White Paper

# Evaluation of the Best System of NOx Emission Reduction for Gas-Fired Stationary Combustion Turbines

Prepared by Vicki Stamper

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In 2006, EPA established New Source Performance Standards (NSPS) for stationary combustion turbines in 40 C.F.R. Part 60, Subpart KKKK. (71 Fed. Reg. 38482, July 6, 2006). The EPA's emission standards for nitrogen oxides (NOx) from stationary gas turbines were generally based on the use of water injection and/or dry low NOx combustors. *See* 70 Fed. Reg. 8314 at 8318 (Feb. 18, 2005). In the time since EPA's 2006 update to gas turbine NSPS emission standards, there have been hundreds of stationary gas turbines constructed in the United States, as peaking power units, combined cycle power plants, for industrial on-site power, and for mechanical power such as in a compressor station. Many of these gas turbines have been subject to major source permitting regulations and have been subject to requirements for best available control technology (BACT) or lowest achievable emission rate (LAER) for NOx emissions, but there are also numerous other gas turbines that have been permitted as synthetic minor or natural minor sources and exempt from BACT or LAER emission limitations. In recent years, most of the companies installing gas turbines have been proposing to install turbines equipped with water injection or dry low NOx combustors along with selective catalytic reduction (SCR) for NOx control, whether or not required to do so as a result of a BACT or LAER requirement. However, at the same time, there are still combustion turbines being constructed and proposed for construction without SCR. While such turbines are subject to the NSPS emissions standards regardless of whether the turbines are subject to major source permitting rules, EPA's 2006 NOx emission standards in 40 C.F.R. Part 60, Subpart KKKK no longer reflect the best system of NOx emission reduction for gas turbines. EPA must adopt more stringent emission standard reflective of the current best system of NOx emission reduction for gas turbines to ensure that all newly constructed or modified turbines are installing the best system of NOx emission reduction. There is a wealth of information available to EPA to update its NOx emission standards for stationary gas turbines, and this report presents some of that information to assist EPA in its update to the NOx emission standards in 40 C.F.R. Part 60, Subpart KKKK.

## I. Background on the Interpretation of the Best System of Emission Reduction under Section 111 of the Clean Air Act.

Section 111 of the Clean Air Act requires EPA to promulgate standards of performance which reflect the "degree of emission limitation achievable through the application of the best system of emission reduction [BSER] which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated." Clean Air Act, §111(a)(1); 42 U.S.C. §7411(a)(1). After promulgating standards of performance for a source category, the EPA is required to review and revise the emission standards, if appropriate, every 8 years. Clean Air Act, §111(b)(1)(B); 42 U.S.C. §7411(b)(1)(B). EPA does not need to review an emission standard "if the Administrator determines that such review is not appropriate in light of readily available information on the efficacy of such standard." *Id.* As will be demonstrated in this report, it is appropriate for EPA to revise and strengthen the NOx emission standards for stationary gas turbines in the NSPS which have not been revised since 2006.

## II. The NOx Emission Standards for Stationary Combustion Turbines Promulgated by EPA in 2006 Do Not Reflect the BSER for NOx Control at Combustion Turbines.

EPA's NSPS emission standards adopted in 2006 for stationary combustions do not reflect the BSER for NOx emissions from these sources because, in general, EPA's standards were not based upon the application of SCR, and yet SCR controls have been used on stationary gas turbines for decades and are commonly installed on many gas turbines today.

EPA's gas turbine emission standards promulgated in 2006 were generally based on manufacturer guarantees of emission limits based on the use of lean premix turbines or dry low NOx combustors without the use of add-on controls. *See* proposed rulemaking at 70 Fed. Reg. 8314 at 8318 (Feb. 18, 2005). EPA said it considered the use of SCR in setting the limits for NOx, but EPA determined "that the costs for SCR were high compared to the incremental difference emission concentration." *Id.* EPA further stated that new large turbines could achieve 9-10 ppm without add-on controls and that SCR "might bring this level down to 2 to 4 ppm." EPA stated that the incremental benefit in emissions reductions did not justify the costs and technical challenges associated with the addition and operation of SCR." *Id.*

EPA also stated that it "identified a distinct difference in the technologies and capabilities between small and large turbines" and found the "breaking point between these two turbine types to be 30 MW." *Id.* EPA also stated that "manufacturer guarantees are, generally speaking, higher for smaller turbines, because of differences in design and technologies." *Id.* EPA did not discuss use of SCR on smaller turbines in the rulemaking for gas turbine emission standards.

EPA's NOx emission standards for stationary turbines fired by natural gas as adopted in 2006 are listed in Table 1 below. EPA adopted NOx emission standards in forms of a concentration-based standard (parts per million (ppm)) and also as an output based standard (pound per megawatt-hour (lb/MW-hr) or nanograms per Joule (ng/J). The table below only presents the EPA emission standards in units of ppm because that is the form of emission limitation that most new turbines are subject to, and thus Table 1 can be used to directly compare to those emission limitations that will be discussed further below.

**Table 1. NOx Emission Standards for Stationary Gas Turbines, from Table 1 to Subpart KKKK of 40 C.F.R. Part 60**

| Combustion turbine type | Combustion turbine heat input at peak load (HHV) | NOx emission standard (ppm @ 15% oxygen ($O_2$)) |
|---|---|---|
| New turbine firing natural gas, electric generating | <= 50 million British Thermal Units per hour (MMBtu/hr) | 42 ppm |
| New turbine firing natural gas, mechanical drive | <= 50 MMBtu/hr | 100 ppm |
| New turbine firing natural gas | >50 MMBtu/hr and <=850 MMBtu/hr | 25 ppm |
| New, modified, or reconstructed turbine firing natural gas | >850 MMBtu/hr | 15 ppm |
| Modified or reconstructed turbine | <= 50 MMBtu/hr | 150 ppm |
| Modified or reconstructed turbine firing natural gas | > 50 MMBtu/hr and <= 850 MMBtu/hr | 42 ppm |
| Turbines located north of the Arctic Circle (latitude 66.5 degrees north),<br>Turbines operating at less than 75% of peak load,<br>Modified and reconstructed offshore turbines, and<br>Turbines operating at temperatures less than 0 degrees F. | >30 megawatts (MW) output | 96 ppm |

These 2006 emission limitations fail to reflect the BSER for gas combustion turbines today. There have been many gas turbines of all sizes that have been subject to lower NOx emission limits, based on the use of SCR and dry low NOx combustors or water/steam injection. NOx emission limits in the range of 2.0-2.5 ppmvd @15% $O_2$ have been commonly required of all sizes of power generating combustion turbines whether operating in simple cycle mode or combined cycle mode to meet BACT or LAER or other permitting requirements since at least 2016. Indeed, SCR has been required as a NOx control for natural gas-fired combustion turbines as far back as the mid-1980's. Appendix A of this report includes tables listing all such BACT or LAER determinations in the RBLC since January of 2016 that were based on application of SCR, and this data is discussed further below. The majority of these BACT and LAER determinations based on use of SCR were for combined cycle gas combustion turbines. However, there are also numerous simple cycle gas combustion turbines that have been permitted with SCR required for control of NOx, but which were not subject to BACT or LAER and are not necessarily listed in EPA's RACT/BACT/LAER Clearinghouse (RBLC). Some of those simple cycle turbines with SCR are listed in Tables 3 and 4 of this report.

Unfortunately, not all NOx BACT or LAER determinations for stationary gas turbines have resulted in a NOx emission limit based on application of SCR, despite how frequently this add-on NOx control technology has been proposed by companies and/or required in air permits. Table 2 below shows several examples of gas combustion turbines that were listed in EPA's RBLC from 2017 to 2022 and otherwise permitted by state air agencies which did not establish NOx emission limits based on the use of SCR.

**Table 2. Examples of Gas Combustion Turbines Permitted During 2017-2022 Without Required Use of SCR for NOx Control**

| RBLC ID or State | Date of Permit | Plant | SCR Required? | NOx Limit |
|---|---|---|---|---|
| TX-0878 | 9/15/2022 | Port Arthur LNG Export Terminal (8 GE Frame 7E CTs for refrigeration and compression) | NO | No Limit Specified |
| AL-0328 | 9/21/2021 | TVA Colbert CT Plant (3 – 229 MW CTs) | NO | 9 ppm |
| MI-0447<br>MI-0441 | 1/17/2021<br>12/21/2018 | Lansing Board of Water & Light – Erickson CTG (Delta Energy Park) | NO for simple cycle,<br>YES for combined cycle | 25.0 ppm (simple cycle)<br>3.0 ppm or 60.0 lb/hr (combined cycle) |
| TX-0900 | 8/17/2020 | Ector County Energy Center<br>2 SC Turbines | NO | 9.0 ppm (3-hr avg)<br>15.0 ppm (1-hr avg) |
| AK-0085 | 8/13/2020 | Alaska Gasline Development Corp Gas Treatment Plant, 6 CTs 44 MW each | NO | 15.0 ppm |
| KS-0041 | 10/30/2019 | Holly Frontier El Dorado Refinery (Cogen CT) | NO | 25.0 ppm |
| MI-0439 | 4/2/2019 | Jackson Generating Station (6 combined cycle CTs, 420 MW) | NO | 25.0 ppm |
| TX-0851 | 12/17/2018 | Rio Bravo LNG Pipeline Facility (12 CTs used as mechanical drive for refrigeration) | NO | 9.0 ppm |

| RBLC ID or State | Date of Permit | Plant | SCR Required? | NOx Limit |
|---|---|---|---|---|
| LA-0331 | 9/21/2018 | Venture Global Calcasieu Pass LNG Project SCCT1 – SCCT3 | NO | 9.0 ppm |
| LA-0327 | 5/23/2018 | Washington Parish Energy, Center One (2-207 MW CTs) | NO | 9.0 ppm |
| TX-0833 | 1/26/2018 | Southern Power, Jackson County Generators (4 CTs, 920 MW total) | NO | 9.0 ppm |
| TX-0826 | 8/16/2017 | Golden Spread Electric Coop, Mustang Station (Unit 6: 162.8 MW) | NO | 9.0 ppm |
| TX-0819 | 4/28/2017 | Southwestern Public Service Co, Gaines County Power Plant, 4 227.5 MW CTs | NO | 9.0 ppm |
| IN-0261 | 2/28/2017 | Duke Energy Indiana, Vermillion Generating Station, (8-80 MW CTs) | NO | 250.0 lb/hr each |
| LA-0316 | 2/17/2017 | Cameron LNG Facility – 9 CTs | NO | 15.0 ppm |
| TX-0816 | 2/14/2017 | Corpus Christi Liquefaction Stage III (12 CTs used in mechanical drive) | NO | 25.0 ppm |
| WV-0026 & 0028 | 1/23/2017<br>3/13/2018 | Pleasants Energy Waverly Facility (2 CTs – 167.8 MW each) | NO | 9.0 ppm<br>69.0 lb/hr |
| IN-0264 | 1/6/2017 | AES Ohio Generation LLC Montpelier Generating Station (4 CTs totaling 236 MW) | NO | 25.0 ppm |
| NA- FL Permit | July 2018 | Lakeland Electric McIntosh Plant (Unit 2 114.7 MW) | NO<br>(net out for NOx) | 25.0 ppm |

| RBLC ID or State | Date of Permit | Plant | SCR Required? | NOx Limit |
|---|---|---|---|---|
| TX-0098 | Aug 2021 | El Paso Electric Company, Newman Unit 6, 230 MW CT | NO for simple cycle, YES for combined cycle | 9 ppm (simple cycle), 3 ppm[1] (combined cycle) |
| LA-0295 | 7/12/2016 | Equistar Chemicals Westlake Facility, 14.117 MW combined cycle | NO | 15.0 ppm (annual average) |

The facilities listed in Table 2 mostly reflect data listed in EPA's RBLC, but that database only includes permits reported to the database which are only those subject to prevention of significant deterioration (PSD) or nonattainment new source review (NSR) permitting. There have been numerous gas combustion turbines permitted in minor source permits for which it is difficult to readily search for those permits that do or do not require SCR. Regardless, the above table demonstrates that there are natural gas-fired combustion turbines that are being permitted without SCR required as a NOx control. In addition, there are many combined cycle combustion turbines being permitted with SCR, but which are authorized to operate in simple cycle mode without the SCR. There also are combustion turbines being permitted with SCR, but which are not subject to NOx emission limits that reflect the capabilities of the SCR systems. This is especially true for simple cycle turbines proposed with SCR systems that are being permitted as synthetic minor sources or minor modifications. An updated NSPS for stationary gas turbines is needed to ensure that all new gas turbines install and operate the BSER for NOx emissions.

