injection as part of an EOR operation is unknown.

Because of the lack of demonstration of CCS on gas turbine power plants, and other power plant applications, lack of commercial deployment, lack of a transport pipeline, and uncertainties on the possible use of the CO_2 for EOR or for storage in geologic storage sites, CCS is not considered to be a technically viable option.

Gas turbo machinery such as that proposed for use at the Chamisa Facility are readily commercially available and demonstrated in practice, and are considered to be technically viable. The Chamisa Facility has a low heat rate (conversely, a high energy efficiency) due to 1) the use of power generated mainly from wind turbines to operate the air compressors, 2) the use of a recuperator to recover heat from the turbine exhaust gas and use it to heat incoming air, and 3) the use of modern gas turbine technology. By minimizing fuel usage, these techniques also minimize the release of GHG. This is discussed further below.

6.1.3 Step 3 - Rank remaining control technologies.

CCS technology has the potential to remove between 85 to 90% of the CO_2 from the turbine train exhaust, and this potential capability gives it the first rank for control effectiveness. The baseline option to use efficient gas turbine technology does not reduce CO_2 further than by the innate efficiency of the CAES production technology.

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[13] Global CCS Institute, The Global Status of CCS: 2012, Canberra Australia, 123-124 (emphasis added).
[12] Ibid, at 129

6.1.4 Step 4 - Evaluate the most effective controls and document results

Post-combustion capture of CO_2 could potentially remove 90%, or 361,159 tons per year of CO_2 from the two turbine train exhausts.

Costs for CCS applied to natural gas-fired gas turbines, primarily in combined cycle applications, have been widely examined in studies conducted by the U.S. Department of Energy, the Interagency Task Force on Carbon Capture and Storage, the Electric Power Research Institute, and others. Results of the most recent of these have been presented in the "The Cost of Carbon Capture and Storage for Natural Gas Combined Cycle Power Plants"[15] along with additional estimates generated from Carnegie Mellon University's Integrated Environmental Control Model. These cost estimates can be readily extrapolated to the CAES turbine exhaust because the exhausts from both CAES turbines and combined cycle power plants have similar characteristics, including similar levels of impurities and carbon dioxide (3-5% by volume). One difference is the scale of the production facility. The studied combined cycle power plants have all featured two F Class gas turbines with a total power output approximately twice that of the two CAES gas turbines. This difference in scale results in a higher capital cost per unit of power produced or carbon dioxide removed for the CAES turbines. While Chamisa has considered that effect in the calculation of capital cost below, we have not escalated the annualized costs to consider the higher relative capital cost for a CCS system used with CAES turbines. The annualized costs for a CAES facility can thus be expected to be even higher than the estimates provided below. Costs are presented in 2011 dollars.

Cost Component	CCS Cost for Chamisa CAES
Total Capital Cost	$230 million
Total Annualized Cost	$22-37.5 million
Cost Effectiveness	$61-104/ton CO_2 removed

The capital costs include the CO_2 absorption trains, CO_2 compression trains, CO_2 pipeline costs, and costs for the injection of CO_2 into storage sites or EOR sites. The total annualized costs included annualized capital costs and all fixed and variable operating and maintenance costs. These costs can be expected to reasonably represent the minimum costs of CCS for the Chamisa facility. The cost of CCS would increase the cost of electricity produced at the plant by $0.015-0.026/kWh. Included in these costs are the cost of the higher energy demands at the plant due to the use of CCS, with an expected increase in energy usage (or a reduction in the net power from the plant) of about 15%. The costs estimates were developed with data from the paper cited above and from the Global CCS Institute's 2012 Status Report.[16]

CCS may also have adverse environmental impacts on subsurface and surface water qualities, but like many aspects of CCS, the extent of these and other environmental effects is uncertain.

