Dominion Energy Services, Inc.
120 Tredegar Street
Richmond, VA 23219
DominionEnergy.com

April 24, 2020

BY: ELECTRONIC MAIL and HAND
Tamera.Thompson@deq.virginia.gov

Ms. Tamera M. Thompson
Manager, Office of Air Permitting
Virginia Department of Environmental Quality
1111 East Main St., Suite 1400
Richmond, VA 23219

Subject: **Atlantic Coast Pipeline, LLC**
Buckingham Compressor Station
Supplemental Information in Support of Application for Stationary Source Permit to Construct and Operate Buckingham Compressor Station
Registration Number 21599

Dear Ms. Thompson:

On January 7, 2020, the United States Court of Appeals for the Fourth Circuit issued its decision in *Friends of Buckingham, et al. v. State Air Pollution Control Board, et al.,* No. 19-1152. In that decision, the Court vacated and remanded the minor source permit to construct and operate the Buckingham Compressor Station with specific instructions to the Air Pollution Control Board.* According to the Court's opinion, the remand is for two purposes:

- "for further explanation of reliance on the redefining the source doctrine, and/or why electric turbines are not required to be considered in Virginia's BACT analysis of the Compressor Station" (Opinion at 31); and

- "for the Board to make findings with regard to conflicting evidence in the record, the particular stud(ies) it relied on, and the corresponding *local character and degree of injury* from particulate matter and toxic substances threatened by construction and operation of the Compressor Station" (Opinion at 47 (emphasis in original)).

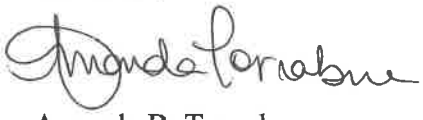
On behalf of Atlantic Coast Pipeline, LLC ("Atlantic"), we request that the Department of Environmental Quality and the Board take the necessary steps to re-issue the minor source permit for the Buckingham Compressor Station in accordance with the Court's instructions.

* Pursuant to the Natural Gas Act, when a federal court of appeals finds an error in a permit such as this, it "shall remand the proceeding to the agency to take appropriate action consistent with the order of the Court". 15 U.S.C. § 717r(d)(3).

In support of this request, Atlantic submits the attached information to supplement its application: Atlantic Coast Pipeline's Supplemental Information on Redefinition of the Source Findings Supporting the Buckingham Compressor Station Air Permit. This information addresses the first issue on which the Fourth Circuit remanded the permit to the Board. In the near future, Atlantic will be submitting additional information that addresses the second issue to further supplement its application.

Should you have any questions, please do not hesitate to contact T.R. Andrake at (804) 839-2760 or at Thomas.R.Andrake@dominionenergy.com.

Sincerely,



Amanda B. Tornabene
Vice President and Chief Environmental Officer
Environmental Services

Attachment

DOCUMENT CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering and evaluating the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I certify that I understand that the existence of a permit under [Article 6 of the Regulations] does not shield the source from potential enforcement of any regulation of the board governing the major NSR program and does not relieve the source of the responsibility to comply with any applicable provision of the major NSR regulations.

SIGNATURE: Brian Wright DATE: 4/24/2020

NAME: Brian M. Wright

TITLE: VP Major Projects

COMPANY: Atlantic Coast Pipeline, LLC

Supplemental Information
Redefinition of the Source Findings Supporting the Buckingham Compressor Station Air Permit

Atlantic Coast Pipeline's Supplemental Information on Redefinition of the Source Findings Supporting the Buckingham Compressor Station Air Permit

The Fourth Circuit vacated and remanded the Buckingham Compressor Station (BCS) Air Permit for "further explanation of reliance on the redefining the source doctrine, and/or why electric turbines are not required to be considered in Virginia's Best Available Control Technology (BACT) analysis of the Compressor Station." Decision p. 31. The court specifically expressed interest in further explanation of "what the Virginia redefining the source doctrine is, how it works, and how this project meets its requirements." Id. at 28. The following sections address each of these topics in turn.

Section I describes the basics of a minor source BACT analysis. Section II describes the regulatory and guidance basis for the redefine the source doctrine. Section III provides examples of how the doctrine has been used in practice over many years. Section IV describes the application of the doctrine to the consideration of electric motor-driven (EMD) compressors for the BCS.

In short, Atlantic Coast Pipeline, LLC (Atlantic) recommends that the Virginia State Air Pollution Control Board (Board) make explicit findings on the legal and factual basis for determining EMDs redefine the source and are not required to be considered in Virginia's BACT analysis of BCS. More specifically, the Board should find, for the reasons detailed below and in the supplemental BACT analysis provided in Attachment A, that, (i) Virginia's BACT does not require redefinition of the source pursuant to law and long-standing practice; and (ii) EMDs at BCS would redefine the source and otherwise not be BACT because they (1) would not meet the project's central purpose of reliability; (2) do not have "practical potential for application" at the BCS site due to the lack of a sufficient electricity source without at least 20 miles of added transmission line to the facility (i.e. the option would be eliminated at Step 1 and Step 2 of the top-down analysis), and (3) would increase environmental impacts – for example, by more than 700% for sulfur dioxide (SO_2) and 200% for nitrogen oxides (NO_x) from power plants within or near Buckingham County justifying elimination at Step 4. These findings should be included in the Board's written decision.

I. Virginia's Minor Source BACT Requirement

Article 6 prohibits the issuance of a minor New Source Review (NSR) permit unless the Board is satisfied that the source will be designed, built and equipped to comply with all applicable standards.[1] One such standard that a new source has to comply with is BACT.[2] The scope of the BACT analysis is determined by the basic purpose or design of the source as proposed by the applicant. The Board's expectation is that BACT for minor sources will be set based on experience with an applicant's industry category without further analysis (i.e., presumptive BACT).[3] In rare cases where BACT is not already identified, a formal BACT analysis is necessary.[4]

[1] 9 VAC 5-80-1180.

[2] 9 VAC 5-50-260.

[3] APG-350A at 8-3.

[4] Although a formal BACT analysis was not necessary for BCS given DEQ's experience with compressor stations, Atlantic nonetheless included it in its application to ensure thorough analysis and transparency given significant public interest in the facility and the project it serves. The rarity of minor source formal BACT determinations, however, has resulted in limited written prior precedent to reference.

For a minor source formal BACT analysis, as prepared for BCS, it is the Board's policy established in Virginia's Article 6 - Minor New Source Review Permit Program Manual that sources follow the top-down process laid out in EPA's Draft New Source Review Workshop Manual (October 1990) (NSR Manual).[5] In accordance with the NSR Manual, available control options are those air pollution control technologies or techniques with a practical potential for application to the emissions unit and the regulated pollutant under evaluation. Air pollution control technologies and techniques include the application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of the affected pollutant. It does not require consideration of different fuel types: "Lower-polluting processes should be considered based on demonstrations made on the basis of manufacturing identical or similar products from identical or similar raw materials or fuels."[6] They also do not include alternatives that would require the basic design of the source to be redefined.

II. Virginia's BACT does not Require Redefinition of the Source

It has long been recognized in the Commonwealth that the BACT requirement, whether for a PSD major source pursuant to Article 8 or a minor source pursuant to Article 6,[7] does not require consideration of alternatives that would redefine the design of the source proposed by the applicant. This concept is incorporated in the Board's regulations and guidance.

A. Virginia regulations do not require redefinition of the source.

Virginia's minor source regulations are focused on the proposed emission unit at a source as defined by the applicant. Specifically, Virginia's minor source BACT regulation requires the Board to consider what "production processes or available methods, systems and techniques" (i.e., controls) can be applied to reduce emissions from the "emissions units" (e.g., natural gas-fired combustion turbines) located at the stationary source (e.g., a compressor station) proposed by the applicant.[8] BACT is determined on an emission unit-by-emission unit basis for each regulated pollutant that triggers permitting.[9] The Board determines the BACT standard by analyzing each emission unit proposed by the applicant in the application.[10]

The regulations do not contemplate the Board considering a fundamentally different "emissions unit" from that proposed for the source. To require a fundamentally different emissions unit through the BACT analysis would override the type of source that the applicant proposes to construct. That is not

[5] APG-350A, Article 6 - Minor New Source Review Permit Program Manual, Draft at 8-3 (Oct. 6, 2005). The top-down process is a five-step analysis: (1) identify all available controls with a potential applicability; (2) eliminate technically infeasible controls identified in step 1; (3) rank the feasible controls; (4) evaluate the feasible controls for economic, environmental, and energy impacts; and (5) select BACT.

[6] NSR Manual at B.10 (addressing what a top-down BACT analysis should consider).

[7] PSD is required for major sources of emissions (e.g., more than 250 tons per year of any regulated pollutant) that are subject to more stringent federal requirements as compared to minor sources, which emit less and are subject to less stringent state requirements.