## III. SCR Plus Dry Low NOx Combustors or Water/Steam Injection Represent the Best System of Emission Reduction for NOx Emitted from Stationary Gas Turbines.

Most recent BACT and LAER NOx emission limits for gas turbines since at least 2016 have been based on the combination of SCR plus dry low NOx combustors (DLNC) or water/steam injection. In the past, the combustion-related NOx controls for gas-fired turbines consisted of water or steam injection, but most natural gas-fired combustion turbines constructed today are designed with DLNC or ultra-low NOx controls. Water or steam injection could generally reduce NOx emissions to 25-42 ppm.[2] DLNC can

[1] Data in the RBLC indicates the NOx limit for combined cycle operation is 2.0 ppm, but a review of the permit issued in August of 2021 shows that it is a 3.0 ppm limit when the unit is operating in combined cycle mode.

[2] *See*, *e.g.*, EPA, Combined Heat and Power Partnership, Catalog of CHP Technologies, Section 3. Technology Characterization-Combustion Turbines, March 2015, at 3-18, available at https://www.epa.gov/sites/default/files/2015-07/documents/catalog_of_chp_technologies_section_3._technology_characterization_-_combustion_turbines.pdf; Ozone Transport Commission, Technical Information, Oil and Gas Sector, Significant Stationary Sources of NOx Emissions, Final, October 17, 2012, at 63, available at https://otcair.org/upload/Documents/Meeting%20Materials/Final%20Oil%20%20Gas%20Sector%20TSD%2010-17-12.pdf.

achieve very low NOx emission rates, in the range of 9-15 ppm, depending on turbine model and size. [3] Ultra-low NOx burners are available for some turbine models that can achieve as low as 5 ppm.[4] SCR in addition to one of these controls can reduce NOx emissions by 80-90% or more.[5]

The most commonly required NOx emission limits with these controls at gas-fired combustion turbines have been a NOx limit of 2.0 ppmvd @15% $O_2$ for combined cycle units and a NOx limit of 2.5 ppmvd @15% $O_2$ for simple cycle units. Appendix A to this report shows the numerous entries in the RBLC for combustion turbines that required these controls and established these emission limits. Of the gas combustion turbines where NOx emission limits were not based on SCR, the arguments against use of SCR were primarily made for simple cycle turbines, whether used for power production or mechanical drive such as at a compressor station, due to claims that the high exhaust gas temperatures would not allow for effective operation of SCR. However, the permitting authorities that made those BACT or LAER decisions failed to conduct a thorough review of the capabilities of SCR for NOx control at combustion turbines, as there are options that have been available for many years to address these concerns. It is also very likely that the outdated New Source Performance Standard for stationary gas turbines, which serves as the "floor" for a BACT determination and which generally does not reflect the use of SCR controls, has significantly influenced the BACT determinations that did not require the use of SCR.

### A. History of Use of SCR at Stationary Gas Turbines.

SCR has long been identified as a NOx control technique for stationary gas turbines. Based on a review of data in the EPA's RBLC, SCR has been required as BACT or LAER in air permits for combustion turbines going back to 1984. Indeed, there are 20 permits listed in the RBLC issued between 1984 and 1990 that required SCR as NOx controls at gas-fired combustion turbines. A January 1993 report by EPA discusses SCR as a NOx control option for gas-fired combustion turbines, especially gas turbines operating in combined cycle mode. This report showed that combustion controls (water or steam injection or dry low NOx combustion) along with SCR achieved the lowest emission rates, which at that time was 9 ppm, and the report identified two air organizations that had established or recommended NOx limits for gas-fired combustion turbines based on use of SCR - the South Coast Air Quality Management District (SCAQMD) and the Northeast States for Coordinated Air Use Management (NESCAUM). Specifically, SCAQMD adopted reference limits in 1989 that were based on use of SCR for gas turbines of size 10.0

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[3] *See*, e.g., Sargent & Lundy, Combustion Turbine NOx Control Technology Memo, Final, Rev. 1, January 2022, at 3, available at https://www.epa.gov/system/files/documents/2022-03/combustion-turbine-nox-technology-memo.pdf. *See also* Bill Major, ONSITE SYCOM Energy Corporation, and Bill Powers, Powers Engineering, Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines, prepared for U.S. Department of Energy, November 5, 1999, at 2-10.

[4] *See*, e.g., Patel, Sonal, GE Marks 'Ultra Low' NOx Gas Turbine Technology Triumph, *Power*, April 18, 2019, available at https://www.powermag.com/ge-marks-ultra-low-nox-gas-turbine-technology-triumph/; Solar Turbines, Combined Heat and Power Hospital, Veterans Administration Hospital, available at https://s7d2.scene7.com/is/content/Caterpillar/CM20150703-52095-61295.

[5] *See*, e.g., Institute of Clean Air Companies, White Paper, Selective Catalytic Reduction (SCR) Control of NOx Emissions from Fossil Fuel-Fired Electric Power Plants, May 2009, at 7, available at https://cdn.ymaws.com/icac.site-ym.com/resource/resmgr/Standards_WhitePapers/SCR_WhitePaper_final_2009.pdf.

MW or larger and combined cycle units of 60 MW and over.[6] NESCAUM had recommended NOx limits for new gas turbines of greater than 100 MMBtu/hr and greater than 10 MW based on the use of SCR.[7] EPA stated that the main limiting factor for use of SCR on gas-fired combustion turbines was the exhaust gas temperature being too high for most SCR catalyst types, which is why SCR was primarily used on gas turbines operated in combined cycle mode at the time. A combined cycle system uses the heat exhausted from the gas turbine in a heat recovery steam generator (HRSG), and the steam is then used to create additional electricity in a steam turbine. In combined cycle plants, the SCR catalyst is installed within the HRSG where the flue gas temperatures are reduced, and thus the temperature of the gas stream is not a concern for SCR operation. However, there have both advancements in SCR catalysts since 1993 as well as other methods put in place to allow SCR to work effectively on gas turbines operated in simple cycle mode. EPA's 1993 report discussed one example of a combustion turbine operating with an SCR using a high temperature zeolite catalyst.[8]

A 1999 report issued by the U.S. Department of Energy stated that high temperature SCR installations had increased significantly since the EPA's 1993 report, being used on base-loaded simple cycle gas turbines with no HRSGs.[9] A 2000 report issued by NESCAUM also stated that SCR has become viable over a wider temperature range due to catalyst developments including for simple cycle turbines.[10] The 2000 NESCAUM report indicated that there were over 150 installations of SCR on gas turbines in the United States at the time, mostly on combined cycle power plants.[11] Clearly, by the year 2000, SCR (along with combustion controls) was the BSER for gas combustion turbines operated in combined cycle mode.

By the early 2000's, NOx emission limits for gas turbines with SCR had evolved to be much lower than the 9 ppm NOx emission limit discussed in EPA's 1993 report. A 2003 report by the California Air Resources Board (CARB) showed several examples of NOx emission limits in the range of 2.0 to 3.5 parts per million by dry volume (ppmvd) for gas turbine power plants equipped with SCR that were permitted in various northeastern states.[12] CARB stated that the lowest NOx BACT limit established for a combined cycle or cogeneration gas turbine was 2.0 parts per million by volume on a dry basis (ppmvd) at 15% oxygen (ppmvd @ 15% $O_2$) averaged over 1-hour, and CARB stated this NOx emission level was first achieved on two 180 MW gas turbines that had started operating in 2001.[13] CARB also stated in its 2003 report that the most stringent NOx BACT limit for a simple cycle gas turbine was 2.5 ppmvd @15% $O_2$

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[6] EPA, Alternative Control Techniques Document – NOx Emissions from Stationary Gas Turbines, EPA-453/R-93-007, January 1993, at 5-32, available at https://www3.epa.gov/airquality/ctg_act/199301_nox_epa453_r-93-007_gas_turbines.pdf.
[7] *Id.* at 5-35.
[8] *Id.*
[9] *See* Bill Major, ONSITE SYCOM Energy Corporation, and Bill Powers, Powers Engineering, Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines, prepared for U.S. Department of Energy, November 5, 1999, at 1-5, available at https://www.energy.gov/sites/prod/files/2013/11/f4/gas_turbines_nox_cost_analysis.pdf.
[10] NESCAUM, Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and Internal Combustion Engines, Technologies & Cost Effectiveness, December 2000, at I-4 to I-5, available at https://www.nescaum.org/documents/nox-2000.pdf.
[11] *Id.* at II-17.
[12] California Environmental Protection Agency Air Resources Board, Report to the Legislature, Gas-fired Power Plant NOx Emission Controls and Related Environmental Impacts, May 2004, at 10, available at https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/reports/l2069.pdf.
[13] *Id.* at 10-11.

averaged over 1-hour.[14] The CARB report indicated that most recent simple cycle gas turbine installations had, at the time of the 2003 report, been comprised of aeroderivative-type turbines which have lower exhaust temperatures than larger industrial frame gas turbines and that there was less experience using SCR on industrial frame turbines in simple cycle configuration.[15] However, CARB also stated that exhaust air cooling had been used on many simple cycle aeroderivative turbines to lower exhaust temperatures so that less expensive SCR catalysts could be used in lieu of using higher temperature SCR catalysts.[16]

A 2009 report issued by the Institute of Clean Air Companies (ICAC) stated that SCR was installed on more than 650 combined cycle gas turbines in the U.S. and over 150 simple cycle gas turbines.[17] The ICAC report stated that SCR was being increasingly used on simple cycle turbines to achieve up to 95% NOx reduction and identified options for successful use of SCR on simple cycle turbines, including the use of tempering air to cool exhaust, use of high temperature catalysts, and/or optimization of SCR catalyst design.[18] The ICAC report identified several examples of simple cycle gas turbines with SCR achieve NOx emission rates of 2 to 2.5 ppm.[19]

A 2013 report prepared by The Brattle Group examined the issue of SCR applicability to frame-type combustion turbines, a type of turbine that CARB had indicated in its 2003 report did not have much experience in SCR implementation. The Brattle Group study for the New York Independent System Operator (NYISO) was done to evaluate the viability of F-class turbines combined with SCR. The Brattle Group study found that F-Class frame combustion turbines can be and have successfully been used with SCR.[20] This study is discussed in more detail further below.