Finally, it is worth noting that anthropogenic CO_2 used and trapped within an EOR reservoir may not serve the goal of reducing overall GHG emissions. The objective of using CO_2 in EOR operations is to

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[15] E.S. Rubin and Haibo Zhai (Carnegie Mellon University), "The Cost of Carbon Capture and Storage for Natural Gas Combined Cycle Power Plants", Environmental Science and Technology, 2012, 46, 3076-3084.
[16] Global CCS Institute, The Global Status of CCS: 2012, Canberra Australia, 145.

produce oil which will be combusted and emit GHG gasses. Consequently, the net result of a CCS system that is used for EOR could ultimately result in zero GHG savings.[17]

The base case option of the CAES turbine system will not entail the CCS costs or energy impacts. In addition, the Chamisa Facility will achieve heat rates over a range of plant operating rates of 50-100% of capacity of 4511-4674 BTU (HHV basis) per net kWh produced.[18] This compares favorably to a heat rate of approximately 7000-7500 BTU/kWh for natural gas combined cycle power plants, and to a heat rate of 10,200 for simple cycle gas turbines. It also compares favorably to the heat rate of 4390-4773 Btu/kWh reported for another recently proposed CAES facility.[19] The heat rate distinctions directly correlate to a reduced potential for GHG emissions as well.

6.1.5 Step 5 - Select the BACT.

Economic, energy, and environmental impacts all argue against the selection of CCS as BACT. The higher annual costs, and the resulting impact on the costs of produced electricity, would in fact result in the cancellation of the Chamisa Facility, if CCS were required as BACT. CCS is also not considered technically viable. BACT for GHG emissions is the use of the efficient gas turbine CAES technology proposed for the Chamisa Facility, with both turbine trains operated and maintained properly according to the manufacturer recommendations.

6.2 Emergency Generator

The natural-gas fired emergency generator will normally operate less than 100 hours per year in non-emergency operations. GHG from the Emergency Generator will amount to 104 tons/yr of CO_2-e emissions, and 87.29 tons/yr of GHG emissions on a mass basis.

6.2.1 Identify all available control technologies.

There are two options for control of GHG emissions from the emergency generator. The first is to implement the add-on CCS option. The second is to maintain and operate the emergency generator properly, according to manufacturer recommendations and good combustion practice.

6.2.2 Eliminate technically infeasible options.

The use of CCS is not technically feasible for the emergency generator due to the generator's infrequent but critical operating requirements for quick response, short-duration operation; the operating period for the generator would usually end before the CCS absorption unit has reached normal operation. Except for its periodic testing, the emergency generator is intended to operate only for emergency situations when grid power may not be available, when its entire electrical output is required for the emergency situation. No CCS systems have been demonstrated for use on emergency generators.

Maintaining and operating the generator properly is technically viable, as demonstrated by widespread use of these units.

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[17] Global CCS Institute, The Global Status of CCS: 2012, Canberra Australia, 153.

[18] The heat rate increases to 4790 Btu/kWh at 36% load and to 4972 Btu/kWh at 25% load, which is just above the lowest sustainable load level. All heat rate values are based on 3% heat rate degradation between overhauls, and internal energy demand of 2.5% of gross power generated; except that internal energy demand at loads below 50% are estimated as a constant load of 900 kW).

[19] Bethel Energy Center, Anderson County, Texas, Prevention of Significant Deterioration Greenhouse Gas Permit Application, June 2012, Submitted to US. EPA Region 6.

6.2.3 Rank remaining control technologies.

The only option is the base option to maintain and operate the generator properly, according to manufacturer recommendations and good combustion practice.

6.2.4 Evaluate the most effective controls and document the results.

GHG emission estimates for the emergency generator reflect the base option to maintain and operate the generator properly. There are no cost impacts for this option. Energy usage for the generator is nominally 10,100 BTU/kWh, which is comparable to that of a simple cycle gas turbine. There are no adverse environmental effects from the limited operation of the generator.

6.2.5 Select the BACT.

BACT is to maintain and operate the generator properly according to manufacturer recommendations, and to operate at the minimal schedule proposed in the permit application.