[8] 9 VAC 5-50-250.

[9] 9 VAC 5-50-240.

[10] 9 VAC 5-80-1190.

the role of BACT; rather, BACT is intended to facilitate state review of control technologies available for the emissions units at the proposed source.

B. Virginia minor source guidance does not require redefinition of the source.

The Board's minor source guidance similarly is clear that Virginia's minor source BACT program does not require redefinition of the source. As noted above, Virginia's minor source guidance provides for a commonly used simplified "presumptive BACT."[11] Virginia's minor source guidance alternatively provides for a more formal BACT approach, as was undertaken at BCS to ensure in-depth analysis and transparency given interest in this minor source facility. And Virginia's minor source guidance is clear that even when undertaking a more formal analysis, redefinition of the source is not required in keeping with EPA permitting guidance.[12] As stated in Virginia's minor source guidance (which incorporates EPA's guidance), a BACT analysis is not "a means to redefine the design of the source" proposed by the applicant.[13]

A source is "redefined" if the alternative source would fundamentally change the proposed emission unit. Analysis of whether an alternative would be a fundamental change focuses on the intended *purpose* of a proposed emission unit for a source.[14] The quintessential example of redefining the source – and one that is highly relevant here – is that an applicant proposing to construct a coal-fired power plant does not have to consider a natural gas-fired power plant as part of the BACT analysis.[15] The BACT requirement is not intended to be a vehicle for the agency to dictate the type of source an applicant is to build. The agency either applies BACT to the source proposed by the applicant or denies the permit on other grounds. It is not the agency's prerogative or responsibility under BACT to mandate that the applicant build a completely different source than that proposed.

C. Redefinition of the source would be inconsistent with Virginia law.

There is further evidence that Virginia's regulations and policy do not require redefinition of the source. The Virginia Code requires the Board to notify the General Assembly if it adopts permitting requirements more stringent than federal law and to explain why more restrictive provisions are

[11] The Board's policy for minor source permitting is found in APG 350, *New Source Review Permits Program Manual* (2002) and APG350A, *Article 6 – Minor New Source Review Permit Program Manual, Draft* (2005). The Board's expectation is that BACT for minor sources will be set based on experience with an applicant's industry category without further analysis (i.e., presumptive BACT).

[12] In rare cases where BACT is not already identified, Virginia's minor source guidance calls for a formal BACT analysis following the top-down process laid out in EPA's Draft New Source Review Workshop Manual (October 1990) (NSR Manual) consistent with the PSD BACT analysis.

[13] NSR Manual at B.13; *see also* EPA-457/B-11-001; *PSD and Title V Permitting Guidance for Greenhouse Gases*, 26-28 (Mar. 2011) (reiterating that BACT is not a means to redefine the source proposed by the applicant). As Judge Posner wrote, BACT requiring consideration of source alternatives "would invite a litigation strategy that would make seeking a permit [] a Sisyphean labor, for there would always be one more option to consider." *Sierra Club v. EPA*, 499 F.3d 653, 654 (7th Cir. 2007) (upholding EPA's redefinition of the source doctrine).

[14] *See, e.g., In re Prairie State Generating Co.*, 13 E.A.D. 1 (EAB 2006) (setting forth an acceptable analysis for determining if an alternative would redefine the source).

[15] NSR Manual at B.13.

needed.[16] No such notification and explanation has occurred on the subject of redefining the source because Virginia law is no more stringent than federal law.

Both Virginia and federal law decline to require consideration of fundamentally different emissions units as part of the BACT analysis. As has been upheld on numerous occasions under federal law, the Clean Air Act does not require consideration of alternatives that would redefine the source to satisfy the BACT requirement for PSD sources.[17] The Board has never informed the General Assembly that Article 6 is more restrictive than the CAA BACT requirement. It did not do so at the time of promulgation of Article 6 and has not done so to date. Instead, the Board has always viewed the Article 6 BACT requirement as being less restrictive than the Article 8 (PSD) requirement, and the Board has never interpreted either article to require consideration of alternatives that would redefine the source proposed by the applicant. Rather, in most instances, minor source BACT in Virginia has used a much more streamlined approach of identifying the "presumptive BACT" for a proposed emissions unit instead of the more formal, top-down analysis used for PSD BACT analyses.[18] For the Article 6 BACT requirement to be interpreted to require consideration of alternatives that would redefine the design of the source would contravene the Board's authority to promulgate regulations under Virginia law since notification was not provided to the General Assembly.

Thus, consistent with the regulations and longstanding policy, the BACT standard for minor sources does not require consideration of alternatives that would redefine the design of the source as proposed by the applicant.

III. Long-Standing Application of the Redefinition of the Source Doctrine

In practice, the Redefinition of the Source Doctrine means the Board considers pollution *control* alternatives, but not alternatives to the type of *emission unit* proposed for a source as illustrated in the following examples.

- 1992 – Clover Generating Station – The agency declined to consider natural gas as an alternative fuel for a proposed coal-fired facility because would "redefine the source." This approach was upheld by the EPA Administrator.[19]

- 2016 – Greensville Generating Station – The agency declined to consider solar as an alternative to natural gas-fired duct burner because would "redefine the source." This approach was upheld upon judicial review.[20]

- 2020 – Transco Compressor Station 165 – In issuing a minor source permit, the agency declined to consider electric motor driven compressors as alternatives to proposed natural gas-fired

[16] Va. Code § 10.1-1308(A).
[17] *See, e.g., Sierra Club v. EPA*, 499 F.3d 653 (7th Cir. 2007) (upholding EPA's redefinition of the source doctrine).
[18] APG-350A at 8-3.
[19] *In re Old Dominion Elec. Coop.* 3 E.A.D. 779, 793-94 (Adm'r 1992) (DEQ issued PSD permit pursuant to delegation from EPA).
[20] *Va. Chapter of the Sierra Club v. Va. State Air Pollution Control Bd.*, No. CL16-3770 (Va. Cir. Ct. City of Richmond, July 28, 2017).

turbine because it would "represent a fundamentally different unit in the project."[21] This permit has not been appealed.[22]

IV. Electric Motor Driven Compressors would Redefine the Design of BCS

EMD compressors would redefine the design of the source proposed for BCS including requiring a different fuel. They would fundamentally change the proposed source and would not meet its central purpose. Moreover, EMDs would not meet BCS's purpose because they are not currently "available" (i.e., they do not have practical potential for application) at the site and likely would result in greater environmental impacts as compared to the proposed natural gas-fired turbines. These factors demonstrate why EMDs are fundamentally contrary to BCS's purpose and would redefine the source at a threshold level. Furthermore, for these same reasons, even if EMDs were included in a top-down BACT analysis, they would be eliminated as BACT at Step 1, Step 2 and Step 4 as reflected in Attachment A.

A. EMD compressors would not satisfy the central purpose of the proposed source.

The purpose of the proposed BCS is to facilitate transport of natural gas along the proposed Atlantic Coast Pipeline. A central purpose of the pipeline is to increase the reliability and security of natural gas supplies in Virginia and North Carolina. Compressor stations, such as BCS, are necessary to maintain the pressure within the pipeline so that the contracted volumes of natural gas can be delivered. If the pipeline is to reliably deliver gas, the compressor station must also be reliable. During the initial design phase of the Project, Atlantic determined that natural gas-fired turbine-driven compression is highly preferable for system reliability, operational flexibility, and to balance the horsepower across the pipeline system. Since the purpose of the facility is to service a natural gas pipeline, natural gas will consistently be available at the site to fuel the combustion turbines. Other sources of energy (e.g., electric), assuming their availability, are susceptible to interruption and therefore would not meet the purpose of the compressor station to provide reliable compression to transport the required volumes of natural gas. BCS is also designed to facilitate this transport efficiently and while minimizing associated environmental impacts.

Electric motors do not provide the reliability required of this proposed source. Although some gas compressors are driven using an electric motor to turn the same type of centrifugal compressor, such installations introduce another measure of gas supply unreliability since an electrical outage would also force a simultaneous natural gas supply outage. Consequently, if electric motors were used and a power outage occurred, facility compression would be unavailable and the ability to make system deliveries would be significantly hindered, which is contrary to the stated purpose of the pipeline that is served by

[21] DEQ Engineering Analysis for Transco – Station 165, Registration No.: 30864, at 9-10 (January 28, 2020) (explaining why use of electric motor driven compressors would redefine the source and were otherwise unavailable for application at the site due to lack of transmission infrastructure).

[22] While the Redefinition of the Source Doctrine has been systematically applied by the agency since the minor source program commenced, there is limited written precedent for it because, prior to BCS, we are not aware of any minor source permit going to the Board and only a few involving formal BACT analysis. Similarly, we are not aware of any prior challenge of a minor source permit.