The reports and studies highlighted above are a sampling of the information available to demonstrate that SCR works effectively with gas-fired combustion turbines to achieve the lowest NOx emission rates, whether operated in simple cycle or combined cycle mode, and regardless of size. Indeed, this has been known for quite some time, as evidenced by the number of air permits that required SCR use at combustion turbines, going back to the mid-1980's.

### B. SCR and DLNB or Water/Steam Injection Have Been Effectively Used at Simple Cycle Gas-Fired Combustion Turbines to Achieve NOx Emission Limits of 2.5 ppm.

There are several examples of simple cycle gas turbines using SCR plus DLNB to achieve NOx emission limits of 2.5 ppm. These examples are not necessarily found in EPA's RBLC because simple cycle turbines

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[14] *Id.* at 11.
[15] *Id.* at 12.
[16] *Id.*
[17] Institute of Clean Air Companies, White Paper, Selective Catalytic Reduction (SCR) Control of NOx Emissions from Fossil Fuel-Fired Electric Power Plants, May 2009, at 8.
[18] *Id.* at 18-20.
[19] *Id.* at 20-21.
[20] *See* Chupka, Mark and Anthony Licata, The Brattle Group, Independent Evaluation of SCR Systems for Frame-Type Combustion Turbines, Report for ICAP Demand Curve Reset, prepared for New York Independent System Operator, Inc., November 1, 2013 at iv, available at https://www.brattle.com/wp-content/uploads/2017/10/6101_independent_evaluation_of_scr_systems_for_frame-type_combustion_turbines.pdf

are often permitted as minor sources or minor modifications and not subject to major source permitting. One good example of an evaluation of the NOx emission limits achievable at simple cycle gas turbines with DLNB and SCR was an analysis done by the Bay Area Air Quality Management District (BAAQMD) for the Mariposa Energy Project, which is a 200 MW power plant consisting of four simple cycle gas turbines, each with a nominal rating of 48.5 MW. This facility was not subject to PSD permitting requirements but was subject to BACT under BAAQMD rules.

In documentation for its air permit, BAAQMD provided numerous examples of simple-cycle gas turbines permitted in the District with 1-hour average NOx limits of 2.5 ppmvd@15% $O_2$, and BAAQMD also required the new simple-cycle gas turbines of the Mariposa Energy Project to meet a NOx BACT limit of 2.5 ppmvd.[21] These BACT determinations are not in EPA's RBLC, and they may not be BACT determinations resulting from PSD permits. These example simple-cycle turbine NOx limits with SCR are given in Table 3, below.

**Table 3. Simple-Cycle Turbines in California with NOx Limits with SCR of 2.5 ppmvd@15%$O_2$, 1-Hour Average[22] (Source: BAAQMD Preliminary Determination at 38)**

| Facility | Turbine Size |
|---|---|
| Panoche Energy Center | 100 MW each |
| Walnut Creek Energy Park | 100 MW each |
| Sun Valley Energy Project | 100 MW each |
| CPV Sentinel Energy Project | 100 MW each |
| Lambie Energy Center | 48.5 MW each |
| Riverview Energy Center | 48.5 MW each |
| Wolfskill Energy Center | 48.5 MW each |
| Goosehaven Energy Center | 48.5 MW each |
| Mariposa Energy Project | 48.5 MW each |

In addition to those simple cycle turbines listed above, there are numerous other simple cycle turbines that are subject to NOx emission limits of 2.5 ppm or lower as show in following table. When a facility's data is available in the EPA's RBLC, the RBLC ID is given.

[21] *See* Bay Area Air Quality Management District, Preliminary Determination of Compliance, Mariposa Energy Project, August 2010, at 38-39, available at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-03.
[22] *Id.* at 38.

**Table 4. Other Simple-Cycle Turbines with NOx Limits with SCR of 2.5 ppmvd@15% $O_2$ or Lower**

| **Facility** | **RBLC ID No.**[23] | **NOx Limit, ppmvd @15% $O_2$** | **NOx Limit Averaging Time** |
|---|---|---|---|
| Alaska Gasline Development Corporation Natural Gas Liquefaction Plant (1,113 MMBtu/hr) | AK-0088 | 2.0 | 3-hour average |
| Dominion Cove Point LNG (two turbines, 21.7 MW each) | MD-0035 | 2.5 | 1-hour average |
| Commonwealth Natural Gas Liquefaction Plant (575 MMBtu/hr each) | NA (to be located in LA) | 2.5 | Not specified |
| Bayonne Energy Center LLC (66 MW each) | NJ-0086 | 2.5 | 3-hour average |
| Howard Down Station (64 MW) | NJ-0077 | 2.5 | 3-hour average |
| Bayonne Energy Center LLC (64 MW each) | NJ-0075 | 2.5 | Not specified |
| PSEG Fossil LLC Kearny Generating Station (49 MW each) | NJ-0076 | 2.5 | 3-hour rolling average |
| El Cajon Energy LLC (49.95 MW) | CA-1174 | 2.5 | 1-hour average |
| Orange Grove Project (49.80 MW) | CA-1176 | 2.5 | 1-hour average |
| Escondido Energy Center LLC (49.95 MW) | CA-1175 | | 1-hour average |
| Pio Pico Energy Center (100 MW each) | CA-1223 | 2.5 | 1-hour average |
| Perryman Generating Station (60 MW) | MD-0043 | 2.5 | 3-hour average |
| Marsh Landing Energy Center (190 MW each) | NA (location is in CA) | 2.5 | 1-hour average |
| Ocotillo Energy Project (102 MW each) | NA (location is in AZ) | 2.5 | 1-hour average |

While the bulk of the data provided above is for simple cycle combustion turbines used to generate electricity, there are also examples of gas-fired combustion turbines used for mechanical drive purposes that are subject to NOx emission limits in the range of 2.0-2.5 ppm (e.g., the compressor turbines at the Alaska Gasline Development Corporation natural gas liquefaction plant, Dominion Cove Point Liquified Natural Gas (LNG) plant, and the turbines at the Commonwealth Natural Gas Liquefaction Plant).

[23] The specific information on these RBLC entries can be found by searching on the RBLC ID number at https://cfpub.epa.gov/rblc/index.cfm?action=Search.SearchByRBLCIdentifier.

For those power generating combustion turbines that are required to report emissions to EPA's Clean Air Markets Program Database (CAMPD),[24] there is ample data to show that simple cycle gas-fired turbines are achieving NOx emission rates of 2.5 ppm or lower. One way to readily assess whether combustion turbines with SCR are achieving 2.5 ppm NOx rates is to evaluate annual NOx emission rates in units of pounds mass of NOx emitted in a year divided by million British Thermal Unit heat input to the turbine (lb/MMBtu). A NOx emission limit of 2.5 ppmvd @ 15% $O_2$ equates to approximately a 0.010 lb/MMBtu NOx emission rate.[25] Appendix B to this paper shows the simple cycle combustion turbines with data in the EPA's CAMPD for the year 2022 with annual NOx emission rates of 0.010 lb/MMBtu or lower.[26] Because annual NOx emissions include emissions during startup and shutdown, during which DLNC will not work effectively to reduce NOx and short term NOx will thus increase,[27] an annual NOx rate of 0.010 lb/MMBtu would accurately capture those combustion turbines that emit NOx at 0.010 lb/MMBtu or lower during normal operations. However, that quick analysis of annual NOx rates will not capture all combustion turbines that are achieving 0.010 lb/MMBtu or lower on an hourly during normal operations, which would require evaluating all hourly emission data at each turbine. There are very likely many more simple cycle combustion turbines equipped with SCR that are emitting NOx at 2.5 ppm or lower rates than listed in Appendix B. The list in Appendix B shows 88 simple cycle combustion turbines equipped with SCR that are achieving annual NOx emission rates at or lower than 0.010 lb/MMBtu (2.5 ppm). These NOx emission limits and the actual annual emission rates demonstrate that DLNC or water/steam injection along with SCR are demonstrated NOx emission controls for use at simple cycle gas-fired combustion turbines to achieve a NOx emission limit of 2.5 ppmvd @ 15% $O_2$ or lower.

As previously discussed, some of the justification for not requiring SCR at simple cycle turbines to meet BACT, LAER, or other requirements include 1) arguments that the exhaust temperature from the combustion turbines is too high to effectively use SCR, 2) arguments that SCR has not been effectively applied to large frame combustion turbines, and 3) arguments that SCR has not been effectively applied to turbines that have varying operating rates such as combustion turbines that operate natural gas pipeline compressor stations. These claims are not justified. These issues are discussed below.

### 1. There are Options to Ensure Effective Use of SCR Use at Simple Cycle Combustion Turbines.

As the permit limits in Tables 3 and 4 above and the actual NOx emission rates in Appendix B demonstrate, SCR can be very effective at reducing NOx at simple cycle turbines. Indeed, according to 2022 data in EPA's CAMPD, there were 389 simple cycle combustion turbines[28] equipped with SCR. While not all of those turbines were achieving annual NOx rates as low as 2.5 ppm, two hundred eleven

[24] Affected sources under the acid rain program are required to submit emissions data to the CAMPD, and that generally includes all electric generating units that deliver at least one-third of potential generating capacity to the grid.

[25] *See* EPA-453/R-93-007, Alternative Control Techniques Document – NOx Emissions for Stationary Gas Turbines, Appendix A for the conversion formula from ppm to lb/MMBtu.

[26] Annual lb/MMBtu NOx rates were calculated based on the reported annual NOx emission for the year, divided by the reported annual heat input for the same year.

[27] Most BACT/LAER determinations for NOx from combustion turbines exclude periods of startup and shutdown, or establish separate emission limits, due to these issues.

[28] That is, these were turbines that were not identified as "combined cycle" units in CAMPD.

(211) of those turbines (54% of the simple cycle turbines with SCR in the CAMPD) were achieving annual NOx rates reflective of 3.0 ppm or lower. These turbines are not necessarily subject to NOx emission limits as low as 2.5 ppm. SCR can be operated to achieve varying levels of NOx removal efficiency, but there might not be incentive to operate the SCR to achieve the lowest NOx emission rate if a turbine is not subject to a strict NOx emission limit. Regardless, this data demonstrates that SCR is being effectively used to reduce NOx at numerous simple cycle combustion turbines.