6.3 Natural Gas Line Fugitives and Maintenance Purges

Fugitive emissions from the natural gas supply lines amount to 84.67 tons/yr of CO_2-e emissions, and 4.07 tons/yr of GHG emissions on a mass basis. Quarterly maintenance purges from the natural gas supply have been conservatively estimated to comprise 217.89 tons/yr of CO_2-e emissions, and 10.49 tons/yr of GHG emissions on a mass basis.

6.3.1 Identify all available control technologies.

Piping fugitive leaks can be controlled by three basic approaches:

1) Use of leak-less and/or seal-less equipment,
2) Use of a leak detection and repair program using either periodic leak inspection by instrument or remote sensing of leaks by infrared camera,
3) Use of audio/visual/olfactory (AVO) observations of leaks in periodic walkthroughs as part of normal operations. (This method of control results in the base emissions of fugitive leaks.)

Maintenance purges of gas lines can be controlled by either flaring the emissions to reduce the CO_2-e emissions or by minimizing the number of purges.

6.3.2 Eliminate technically infeasible options.

Leak-less piping equipment has been used in the chemical process industry when toxic or hazardous materials are used. They have not been used in natural gas supply lines, and operating/maintenance problems with their operation would require line shutdowns to effect repairs. Because of the safety risk and increased GHG emissions of line shutdowns to repair leak-less equipment, and because the natural gas fuel lines do not contain toxic or hazardous materials, the use of leak-less piping components is infeasible and impracticable. The other options to control fugitive leaks are technically feasible.

Both options to control maintenance purges are technically feasible. Quarterly use of a portable flare does entail higher safety risks.

6.3.3 Rank remaining control technologies.

Both instrument detection of leaks and remote sensing of leaks have been determined to be equivalent control methods by EPA.[20] These methods are ranked as most effective, with an estimated effectiveness of 75-95%. AVO methods are less effective since their observations are not conducted at specified intervals. However, because of the presence of natural gas odorants and the high pressure of the natural gas, AVO is moderately effective. We have not attributed a control efficiency to the AVO monitoring by periodic walk-around inspections because this technique is very likely included with the emission factor used to estimate GHG emissions.

For maintenance purges, flaring would reduce CH_4 and other hydrocarbon emissions by 98% but CO_2-e emissions would be reduced only by 81% since the combustion of the hydrocarbon emissions would result in the formation of CO_2 emissions.

6.3.4 Evaluate the most effective controls and document results.

Leak monitoring quarterly using instrument monitoring would cost approximately $1,500 per quarter or $6,000 annually. Leak monitoring using camera/remote sensing would cost approximately $4,000 per quarter or $16,000 annually. Leak repair costs are estimated to be approximately $5,000 per year. Costs for instrumental or remote monitoring of leaks, and their repair, would thus cost $11,000 to $21,000 annually. For an overall reduction of 85% of the CO_2-e emissions from equipment leaks, this would result in a cost effectiveness of $150-290/ton CO_2-e. Periodic AVO monitoring, as a base option, would have no costs other than those included in normal plant operation and maintenance expense. None of these options have significant adverse environmental or energy impacts.

Rental and operation of a portable flare once per quarter for the maintenance purge would cost approximately $3,500 per quarter or $14,000 annually. For an 81% overall reduction in CO_2-e emissions, this would result in a cost effectiveness of $79/ton CO_2-e. Neither this option nor the base option of minimizing the number of maintenance purges has any significant adverse energy or environmental impacts. Natural gas losses in both cases are the same.

6.3.5 Select the BACT.

Due to the high cost of instrument monitoring or remote monitoring of leaks, with a cost effectiveness of $152-290/ton CO_2-e, neither of these options are BACT for fugitive leaks from the natural gas supply system. BACT is the periodic AVO observation of piping equipment.

Due to the high cost of flaring, with a cost effectiveness of $79/ton CO_2-e, flaring is not BACT for maintenance line purges. BACT is the base option of minimizing the number of purges to 8 per year.