BCS. FERC explicitly eliminated EMDs as a preferred option given they did not serve the reliability purpose of BCS and the Atlantic Coast Pipeline.[23]

Because electric motors would redefine the design of the source and, more specifically, would not be able to meet the stated purpose for the proposed BCS, which is to increase the reliability and security of natural gas supplies in Virginia and North Carolina, consideration in the BACT analysis is not appropriate.

B. EMD compressors are not available at the site.

Moreover, EMDs would be eliminated as BACT due to "unavailability." "Available control options are those air pollution control technologies or techniques with a *practical potential for application* to the emissions unit and the regulated pollutant under evaluation."[24] Electric motors do not have a practical potential for application at the BCS. The use of electric motors will require additional aboveground power grid infrastructure, including a high voltage power line and substation, to meet the compression demands of the Project. That infrastructure does not currently exist at the BCS site and there is no guarantee that all the necessary federal, state, and local approvals could be obtained even if one wanted to install it.

To bring power to the site, the power provider for the area, Central Virginia Electric Coop (on its own or working with another utility with transmission infrastructure in the area), would have to obtain all necessary federal, state, and local approvals, including environmental approvals, for the construction and operation of an approximately 12 to 20 mile[25] high voltage transmission line as well as a new substation. Additionally, although the transmission line and substation would be installed in a manner to minimize impacts, such impacts (e.g. land use, right of way clearing, potential impacts on sensitive communities and environments, etc.) must be considered.

In addition to the new electric transmission line and substation needed to bring power to the site, redesigning the facility to use electric motors instead of natural gas-fired combustion turbines would require significant evaluation of the station's overall design, including hydraulic design conditions, extensive engineering designs, planned operational characteristics, and impacts to the construction footprint. Assuming all necessary approvals for an approximately 12-mile to 20-mile electric

[23] *See* FERC, Atlantic Coast Pipeline and Supply Header Project – Final Environmental Impact Statement (Volume I) at 3-60 (July 2017) ("Use of electric-driven compressors, from the perspective of meeting Atlantic's emissions, was not considered environmentally superior to natural gas compressors in terms of reducing regional emissions. Although local air emissions from electric-driven compressors would be lower than those from natural gas-driven compressors, use of electric-driven compressors would result in a higher load on the electric power grid and higher emissions from the electric power generating stations. Additionally, the use of natural gas-driven compressors provides reliable, uninterrupted natural gas transmission because the fuel is continually supplied by the pipeline facility and would not be affected by an electrical outage at the compressor station. Considering these factors, we conclude that electric-driven compressor units would not offer a significant environmental advantage over the proposed gas-driven compressors."). Available online at: https://www.ferc.gov/industries/gas/enviro/eis/2017/07-21-17-FEIS/volume-I.pdf.

[24] NSR Manual at B.5 (emphasis added). Without practical potential for application, they cannot meet the project's purpose and would be eliminated at later steps in the BACT analysis in any case (*see* Attachment A).

[25] Early desk-top study suggested a 12-mile option may be available; upon further study, it appears that the transmission line approximately 12-miles away would not be capable of providing the necessary load requirements to the BCS site. Therefore, the transmission line approximately 20 miles may be required to obtain the necessary power at the BCS site.

transmission line and new substation could be obtained, and accounting for the change from natural gas to electric motors, the timeline for the project would be extended by years with minimal improvements to air quality and with additional impacts to the surrounding community and beyond related to the new electric infrastructure.

C. EMD compressors would result in increased environmental impacts.

Similarly, EMDs would be eliminated due to resulting increases in emissions and environmental impacts, which are contrary to BCS's efficient and environmentally-focused purpose and design as described above. Although EMDs would eliminate emissions associated with on-site combustion to power the compression process,[26] there would be significant emissions associated with the off-site power production required by the EMDs. Approximately 430,000 megawatts (MW) per year would be required to meet the electrical demand for an EMD station. There would be emissions associated with that generation and those emissions would likely be higher than the emissions from the proposed natural gas-fired turbines due to higher emitting coal in the regional fuel mix. These emissions would be made further more significant due to inefficiencies associated with the approximately 20 miles of transmission that would be required to get electricity to the BCS site, when natural gas is already there.

To estimate the air quality impacts of the EMD alternative at the regional level (i.e., when offsite electricity generation is considered), ACP conducted a study-level analysis to determine the emissions associated with regional electricity generation relative to the emissions from the proposed gas turbines. This analysis uses emission rates from EPA's Emissions & Generation Resource Integrated Database (eGRID) to compare the emissions from offsite electricity generation relative to the proposed gas turbine emission.[27] The eGRID subregion SRVC was selected based on the location of the station and the electricity provider, Central Virginia Electric Coop. Based on this eGRID subregion, it is likely that the electricity for an EMD alternative would come from plants within or near Buckingham County.

As presented in Table 1, the comparison showed offsite emissions associated with electricity generation have the potential to be significantly higher for NO_X and SO_2, and lower for carbon dioxide equivalence (CO_2e). While eGRID emissions rates for carbon monoxide (CO), volatile organic compounds (VOC), and particulate matter are not available for comparison, it can reasonably be assumed that they also would be significantly higher than the emissions from the proposed gas turbines based on the NOx and SO_2 rates, particularly considering the planned installation of oxidation catalyst (with control efficiencies of 92% and 50% for CO and VOC, respectively).

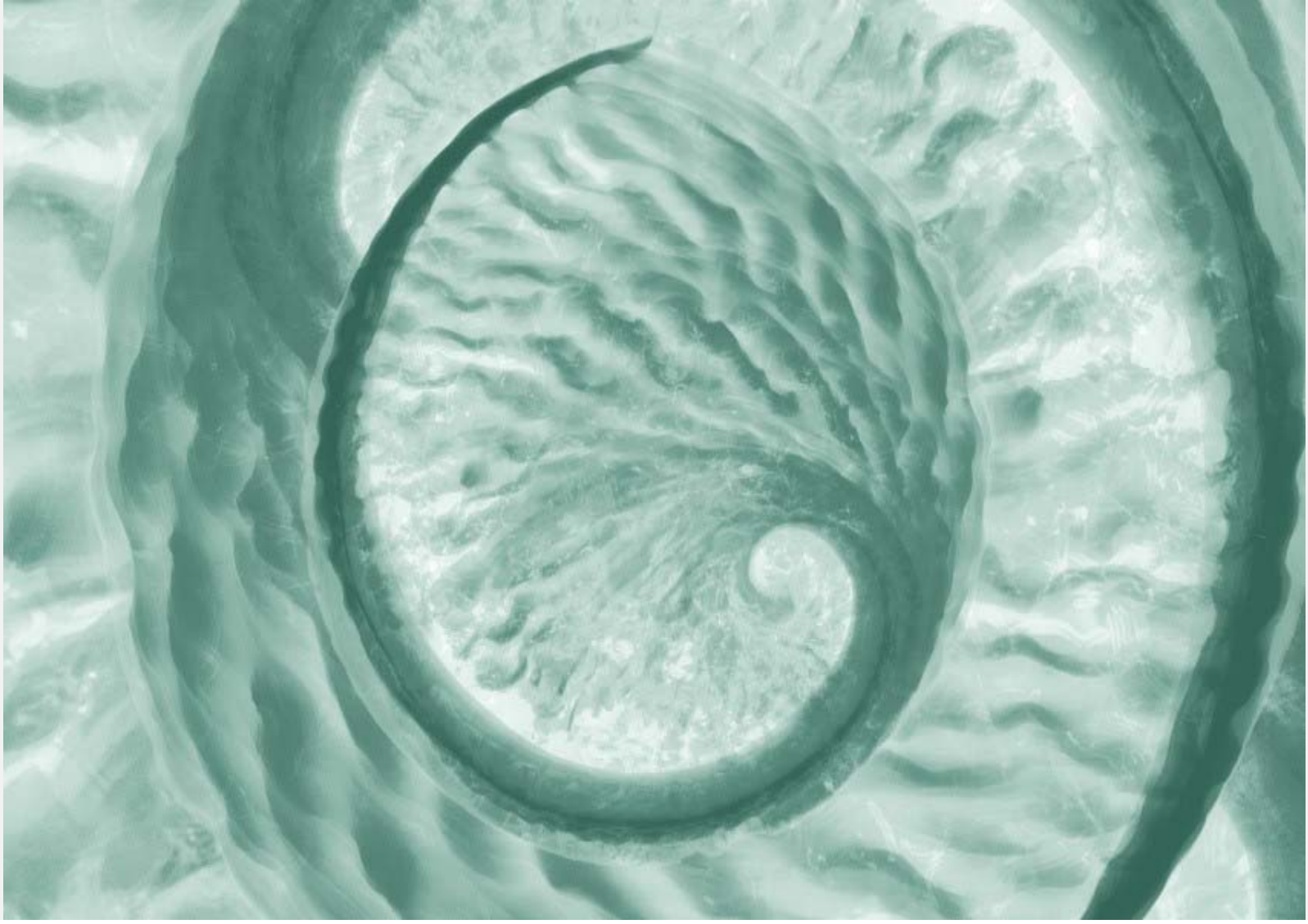
[26] Contrary to statements made in conjunction with the previously issued permit for BCS and subsequent appeal, EMDs would not completely eliminate emissions associated with BCS. Even with EMDs, emissions associated with gas compression would remain.