There are a few approaches that are used to enable SCR to work effectively with the high temperature exhaust gas of simple cycle combustion turbines. One method is the injection of tempering air at the turbine discharge (upstream of the SCR) to cool the exhaust temperature to the optimal temperature of the SCR catalyst.[29] Another approach is to use high temperature SCR catalyst. Several options for SCR catalyst exist for simple cycle turbines. For example, BASF makes several SCR catalysts that it claims can achieve high levels of NOx reduction, and the NOxCat ETZ catalyst is specifically designed for simple-cycle power generating turbines and other high temperature turbine applications.[30] The NOxCat VNX and ZNX catalysts can achieve up to 99% NOx reduction and are most effective at a temperature range of 550 to 800 degrees Fahrenheit.[31] A related catalyst called NOxCat VNX-HT is designed for use in aeroderivative simple-cycle turbines that can achieve 99% NOx removal and can reach optimal performance at 800 to 850 degrees Fahrenheit.[32]

As the actual emissions data for the combustion turbines in Appendix B shows, SCR can be – and has been – effectively used at simple cycle combustion turbines to reduce NOx to 2.5 ppm and lower, despite the high exhaust gas temperature.

### 2. SCR Has Been Effectively Used on Large Frame Combustion Turbines.

As previously stated, a study was conducted in 2013 by The Brattle Group on the ability to effectively control NOx emissions for frame-type combustion turbines. This study was done because there had been prior experience showing that the very high temperatures of exhaust gases of frame-type turbines could damage some SCR catalysts. However, the Brattle Group concluded "that the F-Class frame combustion turbine can be and has been successfully coupled with SCR to meet strict environmental standards," with the use of tempering air and higher temperature catalysts[33] The Brattle Group states that "[r]ecent advances in SCR design and catalyst formulation, along with commercial experience, have eliminated any engineering bias for distinguishing between aeroderivative and frame-type combustion turbines in terms of the economic viability of using SCR to comply with strict environmental limits."[34] The

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[29] *See,* e.g., Buzanowski, Mark A. and Sean P. McMenamin, Peerless Mfg. Co., Automated Exhaust Temperature Control for Simple Cycle Power Plants, available at https://www.powermag.com/automated-exhaust-temperature-control-for-simple-cycle-power-plants/. *See also* Mitsubishi Hitachi Power Systems (MHPS) webpage on SCR systems for simple cycle turbines at https://amer.mhps.com/scr-for-simple-cycle-gas-turbines.html.

[30] *See* BASF, NOxCat ETZ, available at https://products.basf.com/global/en/cc/noxcat-etz.html.

[31] *See* BASF, NOxCat™ VNX™ catalysts, available at https://products.basf.com/global/en/cc/noxcat-vnx-and-znx.html.

[32] *Id.*

[33] *See* Chupka, Mark and Anthony Licata, The Brattle Group, Independent Evaluation of SCR Systems for Frame-Type Combustion Turbines, Report for ICAP Demand Curve Reset, prepared for New York Independent System Operator, Inc., November 1, 2013 at iv and at v.

[34] *Id.* at v.

Brattle Group pointed out that the major catalyst vendors "all provide catalyst formulations for higher temperature applications suitable for F-Class turbines with air tempering systems and SCRs and are willing to provide performance guarantees for this application."[35] The Brattle Group evaluated the SCR performance for such controls installed at three facilities with frame-type combustion turbines: 1) Sacramento Municipal Utility District (SMUD) McClellan power plant, which consists of a 77 MW GE 7E simple cycle frame turbine with SCR that has achieved 90% control without a tempering air system, 2) the Modesto Irrigation District (MID) McClure power plant in California which consists of a simple cycle GE MS7001B gas turbine that was retrofitted with SCR and an air tempering system and achieves 90% NOx control, and 3) the Marsh Landing Generating Station's four Siemens SGT6-5000 F4 simple cycle gas turbines of 190 MW each with SCR and tempering air fans which have achieved 87% NOx removal and have complied with the 2.5 ppmvd 1-hour average NOx BACT limit.[36]

The Marsh Landing Energy Center continues to achieve NOx emission rates at or below 2.5 ppm. Indeed, in 2021 and 2022, the four simple cycle turbines average hourly NOx rates were well below 2.5 ppm, as shown in the table below.

**Table 5. Marsh Landing Units' Average Hourly NOx Emission Rate Calculated from lb/MMBtu NOx Rates Reported to EPA's CAMPD, for Normal Source Operations.[37]**

| Marsh Landing Combustion Turbine | 2021 Average Hourly NOx Rate, ppm | 2022 Average Hourly NOx Rate, ppm |
|---|---|---|
| 1 | 1.7 | 1.6 |
| 2 | 1.9 | 1.8 |
| 3 | 1.7 | 1.7 |
| 4 | 1.6 | 1.5 |

Despite The Brattle Group study and despite at least three facilities with large frame turbines achieving high levels of NOx reduction with SCR, there has been at least one construction permit issued in the past few years for large frame combustion turbines that did not require SCR: that is, Tennessee Valley Authority's (TVA's) proposed addition to the Colbert Combustion Turbine Plant of three new 221 MW combustion turbines (RBLC ID AL-0328). These new combustion turbines were permitted with a 9 ppm NOx emission limit that purportedly reflected BACT. Had SCR been required to meet BACT at these turbines, NOx emissions could be reduced by at least 72% to achieve NOx limit of 2.5 ppm.

### 3. SCR Can Be Effective at Smaller Turbines and at Turbines that have Varying Operating Rates, such as at Compressor Stations.

Combustion turbines are often used in mechanical drive mode as compressor turbines, such as at a natural gas compressor station. Compressor stations are used to move natural gas through pipelines. The required gas flow rates through the pipelines can increase or decrease due to both seasonal demand

[35] *Id.*
[36] *Id.* at 11-12.
[37] Only full hours of operation were analyzed. Partial hours of operation were assumed to reflect startup, shutdown, or malfunction.

and changes in daily demand. In addition, peaking gas-fired power plants coming on line can also require increased gas flow. There can be one or more individual compressor units at a compressor station, and the compressors can be powered by combustion turbines used as mechanical drive, gas or diesel-fired engines, or with electric engines. For those compressors powered by gas-combustion turbines, the turbines are often of smaller sizes compared to the combustion turbines used to generate electricity.

While SCR installation at combustion turbines used for mechanical drive such as compressor stations is not as common as its use at power generating combustion turbines, permitting authorities have been proposing and/or requiring SCR along with DLNC for NOx control at such turbines. In Table 4 above, there are three examples of combustion turbines used for compression at natural gas liquefaction plants that required SCR to meet NOx emission limits of 2.0 to 2.5 ppm. In addition, SCR has been proposed or required at some turbines powering compressor stations. Some examples are given below.

**Table 6. Compressor Stations Powered by Combustion Turbines with SCR Proposed or Required by Air Construction Permit.**

| Facility | Location | Permit Date | Combustion Turbine Size and/or Models | NOx Controls | Emission Limits |
|---|---|---|---|---|---|
| Southern California Gas Company Wheeler Ridge Compressor Station | Kern County, CA | ~2015 | 47.65 MMBtu/hr | SCR | 8 ppmvd @ 15% $O_2$ |
| Pacific Gas & Electric Kettleman Compressor Station | Avenal, CA | ~2014 | 3 - Solar Taurus 60 (58.14 MMBtu/hr) | SoLoNOx (DLNC) and SCR | 8 ppmvd @ 15% $O_2$ |
| Atlantic Coast Pipeline, Marts Compressor Station | Lewis County, WV | 7/21/2016 | Solar Titan 130 (170 MMBtu/hr), Solar Mars 100 (140 MMBtu/hr), Solar Taurus 70 (94.3 MMBtu/hr), and Solar Taurus 60 (71.4 MMBtu/hr) | SoLoNOx (DLNC) and SCR | 5 ppmvd @ 15% $O_2$ |
| Northampton Compressor Station | Northampton County, NC | 2/27/2018 | Solar Taurus 70 (96 MMBtu/hr), Centaur 50 (60 MMBtu/hr), Centaur 40 (51 MMBtu/hr) | SCR | 25 ppm |
| Buckingham Compressor Station | Buckingham County | 1/9/2019 | Solar Mars 100 (15,900 hp), Solar Taurus 70 (11,107 hp), Solar Titan 130 (20,500 hp), Solar Centaur 50 (6,276 hp) | SoLoNOx (DLNC) and SCR | 3.75 ppm |

Some California air districts have adopted lower NOx limits for compressor gas turbines. For example, the South Coast Air Quality Management District (SCAQMD) Rule 1134 will require compressor gas turbines, both existing and newly constructed turbines, to meet a NOx limit of 3.5 ppmvd @ 15% $O_2$ by 1/1/2024. The New Jersey Department of Environmental Protection recently updated its "State of the Art (SOTA) Manual for Stationary Combustion Turbines," which identified a NOx limit of 3.5 ppmvd @15% O2 for simple cycle gas compressor turbines of any size.[38] Ventura County Air Pollution Control District (VCAPCD) recently adopted regulations to require all combustion turbines, including compressor turbines, to meet a 2.5 ppm NOx limit by 1/1/2024.[39]

These permits and state and county rules and policy demonstrate that state and local permitting authorities (and also facility owners and operators) have found that SCR can effectively reduce NOx emissions from combustion turbines used for mechanical drive at compressor stations. This is due to the extensive experience with the effective use of SCR at simple cycle gas turbines used for power production. While the NOx emission limits that have been required for compressor turbines are generally not as low as the 2.5 ppm NOx limit that has been required for numerous simple cycle gas power turbines with SCR, these permits and rules/policies reflect a significant reduction in NOx emissions with SCR.

It is important to note that many of these compressor stations are not subject to PSD permitting requirements or BACT due to total potential to emit being under the 250 ton per year major source threshold of the prevention of significant deterioration permitting program. Thus, it is imperative that EPA include updated NOx emission NSPS standards for compressor gas turbines to ensure the BSER will be required for these turbines. Based on the data presented above, the BSER for compressor turbines is DLNC and SCR, as these controls have been widely and successfully used for simple cycle gas combustion turbines. Based on the permits and local rules for compressor turbines presented above and the extensive data on NOx emission limits required and achieved at simple cycle combustion turbines, EPA should adopt a NOx limit in the range of 2.5 - 3.75 ppm. In establishing the appropriate NSPS standard for compressor turbines, EPA must follow the court's finding regarding implementation of Section 111 of the Clean Air Act that "[a]n achievable standard is one which is within the realm of the adequately demonstrated system's efficiency and which, while not at a level that is purely theoretical or experimental, need not necessarily be routinely achieved within the industry prior to its adoption."[40] Compressor turbines can be equipped with SCR and DLNC and achieve NOx emission rates in the range of 2.5 – 3.75 ppm. The available data on the use of such controls at simple cycle turbines used for power generation demonstrate that SCR along with DLNC is an adequately demonstrated technology for simple cycle gas turbines.

[38] *See* NJDEP, State of the Art (SOTA) Manual for Stationary Combustion Turbines, Third Revision: September 21, 2023, at 3.14-11 (Table 3.14.2-2), available at https://dep.nj.gov/boss/state-of-the-art/.
[39] VCAPCD Rule 74.23 B.3.
[40] 88 Fed. Reg. 33,240 at 33,275 (May 23, 2023). *See also Essex Chem. Corp. v. Ruckelshaus*, 486 F.2d 427, 433-34 (D.C. Cir. 1973), *cert. denied*, 416 U.S. 969 (1974).