6.4 SF_6 Leaks from Circuit Breakers

SF_6 leaks from circuit breakers will amount to 174.47 tons/yr of CO_2-e emissions, and 0.0073 tons/yr of GHG emissions on a mass basis.

[20] 73 FR 78199-78219, December 22, 2008.

6.4.1 Identify all available control technologies.

There are two technology options. The first is to replace SF_6 with an alternate dielectric material or alternative type of circuit breaker. The second is to use comprehensive leak detection with modern SF_6 circuit breaker technology.

6.4.2 Eliminate technically infeasible options.

Although the development of alternative dielectric materials and types of circuit breakers is underway, no alternative or option has been found to be superior to SF_6 based circuit breakers for high voltage applications. SF_6 provides better electrical insulation, and quenches electric arcs more effectively. Circuit-breakers using SF_6 as the insulating and quenching medium are smaller, safer, and have longer useable lifetimes than alternatives. As such, the use of alternate dielectric materials or types of circuit breaker is not technically feasible.

The use of leak detection and modern SF_6 circuit breaker technology is feasible.

6.4.3 Rank remaining control technologies.

The use of modern circuit breaker technology and comprehensive leak detection methods will allow the Chamisa Facility to achieve a leak rate of 0.5%/year.

6.4.4 Evaluate the most effective controls and document results.

The use of modern circuit breaker technology and comprehensive leak detection methods will not cause any significant adverse economic, environmental, or energy effects.

6.4.5 Select the BACT.

Use of modern circuit breaker technology and a comprehensive leak detection and disposition program constitutes BACT. The comprehensive program will involve inventory and use tracking, leak detection by hand-held halogen detectors, and low-gas density alarms. It will also include a recycling program so that SF_6 is evacuated into portable cylinders rather than vented to atmosphere.

6.5 Proposed Emission and Production Limits, Monitoring, and Maintenance Requirements

Table 7 shows the emission and production limits, monitoring, and maintenance requirements proposed to support BACT.

Emission Source	Emission and Production Limits	Monitoring Requirements	Maintenance Requirements
Gas expander turbine trains	• 404,876 tons/yr CO_2-e from both trains • 75,137 lbs/h CO_2-e from each train • 6,270,000 MM Btu/yr (HHV basis), total from both trains • 1,425,000 MWh (net)/yr, total from both trains • 550 lbs CO_2/MWh (net) @ max. load • 620 lbs CO_2/MWh (net) @ any load from 25% to 100% load	• Determine hourly and annual GHG emissions using 40 CFR 98.43 • Determine and record annual GHG emissions on a rolling 12-month basis • Determine and record lbs CO_2/MWh (net) as a rolling 30-day average • Record annual fuel usage in MM BTU/yr (HHV basis) and net electricity output in MWh/yr on a rolling 12-month basis	• Operate and maintain all equipment according to manufacturer recommendations
Emergency generator	• 104 tons/yr CO_2-e	• Determine annual GHG emissions using 40 CFR 98.33 on a calendar year basis	• Operate and maintain all equipment according to manufacturer recommendations
Natural Gas Piping Fugitive Leaks	• 84.7 tons/yr CO_2-e	• Record leak observations reporting by operating and maintenance staff	• Operate and maintain all equipment according to manufacturer recommendations
Natural Gas Maintenance Purges	• 218 tons/yr CO_2-e	• Record purge volumes and determine annual GHG emissions on a calendar year basis	• Operate and maintain all equipment according to manufacturer recommendations
SF_6 Fugitive Leaks	• 174 tons/yr CO_2-e	• Use inventory records to determine SF_6 and CO_2-e emissions on a calendar year basis • Monitor for leaks using halogen detector on a monthly basis	• Implement a recycling program so that SF_6 is evacuated into portable cylinders rather than vented to atmosphere. • Operate and maintain all equipment according to manufacturer recommendations

Table 7. Proposed Emission and Production Limits, Monitoring, and Maintenance Requirements