[27] EPA, Emissions & Generation Resource Integrated Database (eGRID). Emissions (pound per MW hour (lb/MW-hr) and ton per year (tpy)) are based on information loaded to the website on January 28, 2020; fuel mix data are based on information loaded to the website on March 9, 2020. Available online at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid. The fuel mixture for the SRVC subregion, compared to the national average, uses approximately the same natural gas but less coal and more nuclear to generate electricity.

Table 1: Emissions Comparison for Proposed Project Emissions versus Offsite Electricity Generation with EMD Alternative

Pollutant	Proposed Emissions (tpy)	Regional Emissions from Electricity Generation (tpy)	Percent Change (%)
NO_X	28.1	94.1	235% Increase
SO_2	7.0	56.6	712% Increase
CO_2e	246,229	161,013	35% Decrease

Attachment A
Supplemental BACT Analysis



Atlantic Coast Pipeline, LLC

Atlantic Coast Pipeline Project
Permit Application - Supplemental BACT Filing
Buckingham Compressor Station
Buckingham County, VA

April 2020

Environmental Resources Management
75 Valley Stream Parkway, Suite 200
Malvern, PA 19355

The business of sustainability

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Acronyms and Abbreviations

Name	Description
ACP	Atlantic Coast Pipeline, LLC
BACT	best available control technology
BCS	Buckingham Compressor Station
CO	carbon monoxide
eGRID	USEPA's Emissions & Generation Resource Integrated Database
EMD	electric motor-driven
FERC	Federal Energy Regulatory Commission
lb/MW-hr	pounds per megawatt hour
MW	megawatt
NO_X	nitrogen oxides
NSR	New Source Review
$PM_{2.5}$	particulate matter with an aerodynamic particle diameter of 2.5 microns or less
PM_{10}	particulate matter with an aerodynamic particle diameter of 10 microns or less
PSD	Prevention of Significant Deterioration
SAPCB	State Air Pollution Control Board
SRVC	USEPA's eGRID Subregion SERC Virginia/Carolina
tpy	tons per year
UER	uncontrolled emission rate

EPA	Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compounds

1. INTRODUCTION

Atlantic Coast Pipeline, LLC (ACP) filed an application in 2015 for a minor source air permit pursuant to 9 VAC 5-80-1100 *et seq.* (Article 6) to construct the Buckingham Compressor Station (BCS) in Buckingham County, Virginia. After years of permit development involving the ACP, the Virginia State Air Pollution Control Board (SAPCB or Board), the Virginia Department of Environmental Quality (VDEQ) and numerous stakeholders, the Board issued ACP a permit on January 9, 2019. The permit was subsequently vacated and remanded to the Board for further explanation of its decision to not consider electric motor-driven (EMD) compressors as an alternative for the proposed four (4) natural gas-fired combustion turbines to drive the compressors.[1] ACP prepared this best available control technology (BACT) supplemental analysis to consider EMD compressors as an alternative to the proposed natural gas-fired combustion turbines for the BCS.[2]

The purpose of the proposed BCS is to facilitate transport of natural gas along the proposed Atlantic Coast Pipeline. A central purpose of the pipeline is to increase the reliability and security of natural gas supplies in Virginia and North Carolina. Compressor stations, such as BCS, are necessary to maintain the pressure within the pipeline so that the contracted volumes of natural gas can be delivered. If the pipeline is to reliably deliver gas, the compressor station must also be reliable. At the BCS, reliable compression is best provided by natural gas-fired combustion turbines. Since the purpose of the facility is to service a natural gas pipeline, natural gas will be consistently available at the site to fuel the combustion turbines. Other sources of energy (e.g., electric), assuming their availability, are susceptible to interruption and therefore would not meet the purpose of the compressor station to provide reliable compression to transport the required volumes of natural gas. Additional infrastructure (e.g., transmission lines) beyond the control of ACP would also be necessary for EMD compressors as sufficient power is currently not available at the site to run the electric motors.

As shown in the May 25, 2018 application, emissions from the proposed BCS trigger minor source permitting and a BACT analysis for carbon monoxide (CO), nitrous oxides (NO_X), particulate matter 10 microns in diameter or less (PM_{10}), particulate matter 2.5 microns in diameter or less ($PM_{2.5}$), and volatile organic compounds (VOC). ACP submitted a BACT review for these pollutants with the September 2015, August 2017, and May 2018 air permit application submittals. Those submittals appropriately focused on alternative controls for the proposed natural gas-fired combustion turbines. This supplemental analysis considers an alternative type of emission unit, electric motors, in place of the four (4) natural gas-fired combustions turbines proposed to drive the compressors.

[1] *Friends of Buckingham v. State Air Pollution Control Bd*, No. 19-1152 (4th Cir. January 7, 2020). The court also vacated and remanded for additional explanation of certain Board findings regarding demographics and related local character and degree of injury from Station pollutants, which is addressed elsewhere.

[2] This analysis supplements the updated application ACP filed in May 25, 2018 for the BCS: Minor New Source Permit Application Update for Buckingham Compressor Station. Available online at: https://www.deq.virginia.gov/Portals/0/DEQ/Air/BuckinghamCompressorStation/May_25_2018_Updated_Application.pdf.

2. BACT ANALYSIS METHODOLOGY

For a minor source formal BACT analysis, as prepared for BCS, it is the Board's policy established in Virginia's Article 6 - Minor New Source Review Permit Program Manual that sources follow the top-down process laid out in the US Environmental Protection Agency's (EPA) Draft New Source Review Workshop Manual (October 1990) (NSR Manual).[3] The top-down process is a five-step analysis: (1) identify all available controls with a potential applicability; (2) eliminate technically infeasible controls identified in step 1; (3) rank the feasible controls; (4) evaluate the feasible controls for economic, environmental, and energy impacts; and (5) select BACT. The scope of the BACT analysis is determined by the basic purpose or design of the source as proposed by the applicant.

In accordance with the NSR Manual, available control options are those air pollution control technologies or techniques with a practical potential for application to the emissions unit and the regulated pollutant under evaluation. Air pollution control technologies and techniques include the application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of the affected pollutant. They do not include alternatives that would require the basic design of the source to be redefined.

2.1 BACT Considers Alternative Controls Not Emission Units

It has long been recognized in the Commonwealth that the BACT requirement, whether for a Prevention of Significant Deterioration (PSD) source pursuant to Article 8 or a minor source pursuant to Article 6, does not require an applicant to consider alternatives to the source proposed (i.e., redefine the source) in identifying the available controls for step 1 of the top-down analysis.[4] As stated in the NSR Manual, a BACT analysis is not "a means to redefine the design of the source" proposed by the applicant.[5] Nor does it require consideration of different fuel types: "Lower-polluting processes should be considered based on demonstrations made on the basis of manufacturing identical or similar products from identical or similar raw materials or fuels."[6] The quintessential example is that an applicant proposing to construct a coal-fired plant does not have to consider a natural gas-fired plant as part of the BACT analysis.[7] This interpretation of the BACT requirement for minor sources – that the applicant defines the design of the source to be permitted – is also apparent in Virginia regulations.

Article 6 prohibits the issuance of a minor NSR permit unless the Board is satisfied that the source will be designed, built and equipped to comply with all applicable standards.[8] One such standard that a new

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[3] APG-350A, Article 6 - Minor New Source Review Permit Program Manual, Draft at 8-3 (Oct. 6, 2005).

[4] APG-350A (identifying EPA's NSR Manual top-down process as the appropriate methodology for conducting a formal minor source BACT analysis consistent with the analysis for PSD sources); APG350, New Source Review Permits Program Manual (April 1, 2002) (identifying the NSR Manual as the appropriate methodology for a PSD formal BACT analysis and expressly recognizing that it does not require redefinition of the source); APG 309, Air Permitting Guidelines - New and Modified PSD Sources (Nov. 2, 2015) (same). *See also In re Old Dominion Elec. Coop.* 3 E.A.D. 779, 793-94 (Adm'r 1992) (upholding DEQ's application of the redefine the source doctrine to a PSD source); Va. Chapter of the *Sierra Club v. Va. State Air Pollution Control Bd.*, No. CL16-3770 (Va. Cir. Ct. City of Richmond, July 28, 2017) (upholding Board's application of the redefine the source doctrine to a PSD source); DEQ Engineering Analysis for Transco – Station 165, Registration No.: 30864, at 9-10 (January 28, 2020) (explaining why use of electric motor driven compressors would redefine the source and were otherwise unavailable for application at the site due to lack of transmission infrastructure). There is limited case law addressing BACT for minor sources because typically such permits (i) do not involve formal minor source BACT analysis (rather a simplified "presumptive BACT" process is used as recognized by DEQ guidance at APG-350A at 8-3), (ii) are not decided by the Board and (iii) are not appealed.