### C. SCR and DLNB or Water/Steam Injection Have Been Effectively Used at Combined Cycle Gas-Fired Combustion Turbines to Achieve NOx Emission Limits of 2.0 ppm.

Although SCR has been required and installed on combined cycle gas turbines going back to the mid-1980's, the lowest permitted NOx emission limit for combined cycle units with SCR and DLNB or water/steam injection has been 2.0 ppm beginning in 2016. *See* Table 2 of Appendix A to this report. Between January 2016 to present, there were at least sixty-six combined cycle gas turbine plants permitted with NOx emission limits of 2.0 ppm based on SCR and either water/steam injection or DLNC. Not only are there numerous combined cycle plants with NOx limits of 2.0 ppm, but a review of actual NOx emissions reported to CAMPD shows that numerous combined cycle gas turbines are emitting NOx at rates of 2.0 ppm or less. A NOx emission limit of 2.0 ppmvd @ 15% $O_2$ equates to approximately a 0.0082 lb/MMBtu NOx emission rate.[41] Appendix C to this paper shows the combined cycle combustion turbines with data in the EPA's CAMPD for the year 2022 with annual NOx emission rates of 0.0082 lb/MMBtu or lower.[42] There were three hundred and forty-two (342) such units emitting NOx at or below an annual rate 0.0082 lb/MMBtu, which indicates compliance with a 2.0 ppm NOx limit. Because annual NOx emissions include emissions during startup and shutdown, during which DLNC will not work effectively to reduce NOx and short term NOx will thus increase,[43] an annual NOx rate of 0.0082 lb/MMBtu would accurately capture those combustion turbines that emit NOx at 0.0082 lb/MMBtu or lower during normal operations. However, that quick analysis of annual NOx rates will not capture all combustion turbines that are achieving 0.0082 lb/MMBtu or lower on an hourly during normal operations, which would require evaluating all hourly emission data at each turbine. There are very likely many more combined cycle combustion turbines equipped with SCR that are emitting NOx at 2.0 ppm or lower rates during normal operations than listed in Appendix C. Indeed, fifty-eight percent of the eight hundred and seventy-nine (879) combined cycle turbines equipped with SCR emitted NOx at annual rates at or below levels reflective of 2.5 ppm (i.e., 0.010 lb/MMBtu), according to 2022 data reported to CAMPD. These numerous permit limits and actual NOx emissions data provide clear support for EPA to find that the BSER for combined cycle gas combustion turbines is SCR with DLNB or water/steam injection to meet a NOx emission limit of 2.0 ppm @ 15% $O_2$.

#### 1. An Updated NSPS Standard for NOx is Necessary for Combined Cycle Units.

As shown in Table 2 above, most of the combustion turbines that were subject to BACT or LAER since 2016 but that did not require SCR for NOx control were simple cycle turbines. However, one notable exception is the Jackson Generating Station that was permitted by the state of Michigan in 2019 (RBLC ID MI-0439). This facility consisted of 6 combined cycle combustion turbines with a total generating

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[41] *See* EPA-453/R-93-007, Alternative Control Techniques Document – NOx Emissions for Stationary Gas Turbines, APPENDIX A for the conversion formula from ppm to lb/MMBtu.

[42] Annual lb/MMBtu NOx rates were calculated based on the reported annual NOx emission for the year, divided by the reported annual heat input for the same year.

[43] Most BACT/LAER determinations for NOx from combustion turbines exclude periods of startup and shutdown, or establish separate emission limits, due to these issues.

capacity of 420 MW. The BACT control required for NOx was steam injection and the NOx BACT emission limit for each combined cycle turbine was 25.0 ppm @ 15% $O_2$, on a 30-day rolling average basis. This NOx limit, which is the same NOx limit that currently applies in the NSPS standard for stationary gas turbines, is over ten times higher than the 2.0 ppm NOx BACT and LAER emission limits that have generally been required for combined cycle gas turbines under BACT and LAER determinations since at least 2016. It is not clear why the state of Michigan did not impose a more stringent NOx BACT limit. Notes in the RBLC state that "[p]hysical constraints came into BACT decision due to modification to an existing facility."[44] This provides a cogent example of why EPA needs to update the NSPS for stationary gas turbines. The table below shows the NOx emissions for these 6 combined cycle combustion turbines operating at the Jackson Generating Station in 2022 under their 25.0 ppm, 30-day average, NOx BACT limit compared to what the units' NOx emissions would be if the units complied with a the commonly required 2.0 ppm NOx BACT limit reflective of SCR.

**Table 7. Jackson Generating Station, Six Combined Cycle Combustion Turbines, 2022 NOx Emissions Compared to NOx Emissions if Subject to 2.0 ppm NOx Limit[45]**

| Combined Cycle Unit | 2022 Annual Heat Input, MMBtu/hr | 2022 Annual NOx Rate, lb/MMBtu | 2022 Actual NOx Emissions, tons per year | Annual NOx Rate Reflective of 2.0 ppm, lb/MMBtu | Annual NOx Emissions if Complying with 2.0 ppm NOx Limit, tons per year |
|---|---|---|---|---|---|
| LM1 | 2,110,851 | 0.0760 | 80 | 0.0082 | 9 |
| LM2 | 2,066,367 | 0.0770 | 80 | 0.0082 | 8 |
| LM3 | 2,065,140 | 0.0757 | 78 | 0.0082 | 8 |
| LM4 | 2,227,759 | 0.0747 | 83 | 0.0082 | 9 |
| LM5 | 2,148,958 | 0.0766 | 82 | 0.0082 | 9 |
| LM6 | 2,183,053 | 0.0741 | 81 | 0.0082 | 9 |
| **Total** | | | **484** | | **52** |

The six combined cycle combustion turbines permitted at the Jackson Generating Station in 2019 would have emitted one-tenth of what they emitted in 2022 (or 432 fewer tons per year of NOx) if an updated NSPS reflective of the BSER for NOx at combined cycle combustion turbines had been in place at the time of that permit. This example underscores the importance of the need for EPA to update the NSPS for stationary gas turbines to reflect the BSER for NOx.

[44] See RBLC MI-0439 under pollutant information for NOx, in EPA's RBLC.
[45] Data from EPA's CAMPD. Note that Jackson Generating Station also has a combined cycle unit 7EA that was assumed not to be permitted as part of the PSD permit associated with RBLC ID MI-0439, and thus is not reflected in this table.

### 2. EPA Must Find that the BSER for Combined Cycle Combustion Turbines Requires Not Operating in Simple Cycle Mode.

Another example of SCR not being required to meet NOx BACT or LAER is that some permitting authorities have allowed companies with combined cycle units equipped with SCR the ability to operate the unit in simple cycle mode without SCR. Because the SCR is typically located within the HRSG for combined cycle units where the flue gas temperatures are lower, the SCR would be bypassed if the unit is allowed to operate in simple cycle mode. As shown in Table 2 above, that was allowed for the Lansing Board of Water & Light – Erickson Station combined cycle units and also was allowed for the El Paso Electric Company's Newman Unit 6.

As part of its updated NSPS for stationary gas turbines, EPA should promulgate a requirement that combined cycle units must operate in combined cycle mode. Not only would this ensure the SCR was not bypassed and NOx emission rates would be in compliance with a 2.0 ppm limit, but the combined cycle operation would ensure that the unit emitted much lower amounts of all air pollutants per megawatt-hour of power produced. A combined cycle power unit can produce up to 50% more electricity for the same amount of fuel use at a simple cycle plant.[46] It is imperative to ensure that the best system of emission reduction is used for NOx and for all other air pollutants, and thus EPA should adopt a requirement as part of its NSPS update that prohibit combined cycle units from operating in simple cycle mode.

## D. Because of the Widespread Use of SCR at Stationary Gas-Fired Combustion Turbines, the Cost of SCR Should Not Be Considered Unreasonable.

As shown above, SCR has been required and also voluntarily installed at numerous gas turbines, both at simple cycle turbines and those used in combined cycle mode. Installation and operation of SCR at gas turbines used for power generation has been especially commonplace, and there are recent examples of SCR being voluntarily installed at turbines used for gas compression. EPA's policy in the PSD permitting program since at least 1990 is that there is a presumption that the economic impacts of implementing an air pollution control at a particular source are generally not considered to be unreasonable economic impacts if other sources in the same source category have had to similar costs of air pollution control.[47] Because of the widespread use of SCR at stationary gas turbines, the cost of installing and operating an SCR system should not be an impediment to EPA finding that the BSER for stationary gas turbines should be based on use of SCR along with DLNC or water/steam injection.

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[46] *See*, e.g., https://www.ge.com/gas-power/resources/education/combined-cycle-power-plants.

[47] *See* EPA, New Source Review Workshop Manual, October 1990, at B.29, available at https://www.epa.gov/sites/default/files/2015-07/documents/1990wman.pdf.

### E. EPA Should Require that Continuous Emissions Monitoring Systems be Used for Compliance with NOx NSPS Limits.

EPA's current NSPS does not require use of continuous emissions monitoring systems (CEMS) for measurement of NOx emissions, although it is identified an option to show compliance.[48] With a BSER based on use of SCR, NOx CEMS should be required to demonstrate compliance with updated NOx emission limits. For those power-generating combustion turbines that are subject to the acid rain program, the use of CEMS for NOx is already required,[49] so this requirement would not represent a significant burden for the bulk of the combustion turbines installed that will already be required to use NOx CEMs. However, despite CEMs being required for power-generating turbines subject to the acid rain program, some permitting authorities have not required use of the CEMs to verify compliance with permitted NOx emission limits. The use of CEMs to measure NOx would provide timely feedback to plant operators to enable necessary short term adjustments to the SCR systems, as well as to indicate the need for SCR maintenance. Using CEMs data to assist in controlling the ammonia injection rate and flue gas temperatures (such as in simple cycle applications where tempering air is used) will not only ensure the lowest NOx emission rates are achieved, but also help to extend the life of the SCR system.[50] Because of the benefits of the use of NOx CEMs to optimize operation of the SCR, EPA should require NOx CEMs for all combustion turbines, even those used for mechanical drive or as industrial power plants that are not subject to acid rain provisions.