[5] NSR Manual at B.13; *see also* EPA-457/B-11-001; *PSD and Title V Permitting Guidance for Greenhouse Gases*, 26-28 (Mar. 2011) (reiterating that BACT is not a means to redefine the source proposed by the applicant).

[6] NSR Manual at B.10 (addressing what a top-down BACT analysis should consider).

[7] *See Sierra Club v. EPA*, 499 F.3d 653 (7th Cir. 2007) (upholding EPA's redefinition of the source doctrine).

[8] 9 VAC 5-80-1180.

source has to comply with is BACT,[9] which requires consideration of "production processes or available methods, systems and techniques" to reduce emissions from the source.[10] BACT is applied to each emissions unit at the source for each regulated pollutant that triggers permitting.[11] The Board determines whether the BACT standard will be complied with by reviewing and analyzing the application submitted by the applicant.[12] That is, the Board considers what "production processes or available methods, systems and techniques" can be applied to the "emissions units" (e.g., natural gas-fired combustion turbines) located at the stationary source (e.g., a compressor station) proposed by the applicant. The regulations do not contemplate the Board considering a fundamentally different "emissions unit" from that proposed. In short, the Board considers pollution control alternatives, but not alternatives to the type of emission unit proposed. Thus, consistent with the regulations and longstanding policy, the BACT standard for minor sources does not require consideration of alternatives that would redefine the design of the source as proposed by the applicant.

2.2 BACT Analysis of Alternative Emission Units

The top-down analysis used for a formal BACT analysis does not readily lend itself to considering alternative emission units, such as use of electric motors instead of natural gas-fired combustion turbines. The top-down BACT analysis is designed to evaluate on a pollutant-by-pollutant basis what controls can be applied to the proposed emission unit and to compare the emission reductions from each of those controls to determine BACT for that pollutant. It is not designed to evaluate the wholesale replacement of one emission unit for a completely different one. There are inherent challenges with trying to assess a fundamentally different emission unit rather than assessing alternative add-on control devices or processes for the emission unit. For example, under Step 4 of the top-down analysis, when evaluating the cost-effectiveness of a potential $PM_{2.5}$ control for the emission unit, one would compare on a cost-per-ton basis how much incremental $PM_{2.5}$ would be removed in return for the additional cost of that control. Cost-effective controls for $PM_{2.5}$ can be identified, and cost-prohibitive controls can be ruled out. The same analysis can be applied to each pollutant emitted and to each control available to reduce emissions of that particular pollutant. But, when evaluating a fundamentally different emission unit (which, by definition, does not "control" emissions from the original unit), it is impractical to allocate the cost of the emission unit to any particular pollutant. Instead, it is conservative (relative to protection of the environment) to compare the overall costs of the different emission units against the combined pollutants versus trying to allocate costs across the various pollutants and/or applying the full cost to control of individual pollutants.

[9] 9 VAC 5-50-260.

[10] 9 VAC 5-50-250.

[11] 9 VAC 5-50-240.

[12] 9 VAC 5-80-1190.

3. SUPPLEMENTAL BACT ANALYSIS FOR THE PROPOSED COMBUSTION TURBINES

ACP is proposing to install four (4) natural gas-fired combustion turbines (CT-01 – CT-04) at the Buckingham Compressor Station for natural gas compression. The combustion turbines proposed by ACP are properly characterized as "emissions units" under Virginia regulations. Thus, the BACT analysis for the natural gas-fired combustion turbines should be focused on "processes," "methods," or "techniques" (i.e., controls) that can be applied to the turbines to control pollutants. Electric motors are not a control that can be applied to the turbines, but would instead replace the proposed emission units.

The purpose of the proposed BCS is to facilitate transport of natural gas along the proposed Atlantic Coast Pipeline. A central purpose of the pipeline is to increase the reliability and security of natural gas supplies in Virginia and North Carolina. Compressor stations, such as BCS, are necessary to maintain the pressure within the pipeline so that the contracted volumes of natural gas can be delivered. If the pipeline is to reliably deliver gas, the compressor station must also be reliable. During the initial design phase of the Project, Atlantic determined that natural gas-fired turbine-driven compression is highly preferable for system reliability, operational flexibility, and to balance the horsepower across the pipeline system. Since the purpose of the facility is to service a natural gas pipeline, natural gas will consistently be available at the site to fuel the combustion turbines. Other sources of energy (e.g., electric), assuming their availability, are susceptible to interruption and therefore would not meet the purpose of the compressor station to provide reliable compression to transport the required volumes of natural gas. BCS is also designed to facilitate this transport efficiently and while minimizing associated environmental impacts.

Electric motors also would not provide the reliability required of this propose source. In limited cases, some gas compressors are driven using an electric motor to turn the same type of centrifugal compressor. This type of compression does not require the use of natural gas to operate, but rather relies upon the fuel mix of the connected electrical grid to produce energy, which results in line losses and multiple energy conversion losses before arriving at the station. Such installations introduce another measure of gas supply unreliability since an electrical outage would also force a simultaneous natural gas supply outage. It is further noted that the FERC review process for the Atlantic Coast Pipeline previously considered the use of EMDs at the compressor stations associated with the Project and made the determination that the use of natural gas-fired turbines was the preferred Project design.[13] Because electric motors would redefine the source and, more specifically, would not be able to meet the stated purpose for the proposed BCS, which is to increase the reliability and security of natural gas supplies in Virginia and North Carolina, they should be eliminated from a BACT analysis prior to step 1.

Despite these considerations, ACP has developed this supplemental BACT analysis to assess the EMD alternative for the natural gas-fired compression turbines and carried it through the 5-step BACT analysis even though as shown it can be ruled out at (and before as discussed above) step 1.

The evaluation of the EMD alternative has been considered at the process level collectively for the pollutants subject to a BACT analysis under 9 VAC 5-50-260(C) for the BCS as proposed (CO, NO_X, PM_{10}, $PM_{2.5}$, and VOC).[14] At the station level, the EMD alternative would eliminate the emissions

[13] FERC. July, 2017. Atlantic Coast Pipeline and Supply Header Project – Final Environmental Impact Statement (Volume I). Available online at: https://www.ferc.gov/industries/gas/enviro/eis/2017/07-21-17-FEIS/volume-I.pdf.

[14] Of note, the emissions of particulate matter from gaseous fuel combustion have been estimated to be less than 1 micron in equivalent aerodynamic diameter, have filterable and condensable fractions, and usually consist of hydrocarbons of larger molecular weight that are not fully combusted. EPA. May, 2006. EPA National Emissions Inventory Conference Presentation. Available online at: http://www.epa.gov/ttnchie1/conference/ei15/training/pm_training.pdf. Because the particulate matter typically is less than 2.5 microns in diameter, this BACT discussion assumes any mitigation approaches for PM_{10} and $PM_{2.5}$ are the same.

associated with the natural gas-fired turbine; however, it would not eliminate other emissions from the other sources at station (e.g., emergency generator, boiler, etc.).

This supplemental BACT analysis focused on the four (4) proposed combustion turbines. For purposes of this BACT analysis supplement, the BACT determination for the EMD alternative applies equally to all the proposed turbines and the collective pollutants undergoing BACT evaluation. Therefore, the analysis presented below has been consolidated into one analysis. Consistent with previously submitted analyses, the EMD alternative addressed in this supplement formal BACT analysis follows the "top-down" procedures but on a combined pollutant basis.

Step 1 – Identify Potential Control Technologies

- Electric motors (in lieu of natural gas-fired combustion turbines) to drive the compressors.

In addition to the reasons discussed above, electric motors should be eliminated from consideration at step 1 because they do not have a practical potential for application at the BCS. "Available control options are those air pollution control technologies or techniques with a *practical potential for application* to the emissions unit and the regulated pollutant under evaluation."[15] The use of electric motors will require additional aboveground power grid infrastructure, including a high voltage power line and substation, to meet the compression demands of the Project. That infrastructure does not currently exist at the BCS site and there is no guarantee that all the necessary approvals can be obtained to install it.

To bring power to the site, the power provider for the area, Central Virginia Electric Coop (on its own or working with another utility with transmission infrastructure in the area), would have to obtain all necessary federal, state, and local approvals, including environmental approvals, for the construction and operation of an approximately 12 to 20 mile[16] high voltage transmission line as well as a new substation. Additionally, although the transmission line and substation would be installed in a manner to minimize impacts, such impacts (e.g. land use, right of way clearing, potential impacts on sensitive communities and environments, etc.) must be considered.

In addition to the new electric transmission line and substation needed to bring power to the site, redesigning the facility to use electric motors instead of natural gas-fired combustion turbines would require significant evaluation of the station's overall design, including hydraulic design conditions, extensive engineering designs, planned operational characteristics, and impacts to the construction footprint. Assuming all necessary approvals for an approximately 12-mile to 20-mile electric transmission line and new substation could be obtained, and accounting for the change from natural gas to electric motors, the timeline for the project would be extended by years with minimal improvements to air quality and with additional impacts to the surrounding community and beyond related to the new electric infrastructure.

For these reasons (e.g., changes the emission unit, does not satisfy the stated purpose for the project, and no practical potential for application), EMD compression would be eliminated from the BACT analysis. Nonetheless, electric motors will be further considered as an alternative to the proposed natural gas-fired combustion turbines to drive the compressors.

Step 2 – Eliminate Technically Infeasible Options

As described in Step 1, the EMD alternative is not practical to apply at BCS since, among other things, it would require building a new electric transmission line, adding a substation, and redesigning the facility. As such, it is technically infeasible for BCS for the same reasons it is unavailable under Step 1. However,

[15] 1990 Workshop Manual at B.5 (emphasis added).

[16] Early desk-top study suggested a 12-mile option may be available; upon further study, it appears that the transmission line approximately 12-miles away would not be capable of providing the necessary load requirements to the BCS site. Therefore, the transmission line approximately 20 miles may be required to obtain the necessary power at the BCS site.

electric motors have been implemented at other compressor stations in the US where electricity has been available. Therefore, for purposes of this analysis, the use of electric motors is considered further.

Step 3 – Rank Remaining Control Technologies by Control Effectiveness

The EMD alternative would eliminate emissions from the combustion turbines at the station (but not those associated with the compressor); however, there would be an increase in offsite emissions associated with the production of electricity to power the electric motors. The economic, energy, and environmental impacts associated with the EMD alternative are discussed further in Step 4.

Step 4 – Evaluate Most Effective Controls and Document Results

Replacing the proposed natural gas-fired combustion turbines with electric motors would require significant engineering design changes, an increase in the construction footprint of the project, and additional infrastructure outside the control of ACP, as well as extensive additional permitting and approvals. The environmental, energy, and economic impacts associated with the EMD alternative as compared to the proposed natural gas-fired turbines are presented below.

Environmental Impacts

If electric motors were to be implemented, it would be necessary to construct additional transmission power lines to bring the necessary power to the station. It is estimated that up to 20 miles of transmission power line would be required. Although the installation of this line can be done in a way to minimize impacts on the environment, the impacts (e.g. land use, right of way clearing, etc.) cannot be eliminated and are considered as part of this analysis.

Although EMDs would eliminate emissions associated with on-site combustion to power the compression process,[17] there would be significant emissions associated with the off-site power production required by the EMDs. Approximately 430,000 megawatts (MW) per year would be required to meet the electrical demand for an EMD station. There would be emissions associated with that generation and those emissions would likely be higher than the emissions from the proposed natural gas-fired turbines due to higher emitting coal in the regional fuel mix. These emissions would be made further more significant due to inefficiencies associated with the approximately 20 miles of transmission that would be required to get electricity to the BCS site, when natural gas is already there.

To estimate the air quality impacts of the EMD alternative at the regional level (i.e., when offsite electricity generation is considered), ACP conducted a study-level analysis to determine the emissions associated with regional electricity generation relative to the emissions from the proposed gas turbines. This analysis uses pound per MW hour (lb/MW-hr) and ton per year (tpy) emission rates from EPA's Emissions & Generation Resource Integrated Database (eGRID) to compare the emissions from offsite electricity generation relative to the proposed gas turbine emission.[18]

Emissions of NO_X, SO_2, and CO_2e are available in EPA's eGRID datasets. Emissions are available on an annual average basis and are dependent upon the fuel mixtures utilized in each subregion. The eGRID subregion SRVC, shown in **Figure 1 below,** was selected based on the location of the station and the electricity provider, Central Virginia Electric Coop.[19]

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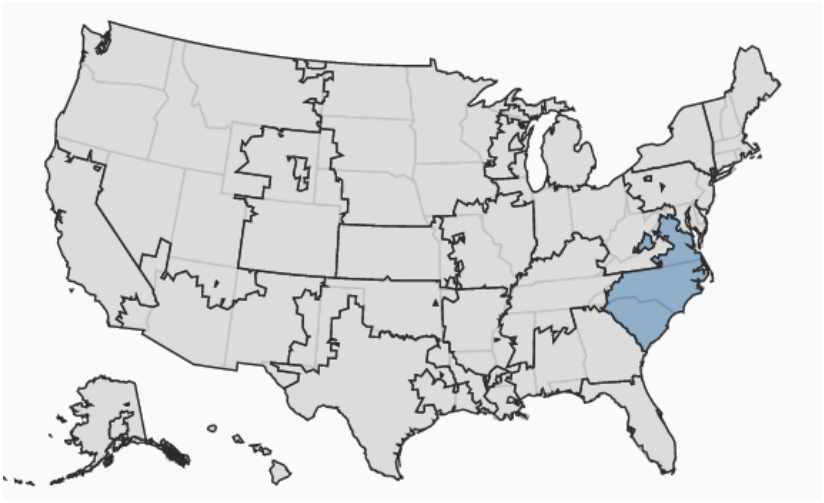
[17] Contrary to statements made in conjunction with the previously issued permit for BCS and subsequent appeal, EMDs would not completely eliminate emissions associated with BCS. Even with EMDs, emissions associated with gas compression would remain.

[18] EPA, Emissions & Generation Resource Integrated Database (eGRID). Emissions (pound per MW hour (lb/MW-hr) and ton per year (tpy)) are based on information loaded to the website on January 28, 2020 and revised on March 9, 2020. Available online at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid. .

[19] Given the service region, it is likely that the electricity for the EMD alternative would come from plants within or near Buckingham County.

Figure 1: Applicable eGrid Subregion for BCS



The fuel mixture for this subregion, compared to the national average, is provided below in **Figure 2**. Compared to the national average, the SRVC subregion uses approximately the same natural gas but less coal and more nuclear to generate electricity.

Figure 2: Fuel Mixture for Electricity Generation in the eGRID SRVC Subregion

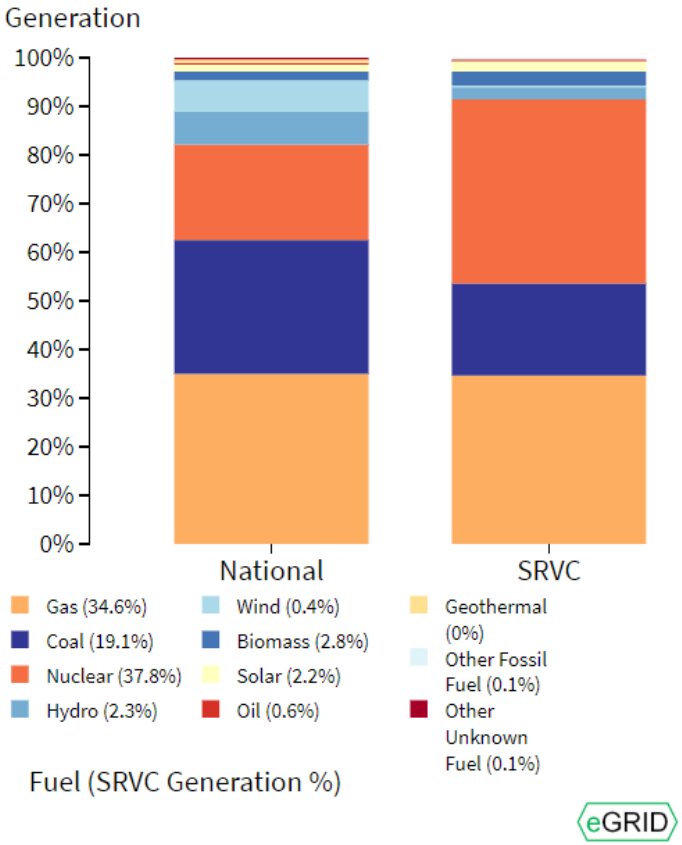


Table 3-1 below provides an emissions comparison for the proposed Project emission rates and the eGRID regional emissions representation for the offsite emissions resulting from the EMD alternative. Detailed emissions comparisons for the proposed Project emissions and the eGRID emissions profile are provided in **Appendix C**.