### F. EPA Should Impose Shorter Averaging Times for the Updated NOx NSPS Limits for Gas Turbines.

EPA's current NSPS requirements in 40 C.F.R. Part 60, Subpart KKKK, establishes a 4-hour averaging time for NOx emission limits for simple cycle combustion turbine and a 30-day rolling average for NOx emission limits for combined cycle units.[51] The current NSPS also requires that all periods of operation including startup and shutdown be included in determining compliance with the rolling average emission limits.[52] Most BACT and LAER NOx emission limits that are based on use of SCR have been based on a 1-hour to 3-hour rolling average basis, as shown in the data in Appendix A and also in Tables 3 and 4 above. However, most BACT and LAER NOx limits for gas-fired combustion turbines with SCR have exemptions for periods of startup and shutdown. The main problem with complying with a 2.0 to 2.5 ppm NOx limit during startup and shutdown is due to the DLNC controls, which do not control NOx effectively below 50 percent load,[53] and thus the NOx loading to the SCR can be much higher during those periods. Fortunately, most combustion turbines manufactured today have fast startup and

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[48] *See* 40 C.F.R. §60.4340(b)(1).
[49] *See* 40 C.F.R. §75.10.
[50] See, e.g., Monitoring Madness, High quality continuous monitoring capability can be as essential as high quality emission control equipment, 1-1-2006, Power Engineering, available at https://www.power-eng.com/emissions/monitoring-madness/#gref.
[51] 40 C.F.R. § 60.4350(g) and (h).
[52] 40 C.F.R. § 60.4375.
[53] *See*, e.g., Sargent & Lundy, Combustion Turbine NOx Control Technology Memo, Final, Rev. 1, January 2022, at 3.

shutdown periods, sometimes as short as 10 minutes to start up and options are even available for combined cycle units to have fast startup times.[54]

With updated NOx NSPS limits based on the use of SCR, EPA should adopt a different averaging scheme and consider regulating emissions during startup and shutdown with a separate emission standard. For normal source operation, a 1-hour to 3-hour averaging time is what has been most commonly required in recent BACT and LAER determinations for both simple cycle and combined cycle. EPA should adopt a similar averaging time range for its updated NOx NSPS standards for gas turbines. For simple cycle power generating turbines, a 1-hour standard makes the most sense because some of these units only operate for a few hours at a time to meet peak demand.

If EPA does allow for exemptions from the updated NOx emission limits during startup and shutdown, EPA should require records be kept on the length of time expended for each startup and shutdown. Further, EPA should make clear that such data will be directly relevant to determine a facility's compliance with the requirement of 40 C.F.R. §60.4333(a) to operate the stationary combustion turbine in accordance with good air pollution control practices for minimizing emissions at all times including startup, shutdown, and malfunction. EPA should also consider continuing to impose a second set of higher NOx emission limits that covers all periods of operation.

## IV. As part of its Forthcoming Stationary Gas Turbine NSPS Update, EPA Should Issue Guidance Regarding the "Alternatives Analysis" Required under the Prevention of Significant Deterioration Permitting Program.

EPA's NSPS standards are directly relevant to the PSD permitting program because the NSPS emission standards for an affected facility provide the floor for determinations of BACT.[55] In its recently proposed NSPS standards for greenhouse gas emissions from fossil fuel-fired electric generating units, EPA states that "the fact that a minimum control requirement is established by an applicable NSPS does not mean that a permitting authority cannot select a more stringent control level of the PSD permit or consider technologies for BACT beyond those that were considered in developing the NSPS."[56] EPA should make that clear in its updated NSPS for stationary gas turbines. Further, EPA should point out that Section 165(a)(2) of the Clean Air Act provides an additional PSD requirement that states must consider "alternatives thereto" a proposed new or modified stationary source: the proposed permit must be subject to review that includes a public hearing "with opportunity for interested persons including representatives of the Administrator to appear and submit written or oral presentations on the air quality impact of such source, alternatives thereto, control technology requirements, and other appropriate considerations."

The EPA has, in the past, interpreted this Clean Air Act provision to provide the opportunity for a permitting authority to consider alternative, inherently lower-emitting technologies, such as the installation of an integrated gasification combined cycle (IGCC) power plant in lieu of constructing a coal-

[54] *See*, e.g., Fast Start Combined Cycles: How Fast is Fast?, In recent years, the term "fast start" has become commonplace in the power generation industry," 3/9/2017, Power Engineering, available at https://www.power-eng.com/emissions/fast-start-combined-cycles-how-fast-is-fast/#gref.

[55] *See* Section 169(3) of the Clean Air Act. See also 40 C.F.R. §52.21(b)(12).

[56] 88 Fed. Reg. 33,240 at 33,408 (May 23, 2023).

fired power plant.[57] However, the Environmental Appeals Board (EAB) has also stated that permitting authorities have the discretion as to whether to evaluate alternatives, and the EAB has relied on EPA policy statements that permitting authorities are not required to consider BACT control options that would "redefine the source."[58]

EPA should issue clear guidance regarding implementation of Section 165(a)(2) of the Clean Air Act and regarding the NOx BACT control options for gas turbines that should be considered by permitting authorities in the context of an updated NSPS rulemaking for stationary gas turbines. To facilitate technological advancements in zero- to low-emitting energy sources that can protect public health and the environment by reducing multiple air pollutants and to recognize the congressionally enacted incentives for clean zero-emitting electricity generation and EPA's related mandate for a low emissions electricity program (considering that zero-emitting solutions are now widely available at comparable or lower costs which save ratepayers and customers money and recognizing that zero-emitting solutions are being widely deployed in a context that provides functionally comparable electricity generation) -- it is necessary and appropriate to consider, in PSD application reviews and in BACT analyses, the best technological approaches to minimize emissions, including widely available and highly cost-effective zero-emitting electricity generating options. For example, Southern California Edison has recently built two hybrid power plants which combined simple cycle gas combustion turbines with battery storage.[59] These plants combined battery storage with peaking generation and thus optimized the operation of the combustion turbines. Rather than frequently starting up and shutting down the turbine as is common with a peaking power plant, the energy produced by the turbines during off peak hours is stored in the batteries. A recent study on the levelized costs of energy shows that utility-scale solar, solar plus storage, geothermal, onshore wind, and wind plus storage all have a lower levelized cost per megawatt-hour than gas peaking plants.[60] When the tax subsidies of the Inflation Reduction Act (IRA) are taken into account, the costs per megawatt-hour for these and other renewable forms of energy production are even further reduced such that several of these renewable energy production options would have a lower levelized cost in terms of cost per megawatt-hour than a gas-fired combined cycle power plant.[61] Thus, there are sound economic justifications and environmental justifications for EPA to require consideration of alternatives to construction of natural gas-fired power plants in the context of the BACT analyses.

As another example, instead of using a gas turbine to power a compressor station, installing an electric compressor and using energy from the grid that will be increasingly powered by renewable energy and energy storage reflects the best technological approach to minimize emissions from compressor stations. The use of electric compressors rather than gas-fired compressor turbines has been found to have

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[57] *See, e.g.*, Letter from Mr. Stephen D. Page, Director, US EPA Office of Air Quality Planning and Standards (OAQPS), to Mr. Paul Plath, Senior Partner, E3 Consulting, LLC, "Best Available Control Technology Requirements for Proposed Coal-Fired Power Plant Projects," (Dec. 13, 2005).

[58] *See, e.g.*, *In re Prairie State Generating Co.*, 13 E.A.D. 1, 22-26 (EAB 2006).

[59] *See* SCE Unveils World's First Low Emission Hybrid Battery Storage, Gas Turbine Peaker System, April 18, 2017, at https://energized.edison.com/stories/sce-unveils-worlds-first-low-emission-hybrid-battery-storage-gas-turbine-peaker-system.

[60] *See* Lazard's Levelized Cost of Energy, April 2023, at 2, available at https://www.lazard.com/research-insights/2023-levelized-cost-of-energyplus/.

[61] *Id.* at 2-3.

reduced maintenance requirements and thus lower costs.[62] Further, with less frequent maintenance required, there will be less methane released from compressor blowdowns.[63]

Thus, in the context of updating the NSPS standards for stationary gas turbines, EPA should take this opportunity to align its regulations and guidance with the Clean Air Act's requirements discussed above by placing the obligation on permitting entities to explore zero- to low-emitting technologies and alternatives in the context of BACT analyses and also to consider alternatives to a proposed source (including source siting, source need, "no build" options, and other case-specific factors) raised in public hearings and comments.

[62] *See* EPA, Partner Reported Opportunities (PROs) for Reducing Methane Emissions, PRO Fact Sheet No. 103 Install Electric Compressors, 2011, available at https://19january2017snapshot.epa.gov/natural-gas-star-program/install-electric-compressors_.html.

[63] *Id.*

# Appendix A

# Gas Combustion Turbines with SCR Listed in EPA's RACT/BACT/LAER Clearinghouse

**Table 1. Combined Cycle or Cogeneration Gas-Fired Combustion Turbines with SCR, Permitted Between 1/1/2016 to 12/31/2023 in EPA's RBLC**

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| NY-0103 | 2/3/2016 | Cricket Valley Energy Center, 1000 MW, 4 combined cycle gas turbines | DLN burners with SCR | 2.0 ppmvd @15% $O_2$ (1-hour) (LAER) |
| PA-0306 | 2/12/2016 | Tenaska PA Partners LLC/Westmoreland Gen Fac, combustion turbines, combined cycle (2x1) | SCR, DLN | 2.0 ppmvd @15% $O_2$ (LAER) |
| TX-0789 | 3/8/2016 | Decordova II Steam Electric Station, combined cycle and cogen, 231 MW | SCR | 2.0 ppm (BACT) |
| FL-0356 | 3/9/2016 | Florida Power & Light, Okeechobee Clean Energy Center, combined cycle combustion turbines (3x1), 3096 MMBtu/hr | SCR, DLNC | 2.0 ppmvd @15% $O_2$ (24-hr avg) (BACT) |
| NJ-0084 | 3/10/2016 | PSEG Fossil Sewaren Generating Station, combined cycle combustion turbine, GE 7HA.02 (345 MW, 3453 MMBtu/hr) | SCR | 2.0 ppmvd@15% $O_2$ (1-hour block), 25.4 lb/hr (avg three one-hour stack tests) (LAER) |
| TX-0788 | 3/24/2016 | Apex Texas Power LLC, Neches Station, combined cycle and cogen | SCR | 2.0 ppm (BACT) |
| TN-0162 | 4/29/2016 | TVA, Johnsonville Cogen, 1339 MMBtu/hr | SCR | 2.0 ppmvd @15% $O_2$ (30-day avg) (BACT) |
| VA-0325 | 6/17/2016 | Virginia Electric and Power Company, Greensville Power Station, 3 combined cycle combustion turbines, 3227 MMBtu/hr | SCR | 2.0 ppmvd @15% $O_2$ (1-hr avg) (BACT) |
| MA-0041 | 7/1/2016 | MATEP Limited Partnership, Medical Area Total Energy Plan, combustion turbine combined cycle with duct burner, 203.4 MMBtu/hr | SCR and DLNC | 2.0 ppmvd@15% $O_2$ (1-hour block) |
| NJ-0085 | 7/19/2016 | Stonegate Power LLC, Middlesex Energy Center, combined cycle | SCR and DLNC | 2.0 ppmvd @15% $O_2$ (3-hr avg) (LAER) |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| | | combustion turbine, 633 MW | | |
| LA-0313 | 8/31/2016 | Entergy Louisiana, St. Charles Power Station, 2 combined cycle combustion turbines, 3625 MMBtu/hr | SCR w/DLNC | 2.0 ppm@15% $O_2$ (24-hr avg) (BACT) |
| PA-0310 | 9/2/2016 | CPV Fairview LLC, Fairview Energy Center, combustion turbine, combined cycle, 3338 MMBtu/hr | DLNC and SCR | 2.0 ppmvd @15% $O_2$ (LAER) |
| OH-0367 | 9/23/2016 | Southfield Energy LLC, 2 combined cycle combustion turbines, 3131 MMBtu/hr | DLNC and SCR | 30.51 lb/hr, 2.0 ppm @15% $O_2$ (1-hour) (BACT) |
| MI-0424 | 12/5/2016 | Holland Board of Public Works, East 5th Street, 2 combined cycle combustion turbines, 554 MMBtu/hr | SCR and DLNC | 3.0 ppm @15% $O_2$ (24-hr avg), 8.18 lb/hr (24-hr avg) (BACT) |
| MI-0423 | 1/4/2017 | Indeck Niles, 2 combined cycle combustion turbines, 8322 MMBtu/hr | SCR and DLNB | 38.1 lb/hr (24-hr), 3.0 ppmvd @15% $O_2$ (24-hr avg) (BACT) |
| PA-0315 | 4/12/2017 | Hilltop Energy Center, combustion turbine combined cycle, 3509 MMBtu/hr | SCR | 2.0 ppmvd (LAER) |
| TX-0819 | 4/28/2017 | Southwestern Public Service Co., Gaines County Power Plant, combined cycle combustion turbine, 426 MW | SCR and DLNB | 2.0 ppmvd (3-hr avg) (BACT) |
| MA-0043 | 6/21/2017 | MIT Central Utility Plant, 2 combustion turbines combined cycle with duct burner (22 MW, 353 MMBtu/hr) | SCR and DLNC | 2.0 ppmvd @15% $O_2$ (1-hour block) |
| CT-0161 | 6/30/2017 | Killingly Energy Center, combined cycle combustion turbine, 2969 MMBtu/hr | SCR | 2.0 ppmvd (1-hr avg) (LAER) |
| OH-0370 | 9/7/2017 | Trumball Energy Center, 2 combined cycle | DLNC and SCR | 25.3 lb/hr (w/ duct burner), 2.0 ppm @15% $O_2$ |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| | | combustion turbines, 3025 MMBtu/hr | | (BACT) |
| OH-0372 | 9/27/2017 | Oregon Energy Center, 2 combined cycle combustion turbines, 3055 MMBtu/hr | DLNC and SCR | 25.3 lb/hr (w/ duct burner), 2.0 ppm @15% $O_2$ (BACT) |
| OH-0374 | 10/23/2017 | Guernsey Power Station, 3 combined cycle combustion turbines, 3516 MMBtu/hr | SCR | 33.85 -26.37 lb/hr (w/ or wo/ duct burner), 2.0 ppm @15% $O_2$ (BACT) |
| OH-0375 | 11/7/2017 | Long Ridge Energy Generation, Hannibal Power, combined cycle combustion turbine, 3544 MMBtu/hr | DLNB and SCR | 26.1 lb/hr, 2.0 ppm @15% O2 (BACT) |
| MI-0427 | 11/17/2017 | Filer City Station, combined cycle combustion turbine, 1934.7 MMBtu/hr | SCR w/DLNB | 3.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| PA-0314 | 12/27/2017 | Robinson Power Company, LCC, Beech Hollow, combustion turbine combined cycle without duct burners, 2433 MMBtu/hr | SCR | 2.0 ppmvd @15% $O_2$ |
| PA-0316 | 1/26/2018 | Renova Energy Center LLC, GE 7AH.02 combustion turbine, combined cycle | SCR | 2.0 ppmvd @15% $O_2$ (LAER) |
| TN-0164 | 2/1/2018 | TVA – Johnsonville Cogeneration, combined cycle combustion turbine, 1020 MMBtu/hr | SCR | 2.0 ppmvd @15% $O_2$ (30-day avg) (BACT) |
| WV-0029 | 3/27/2018 | ESC Harrison County Power Plant, combined cycle combustion turbine, 640 MW | DLNB, SCR | 32.9 lb/hr (1-hr avg), 2.0 ppm (BACT) |
| TX-0834 | 3/30/2018 | Entergy Texas Inc, Montgomery County Power Station, 2 combined cycle turbines, 2635 MMBtu/hr | SCR and DLNB | 2.0 ppmvd @15% $O_2$ (1-hr) (LAER) |
| OH-0377 | 4/19/2018 | Harrison Power, 2 combined cycle combustion turbines | DLNC and SCR | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| CA-1251 | 4/25/2018 | Palmdale Energy Project, 2 combined cycle | SCR, DLNC | 2.0 ppmvd @15% $O_2$ (1-hr) |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| | | combustion turbines, 2217 MMBtu/hr | | (BACT) |
| VA-0328 | 4/26/2018 | Novi Energy, C4GT, combined cycle, 2 turbines, 3116 MMBtu/hr | SCR w/DLNB | 2.0 ppmvd @15% $O_2$ (1-hr) (BACT) |
| MI-0431 | 6/26/2018 | Indeck Niles LLC, 2 combined cycle combustion turbines, 3421 MMBtu/hr | SCR w/DLNB | 2.0 ppmvd @15% $O_2$ (24-hr) |
| MI-0433 | 6/29/2018 | Marshall Energy Center North and South, two combined cycle combustion turbines, 500 MW | SCR w/DLNB | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| MI-0435 | 7/16/2018 | DTE Electric Company, Belle River Combined Cycle Power Plant, 2 turbines | SCR with DLNB | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| FL-0367 | 7/27/2018 | Shady Hills energy Center Combined Cycle Facility | DLNC and SCR | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| MI-0432 | 7/30/2018 | New Covert Generating Facility, 1230 MW, 3 combined cycle combustion turbines | DLNC and SCR | 2.0 ppmvd @15% $O_2$ (24-hr avg) (BACT) |
| IL-0129 | 7/30/2018 | CPV Three Rivers Energy Center, combined cycle combustion turbines, 3470 MMBtu/hr | DLNC and SCR | 2.0 ppmvd @ 15% $O_2$ (3-hr)<br><br>(LAER) |
| MI-0436 | 8/23/2018 | The Regents of the University of Michigan, Central Power Plant, Combined heat and power turbine, 190.1 MMBtu/hr | DLNC and SCR | No limit specified in RLBC |
| PA-0319 | 8/27/2018 | APV Renaissance Energy Center, 2 combined cycle combustion turbines, 3580 MMBtu/hr | SCR | 2.0 ppmvd @15% $O_2$ (LAER) |
| WV-0032 | 9/18/2018 | ESC Brooke County Power Plant, GE 7HA.01 turbine, 925 MW combined cycle, 2737 MMBtu/hr | DLNB and SCR | 23.2 lb/hr 2.0 ppm (BACT) |
| LA-0331 | 9/21/2018 | Venture Global Calcasieu Pass LNG Project, 5 combined cycle | LNB, SCR | 2.5 ppmvd (30-day avg) (BACT) |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| | | combustion turbines, 921 MMBtu/hr | | |
| MI-0441 | 12/21/2018 | Lansing Board of Water and Light, Erickson Station, 1 combustion turbine combined cycle, 667MMBtu/hr | DLNC and SCR | 3.0 ppmvd @ 15% $O_2$ (24-hr avg) (BACT) |
| VA-0332 | 6/24/2019 | Chickahominy Power LLC, 3 combined cycle combustion turbines | DLNB and SCR | 2.0 ppmvd 15% $O_2$ (1-hr avg) (BACT) |
| NJ-0088 | 7/30/2019 | Cogen Tech Linden Venture LP, 250 MW combined cycle combustion turbine | SCR, DLNC | 18.3 lb/hr, 2.0 ppmvd @15% $O_2$ (3-hr avg) (BACT) |
| PA-0333 | 8/20/2019 | ESC Tioga County Power, LLC, Elec Power Gen Facility, combined cycle gas turbine, 4469 MMBtu/hr | SCR, catalytic oxidizer | 2.0 ppmvd @ 15% $O_2$ (1-hr) (LAER) |
| MI-0442 | 8/21/2019 | Thomas Township Energy, LLC, 2 combined cycle gas turbines, 4200 MMBtu/hr | SCR with DLNB | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| MI-0445 | 11/26/2019 | Indeck Niles, LLC, combined cycle gas turbines, 3421 MMBtu/hr | SCR with DLNB | 2.0 ppmvd @15% $O_2$ (24-hr) (BACT) |
| LA-0364 | 1/6/2020 | FG LA LLC Complex, Cogeneration units, 2222 MMBtu/hr | DLNC and SCR | 2.0 ppmvd (12-month rolling avg) (BACT) |
| WI-0300 | 9/1/2020 | Nemadji Trail Energy Center, combined cycle gas turbine, 4671 MMBtu/hr | SCR and LNB | 2.0 ppm @15% $O_2$ (24-hr avg) (BACT) |
| AL-0328 | 11/9/2020 | Alabama Power Company, Plant Barry, 2-744 MW combined cycle gas turbines | SCR | 2.0 ppm @ 15% $O_2$ (3-hr avg) (BACT) |
| VA-0334 | 12/1/2020 | Virginia Electric and Power Company, Dominion Energy – Brunswick, 3 combined cycle combustion turbines, 3442 MMBtu/hr (Mitsubishi M501 GAC turbines) | DLNC and SCR | 604.0 lb/calendar day/turbine ("with 2.0 ppmvd @15% $O_2$ performance") (BACT) |
| VA-0335 | 12/18/2020 | Panda Stonewall LLC, 2 combustion turbines (Siemens SGT6-5000F5), combined cycle, 2554 MMBtu/hr | SCR with ammonia injection and DLNC | 2.0 ppmvd @ 15% $O_2$ (LAER) |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| MI-0447 | 1/7/2021 | Lansing Board of Water and Light, Erickson Station, 1 simple cycle turbine (667 MMBtu/hr), and 2 combined cycle turbines (667 MMBtu/hr) | DLNC and SCR (but no SCR required for simple cycle turbine) | 60.0 lb/hr (1-hr and 24-hr), 3.0 ppmvd @ 15% $O_2$ (24-hr avg) (BACT) |
| AK-0086 | 3/26/2021 | Agrium US Inc, Kenai Nitrogen Operations. 5 cogeneration gas-fired Solar Turbine with 55.4 MMBtu/hr heat input to turbine (waste heat boiler with 46.7 MMBtu/hr heat input) | SCR and SoLoNOx | 5.0 ppm @ 15% $O_2$ (3-hour avg) |
| PA-0334 | 4/29/2021 | Renovo Energy Center LLC/Renovo Plant, 2 combustion turbines combined cycle, 4546 MMBtu/hr | SCR, catalytic oxidizer | 2.0 ppmvd @ 15% $O_2$ (1-hr) (LAER) |
| FL-0371 | 6/7/2021 | Shady Hills Energy Center, GE 7HA.02 combustion turbine combined cycle, 3622.1 MMBtu/hr | DLNC and SCR | 2.0 ppmvd @ 15% $O_2$ (24-hr avg) (BACT) |
| TX-0908 | 8/27/2021 | El Paso Electric Company, Newman Power Station, combined cycle turbine, 230 MW | DLNB and SCR (for combined cycle operation only) | 2.5 ppmvd (BACT) 9.0 ppmvd for simple cycle operation |
| WV-0033 | 1/5/2022 | Mountain State Clean Energy LLC, Maidsville, combustion turbine combined cycle, 1275 MW | DLNC with SCR | 2.0 ppmvd @ 15% $O_2$ (3-hr avg) (BACT) |
| LA-0391 | 6/3/2022 | Magnolia Power LLC, Magnolia Power Generating Station Unit 1, combined cycle gas turbine, 5081 MMBtu/hr | DLNC and SCR | 2.0 ppmvd (24-hr rolling avg) (BACT) |
| MI-0451 | 6/23/2022 | Marshall Energy Center, LLC, MEC North, LLC, 500 MW combined cycle gas turbine 3064 MMBtu/hr | SCR with DLNB | 2.0 ppm (24-hr avg) (BACT) Note, entry says 2.5 ppm but text says 2 ppm limit |
| MI-0452 | 6/23/2022 | Marshall Energy Center, LLC, MEC North, LLC, 500 | SCR with DLNB | 2.0 ppm (24-hr avg) (BACT) |