Table 3-1: Emissions Comparison for Proposed Project Emissions versus Offsite Electricity Generation with EMD Alternative

Pollutant	Proposed Emissions (tpy)	Regional Emissions from Electricity Generation (tpy)	Percent Change (%)
NO_X	28.1	94.1	235% Increase
SO_2	7.0	56.6	712% Increase
CO_2e	246,229	161,013	35% Decrease

Based on the emissions comparison presented in **Table 3-1**, the offsite emissions associated with electricity generation have the potential to be significantly higher for NO_X and SO_2, and lower for CO_2e. While eGRID emissions rates for CO, VOC, and particulate matter are not available for comparison, it can reasonably be assumed that they also would be significantly higher than the emissions from the proposed gas turbines, particularly considering the planned installation of oxidation catalyst (with control efficiencies of 92% and 50% for CO and VOC, respectively).

Energy Impacts

In addition to the economic impacts associated with the EMD alternative, approximately 430,000 megawatts (MW) per year of electricity would have to be produced offsite to provide the power needed for the station. While the facility would no longer be required to combust natural gas for compression needs, the electricity provider (Central Virginia Electric Coop) would likely still combust some volume of natural gas, and possibly other fossil fuels such as coal which generally emit more emissions than natural gas when combusted.

Furthermore, during the initial design phase of the Project, ACP determined that natural gas-fired turbine-driven compression is highly preferable for system reliability, operational flexibility, and to balance the horsepower across the pipeline system. Consequently, if electric motors were used and a regional utility power outage occurred, facility compression would be unavailable and the ability to make system deliveries would be significantly hindered, which is contrary to the stated purpose of the pipeline that is served by BCS.[20]

Economic Impacts

As previously discussed, the EMD alternative would require the station to be redesigned and would require additional infrastructure including a high voltage electrical line and an electrical substation. It would replace the proposed natural gas fired combustion turbines, eliminating those emissions. It Therefore, ACP conducted a cost effectiveness evaluation on a total pollutant basis instead of a pollutant-by-pollutant basis in a typical BACT analysis using study-level equipment and engineering costs and procedures outlined in EPA's OAQPS Control Cost Manual (6th Edition)[21]. The results of this analysis are provided in **Table 3-2** below. Based on this study-level cost analyses, the EMD alternative is cost-prohibitive.

When considering only the station level emission reductions (elimination of the emissions otherwise emitted from the combustion turbines for each pollutant), the cost effectiveness of the EMD alternative relative to the emissions for CT-01 – CT-04 is $398,500 per total tons of NOx, CO, PM, and VOC removed. As discussed in the environmental impacts section above, there would be regional emissions, significantly higher than those projected for the combustion turbines, associated with the electricity generation that would be required for the EMD alternative. As such, the local reductions in emissions would be offset by increases in regional emissions.

[20] *See* FERC, Atlantic Coast Pipeline and Supply Header Project – Final Environmental Impact Statement (Volume I) (July 2017) (FERC reviewed scenarios involving the use of electric motors at the station and determined that the use of electric motors was not a preferred alternative). Available online at: https://www.ferc.gov/industries/gas/enviro/eis/2017/07-21-17-FEIS/volume-I.pdf.

[21] USEPA. January, 2002. EPA Air Pollution Control Cost Manual. Sixth Edition. Available online at: https://www3.epa.gov/ttncatc1/dir1/c_allchs.pdf.

Table 3-2: EMD Alternative Cost Effectiveness Based on Total Emissions

Control Alternative	Emissions (tpy)[1]	Emissions Reductions (tpy)	Installed Capital Cost ($)	Total Annualized Cost ($/yr)[2]	Energy Cost Comparison ($/MWh)[3]	Cost Effectiveness Over Baseline ($/ton)[4]
EMD Alternative	0	81.5	$ 94,687,488	$ 32,475,048	$ 110	$ 398,500
NGCT Proposed	81.5	-	$ 54,000,436[5]	$ 21,776,979	$ 57	-

Notes:
[1] NGCT Baseline emissions of NOx, CO, VOC and $PM_{10}/PM_{2.5}$ for CT-01 – CT-04 as previously permitted including SCR and oxidation catalyst. The 0 emissions for the EMD alternative represent the lack of onsite emissions from electric motors themselves and do not reflect the significant emissions associated with producing the electricity elsewhere, which are more than significantly higher than the NGCT emissions as discussed below in the environmental impact section.
[2] Total annualized cost (capital, direct, and indirect) of purchasing, installing, and operating the proposed alternative. A capital recovery factor approach using a real interest rate (i.e., absent inflation) is used to express capital costs in present-day annual costs.
[3] Energy cost comparison is based on the 43.4 MWh produced by the proposed CT.
[4] Cost effectiveness over baseline is equal to total annualized cost for the alternative option divided by the emissions reductions resulting from the uncontrolled baseline.
[5] The NGCT capital and annualized cost are based on EIA cost data, $1,101/kW capital cost and $5.5/MWh O&M costs, and includes the cost of the SCR.

Detailed impacts analyses are provided in **Appendix A**. The detailed cost effectiveness analysis using EPA OAQPS procedures is provided in **Appendix B**.

Step 5 – Select BACT

As outlined in Step 4, the EMD alternative is cost prohibitive and will result in regional energy and environmental impacts not otherwise experienced with the original station design. There is the potential for significant offsite emissions – likely from power plants within or near Buckingham County – associated with electricity generation that far outweigh the proposed Project emissions associated with natural gas-fired turbine-driven compression. This is in addition to it not meeting the purpose for the BCS, redefining the design of the BCS, and not having a practical potential for application to the site. Therefore, the EMD alternative has been eliminated as a viable BACT alternative to the proposed natural gas-fired combustion turbines.

ACP maintains that BACT for particulate matter emissions from the natural gas-fired combustion turbines is the use of clean-burning fuels, good combustion practices, and inlet filtration as discussed in its May 25, 2018 application. Additionally, ACP maintains that BACT for NO_X and CO and VOC are satisfied through the use of SCR and oxidation catalyst systems, respectively.

APPENDIX A EMISSIONS IMPACT ANALYSIS

Appendix A
Atlantic Coast Pipeline Project
Buckingham Compressor Station, Buckingham County, VA

Summary of Top-Down BACT Impact Analysis Results[1]

Control Alternative[2,3]	Emissions (tpy)	Emissions Reduction (tpy)[4]	Installed Capital Cost ($)[5]	Total Annualized Cost ($/yr)[6]	Cost Effectiveness Over Baseline ($/ton)[8]	Incremental Cost Effectiveness ($/ton)[9]	Energy Cost Comparison ($/MWh)	Adverse Environmental Impact
EMD Alternative (Facility-Level)	0	81.50	$ 94,687,488	$ 32,475,048	$ 398,500	$ 398,500	$ 110	Land Impacts - Transmission Lines / ROW Clearing Air Impacts - Regional Electricity Generation
Solar Turbines (Baseline)	81.50	-	$ 54,000,436	$ 21,776,979	-	-	$ 57	-

Notes:

[1] *The analysis presented above was organized based on guidance presented in the USEPA's Draft New Source Review Workshop Manual (Oct., 1990), Table B-8.*

[2] *The EMD alternative was presented at the facility level and excludes regional emission increases associated with electricity generation.*

[3] *For simplicity, values presented above for the baseline option includes all four turbines (CT-01 - CT-04).*

[4] *Emissions reduction over baseline level. NGCT Baseline emissions of NOx, CO, VOC and $PM_{10}/PM_{2.5}$ for CT-01 – CT-04 as previously permitted including SCR and oxidation catalyst. The 0 emissions for the EMD alternative represent the lack of onsite emissions from electric motors themselves and do not reflect the significant emissions associated with producing the electricity elsewhere, which are more than significantly higher than the NGCT emissions as discussed below in the environmental impact section.*

[5] *The NGCT capital and annualized cost are based on EIA cost data, $1,101/kW capital cost and $5.5/MWh O&M costs, and includes the cost of the SCR.*

[6] *Total annualized cost (capital, direct, and indirect) of purchasing, installing, and operating the proposed control alternative. A capital recovery factor approach using a real interest rate (i.e., absent inflation) is used to express capital costs in present-day annual costs.*

[8] *Cost Effectiveness over baseline is equal to total annualized cost for the control option divided by the emissions reductions resulting from the baseline.*

[9] *The incremental cost effectiveness criteria is the same as the total cost effectiveness criteria except that the control alternative is considered relative to the next most stringent alternative rather than the baseline control alternative. As only one alternative is presented, cost effectiveness and incremental cost effectiveness are the same in this analysis.*

APPENDIX B COST EFFECTIVENESS ANALYSES

Appendix B

Atlantic Coast Pipeline Project
Buckingham Compressor Station, Buckingham County, VA

Electric Motor-Driven Compression - Annualized Cost-Effectiveness (Facility-Level)

Control Technology/Alternative:	Electric Motor-Driven Compression
Emission Sources Replaced[1]:	CT-01 - CT-04 (Uncontrolled Baseline)
Emissions for CT-01 - CT-04[2] (tpy):	81.5
Emissions from EMD Alternative[3] (tpy):	0
Emissions Reduction from Baseline (tpy):	81.5

COST COMPONENT			COST	BASIS
DIRECT COSTS:				
	Direct Costs for EMD Alternative Relative to Baseline			
	One (1) 19,000 HP VFD EMD for the C453 Compressor Set One (1) 13,000 HP VFD EMD for the C453 Compressor Set One (1) 9,000 HP VFD EMD for the C405 Compressor Set One (1) 7,000 HP VFD EMD for the C335 Compressor Set EMD Lube Oil System		$ 19,000,000	Estimates provided are based on preliminary engineering designs to convert the four natural gas-fired compressors to electric motor drive, install the required ancillary equipment, and install an electrical substation at the compressor station.
	EMD Ventilation System		$ 1,000,000	
	Electric Power Building, Switchgear, and 125 VDC Power Distribution System		$ 2,300,000	
	VFD Buildings (4 buildings w/ HVAC included) VFD and Coolers		$ 800,000	
	Cooling Water Piping		$ 20,000	
	Electrical Substation (Positioned on Compressor Station Property)		$ 12,000,000	
	Direct Costs for New Double Circuit 230 kV Electrical Line			
	Double Circuit 230 kV Electrical Line		$ 50,000,000	Estimates to tie into existing electrical grid power sources.
	Instrumentation		$ -	Included in Estimate Above
	Taxes		$ 2,553,600	OAQPS - 3% Equipment Cost
	Freight		$ 4,256,000	OAQPS - 5% Equipment Cost
	Subtotal - Purchased Equipment Costs		**$ 91,929,600**	
	Direct Installation Costs			
	Foundation and Supports		$ -	Included in Estimate Above
	Handling and Erection		$ -	Included in Estimate Above
	Electrical		$ -	Included in Estimate Above
	Piping		$ -	Included in Estimate Above
	Insulation		$ -	Included in Estimate Above
	Painting		$ -	Included in Estimate Above
	Site Preparation / Buildings		$ -	Included in Estimate Above
	Subtotal - Direct Installation Costs		**$ -**	Included in Estimate Above
TOTAL DIRECT COSTS:			**$ 91,929,600**	
INDIRECT COSTS:				
	Engineering and Redesigns		$ -	Included in Estimate Above
	Construction and Field Expenses		$ -	Included in Estimate Above
	Contractor Fees		$ -	Included in Estimate Above
	Start-Up		$ -	Included in Estimate Above
	Performance Testing		$ -	Included in Estimate Above
	Contingencies		$ 2,757,888	OAQPS - 3% Equipment Costs
TOTAL INDIRECT COSTS:			**$ 2,757,888**	
TOTAL CAPITAL INVESTMENT (TCI)			**$ 94,687,488**	
ANNUAL DIRECT COSTS:				
	Operation and Maintenance Labor			
	Operating Labor ($31.38/hr at 0.5 hr/8 hr shift)		$ -	Assumed Equivalent to Baseline
	O&M Supervision ($55.98/hr at 1 hr/day)		$ -	Assumed Equivalent to Baseline
	Maintenance Labor and Materials		$ -	Assumed Equivalent to Baseline
	Subtotal - Operation and Maintenance Labor and Materials		**$ -**	
	Utilities			
	Electricity Cost Associated with EMD Alternative Relative to Baseline			
	Electricity Consumption (MW-hr)	49.2		Based on turbine horsepower replacement and electrical grid efficiency losses.
	Electrical Power Cost ($/kW-hr)	0.072		US Energy Information Administration, Electric Power Monthly (Feb, 2013); Adjusted for inflation (2013 to 2018 USD)
	Annual Electricity Cost		$ 30,938,646	Based on 8,760 hours of operation
	Natural Gas Cost Savings with EMD Alternative Relative to Baseline			
	Natural Gas Consumption for CT-01 - CT-04 (MMBtu/hr) at Nominal Performance	427.4		Solar Performance Specifications
	Natural Gas Cost ($/MMBtu)	2.56		Market Price
	Annual Natural Gas Cost		$ 9,585,598	Based on 8,760 hours of operation
	Subtotal - Increased Utility Costs		**$ 21,353,048**	
TOTAL ANNUAL DIRECT COSTS			**$ 21,353,048**	
INDIRECT ANNUAL COSTS:				
	General Overhead			
	Overhead		$ -	Assumed Equivalent to Baseline
	Administrative		$ -	Assumed Equivalent to Baseline
	Insurance		$ -	Assumed Equivalent to Baseline
	Property Tax		$ -	Assumed Equivalent to Baseline
	Subtotal - Annual General Overhead Expenses		**$ -**	
CAPITAL RECOVERY:				
	Capital Recovery for EMD Alternative			
	Equipment Life (years) =	20.0		
	Interest Rate (%) =	10.00%		
	Capital Recovery Factor (CRF)	0.12		OAQPS
	Subtotal - Capital Recovery for Baseline Option		**$ 11,122,000**	**CR = TCI * CRF**
TOTAL ANNUAL INDIRECT COSTS			**$ 11,122,000**	
TOTAL ANNUALIZED COST			**$ 32,475,048**	**TAC = DAC + IDAC**
TONS OF EMISSIONS REMOVED PER YEAR			**81.5**	
COST-EFFECTIVENESS:	**ENVIRONMENTAL BASIS** **($/Ton of Pollutants (NOx, CO, PM, VOC) Removed)**		**$ 398,500**	

Notes:

[1] The costs presented in this analysis are the costs required to convert the originally designed compressors to electric-motor driven, associated changes to the compressor station and equipment, double circuit 230kV electric lines and right-of-way, and an electrical substation. These values do not account for regional emissions increases associated with electricity generation.

[2] Emissions represent the total emission rates for CT-01 - CT-04 for NOx + CO + PM + VOC.

[3] These values do not account for regional emissions increases associated with electricity generation.

APPENDIX C EMISSIONS COMPARISON FOR THE PROPOSED PROJECT AND OFFSITE ELECTRICITY GENERATION

Appendix C

Atlantic Coast Pipeline Project
Buckingham Compressor Station, Buckingham County, VA

Natural Gas-Fired Compression (Proposed Project Emissions vs Electric Motor-Driven Alternative)

Pollutant	Proposed Project Emission Rates (tpy)	EMD Alternative Emission Rates (Facility-Level) (tpy)	EMD Alternative Emissions Reduction (Facility-Level) (%)	EMD Alternative Emission Rates (Regional-Level) (tpy)	EMD Alternative Emissions Change (Regional-Level) (%)
NO_X	28.1	0	100.0%	94.1	235%
CO	9.1	0	100.0%	Not Available	-
VOC	3.3	0	100.0%	Not Available	-
$PM_{10}/PM_{2.5}$	41.0	0	100.0%	Not Available	-
SO_2	7.0	0	100.0%	56.6	712%
CO_2e	246,229.2	0	100.0%	161,012.9	-35%

Appendix C

Atlantic Coast Pipeline Project
Buckingham Compressor Station, Buckingham County, VA

Regional Emissions from Electricity Generation

USEPA eGRID Electricity Generation Emissions Data [1]		
NO_X	0.44	lb/MWh
CO	Not Available	lb/MWh
VOC	Not Available	lb/MWh
$PM_{10}/PM_{2.5}$	Not Available	lb/MWh
SO_2	0.26	lb/MWh
CO_2e	747.51	lb/MWh

Regional Emissions from Electricity Generation for EMD Alternative		
Electric Motor-Drive Efficiency [2]		
Electric Motor Efficiency	97.6	%
Voith Efficiency	95.0	%
Total Electric Motor Drive Efficiency	92.7	%
eGRID Transmission Efficiency [3]		
Eastern Grid Gross Efficiency	95.1	%
Overall Efficiency		
Electric Drive and Transmission Efficiency	88.2	%
Electrical Demand		
Combined Replacement Shaft Power Needed	58,162	HP
	43.4	MW
Power Needed to Operate (w/ eGRID Losses)	65,948	HP
	49.2	MW
Emissions for EMD Alternative		
NO_X	94.13	tpy
CO	Not Available	tpy
VOC	Not Available	tpy
$PM_{10}/PM_{2.5}$	Not Available	tpy
SO_2	56.65	tpy
CO_2e	161,012.90	tpy

Notes:

[1] Data obtained from USEPA Emissions & Generation Resource Integrated Database (eGRID). Released January 28, 2020 (updated March 2020). Available online at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

[2] Based on preliminary engineering estimations.

[3] Data obtained from US EPA's eGRID database (Mar., 2020) for the Eastern United States.