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| | | MW combined cycle gas turbine 3064 MMBtu/hr | | |
| AK-0088 | 7/7/2022 | Alaska Gasline Development Corporation Liquefaction Plant, four combined cycle gas turbines, 384 MMBtu/hr | SCR and DLNC | 2.0 ppmvd @ 15% $O_2$ (3-hr) (BACT) |
| IL-0133 | 7/29/2022 | Lincoln Land Energy Center (aka Emberclear), combined cycle combustion turbines, 3647 MMBtu/hr | DLNC, low NOx duct burners, and SCR | 2.0 ppmv@15% $O_2$ (3-hr avg, reducing to 1-hr avg after 36 months) (BACT) |
| MI-0454 | 12/20/2022 | Lansing Board of Water and Light, Erickson Station, 2-667 MMBtu/hr combustion turbines combined cycle | DLNC and SCR | 3.0 ppmvd @15% $O_2$ (24-hr avg) (BACT) |
| MI-0455 | 2/1/2023 | Midland Cogeneration Venture Limited Partnership, 1 turbine combined cycle, 4197.6 MMBtu/hr | SCR | 2.0 ppmvd @ 15% $O_2$ (24-hr avg) (BACT) |
| IN-0365 | 6/19/2023 | Maple Creek Energy LLC, 2 turbines combined cycle, 3800 MMBtu/hr and 42000 MMBtu/hr | SCR and DLNC | 2.0 ppmvd@15% $O_2$ (3-hr avg) and also lb/MMBtu limits (BACT) |

**Table 2. Simple Cycle or Mechanical Drive Combustion Turbines with SCR, Permitted Between 1/1/2016 to 12/31/2023 in EPA's RBLC**

| RBLC ID | Date of Permit | Plant | NOx Controls Required | NOx Limit |
|---|---|---|---|---|
| TN-0187 | 8/31/2022 | Tennessee Valley Authority, Johnsonville, 10 simple cycle aeroderivative turbines, 465.8 MMB/hr each | Yes | 5.0 ppmvd @ 15% $O_2$ (4-hr rolling avg)<br><br>(BACT) |
| AK-0088 | 7/7/2022 | Alaska Gasline Development Corporation Liquefaction Plant, six simple cycle gas turbines used for compression, 1113 MMBtu/hr | SCR and DLNC | 2.0 ppmvd @ 15% $O_2$ (3-hr) |
| TX-0933 | 11/17/2021 | Nacero TX 1 LLC, Necero Penwell Facility, Methanol Plant | Low NOx Burners and SCR | 9.0 ppmvd @15% $O_2$ |
| LA-0383 | 4/30/2020 | Lake Charles LNG Export Terminal, combustion turbines | Low NOx Burners and SCR | 3.1 ppmvd @15% $O_2$ (3-hr avg) |
| LA-0331 | 9/21/2018 | Venture Global Calcasieu Pass, LLC, Calcasieu Pass LNG Project, 5 aeroderivative simple cycle turbines, 263 MMBtu/hr | SCR and good combustion practices | Simple cycle operation: 25.0 ppmvd (30-day rolling avg)<br><br>(BACT) |
| LA-0349 | 7/10/2018 | Driftwood LNG Facility, compressor turbines, 540 MMBtu/hr | DLN and SCR | 5.0 ppmvd @ 15% $O_2$ (BACT) |
| CA-1238 | 10/13/2016 | Puente Power, simple cycle combustion turbine, 262 MW | No controls listed but emission limit reflects SCR | 2.5 ppmvd @15% $O_2$ (1-hour)<br><br>(other case-by-case) |
| NJ-0086 | 8/26/2016 | Bayonne Energy Center, 2 CTs, 66 MW each | SCR and water injection | 2.5 ppmdv @15% $O_2$ |
| TX-0790 | 2/17/2016 | Port Arthur LNG Export Terminal, simple cycle gas turbines, 34 MW | SCR | 5.0 ppm (24-hr avg) |

# Appendix B

## Electric Utility Simple Cycle Combustion Turbines Equipped with Selective Catalytic Reduction that Emitted NOx at or Lower Than 2.5 ppmvd @ 15% Oxygen in 2022

**Table 1. Simple Cycle Natural Gas-Fired Combustion Turbines Equipped with Selective Catalytic Reduction (SCR) and Dry Low NOx Combustors (DLNC) or Water/Steam Injection that Achieved Annual NOx Emission Rates[1] of 0.010 lb/MMBtu or Lower (Equivalent to 2.5 ppmvd @15% Oxygen or Lower[2]) in 2022[3]**

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| AZ | Ocotillo Power Plant | GT3 | 177,441 | 7.0 | 0.008 | 1,647,927 |
| AZ | Ocotillo Power Plant | GT4 | 153,918 | 5.9 | 0.008 | 1,434,223 |
| AZ | Ocotillo Power Plant | GT5 | 191,610 | 7.2 | 0.008 | 1,756,586 |
| AZ | Ocotillo Power Plant | GT6 | 155,106 | 6.5 | 0.009 | 1,436,541 |
| AZ | Ocotillo Power Plant | GT7 | 92,698 | 3.7 | 0.008 | 876,919 |
| AZ | Yucca Power Plant | CT5 | 79,313 | 3.9 | 0.009 | 814,170 |
| AZ | Coolidge Generating Station | CT01 | 15,734 | 0.6 | 0.007 | 162,720 |
| AZ | Coolidge Generating Station | CT02 | 19,035 | 1.0 | 0.010 | 196,547 |
| AZ | Coolidge Generating Station | CT03 | 21,150 | 1.1 | 0.010 | 215,545 |
| AZ | Coolidge Generating Station | CT04 | 22,206 | 1.1 | 0.010 | 226,847 |
| AZ | Coolidge Generating Station | CT05 | 41,525 | 1.9 | 0.009 | 420,639 |
| AZ | Coolidge Generating Station | CT06 | 40,779 | 1.4 | 0.007 | 417,178 |
| AZ | Coolidge Generating Station | CT08 | 41,405 | 1.8 | 0.009 | 418,792 |
| AZ | Coolidge Generating Station | CT10 | 26,257 | 1.3 | 0.009 | 265,885 |
| AZ | Coolidge Generating Station | CT11 | 27,540 | 1.3 | 0.010 | 282,165 |
| CA | Cabrillo Power I Encina Power Station | 6 | 59,162 | 2.6 | 0.009 | 584,159 |
| CA | Cabrillo Power I Encina Power Station | 7 | 65,659 | 2.5 | 0.008 | 659,926 |
| CA | Cabrillo Power I Encina Power Station | 8 | 70,600 | 2.7 | 0.008 | 722,190 |
| CA | Cabrillo Power I Encina Power Station | 9 | 70,954 | 2.8 | 0.008 | 718,659 |

[1] Annual NOx emission rates were calculated for each unit by converting reported annual NOx emissions for 2022 from tons to pounds and divided by reported annual heat input in million British Thermal Units (MMBtu) for 2022.
[2] *See* EPA-453/R-93-007, January 1993, Alternative Control Techniques Document – NOx Emissions for Stationary Gas Turbines, Appendix A for the conversion formula from ppm to lb/MMBtu, available at https://www3.epa.gov/airquality/ctg_act/199301_nox_epa453_r-93-007_gas_turbines.pdf.
[3] Based on data reported to EPA's Clean Air Markets Program Database, at https://campd.epa.gov/.

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CA | Cabrillo Power I Encina Power Station | 10 | 89,790 | 3.1 | 0.007 | 861,672 |
| CA | Haynes Generating Station | 11 | 21,458 | 0.8 | 0.008 | 196,616 |
| CA | Haynes Generating Station | 12 | 161,314 | 5.8 | 0.008 | 1,489,982 |
| CA | Haynes Generating Station | 13 | 57,334 | 2.3 | 0.009 | 526,040 |
| CA | Haynes Generating Station | 14 | 30,093 | 1.3 | 0.009 | 283,522 |
| CA | Haynes Generating Station | 15 | 67,529 | 2.6 | 0.008 | 632,501 |
| CA | Haynes Generating Station | 16 | 78,071 | 3.2 | 0.009 | 729,314 |
| CA | Scattergood Generating Station | 6 | 81,914 | 3.4 | 0.009 | 783,683 |
| CA | Scattergood Generating Station | 7 | 14,493 | 0.7 | 0.009 | 140,008 |
| CA | Woodland Generation Station | 1 | 93,878 | 4.0 | 0.009 | 917,375 |
| CA | Almond Power Plant | 2 | 64,003 | 2.9 | 0.009 | 627,280 |
| CA | Almond Power Plant | 3 | 98,702 | 4.5 | 0.009 | 1,000,971 |
| CA | Almond Power Plant | 4 | 55,880 | 2.6 | 0.009 | 560,718 |
| CA | Procter and Gamble Power Plant | 1C | 19,786 | 0.8 | 0.009 | 175,684 |
| CA | Bear Mountain Limited | GT1 | 97,529 | 4.0 | 0.009 | 912,594 |
| CA | Cuyamaca Peak Energy | GT-1 | 13,109 | 0.7 | 0.010 | 143,833 |
| CA | Niland Gas Turbine Plant | 1 | 46,768 | 2.2 | 0.010 | 437,422 |
| CA | Niland Gas Turbine Plant | 2 | 58,711 | 2.6 | 0.009 | 556,684 |
| CA | Panoche Energy Center | 1 | 178,664 | 7.7 | 0.010 | 1,585,586 |
| CA | Canyon Power Plant | 1 | 41,236 | 1.8 | 0.009 | 418,443 |
| CA | Canyon Power Plant | 2 | 30,662 | 1.3 | 0.008 | 310,072 |
| CA | Canyon Power Plant | 3 | 30,993 | 1.4 | 0.009 | 315,573 |
| CA | Canyon Power Plant | 4 | 45,362 | 2.2 | 0.010 | 461,509 |
| CA | Marsh Landing Generating Station | 1 | 22,780 | 0.9 | 0.008 | 248,421 |
| CA | Marsh Landing Generating Station | 2 | 60,939 | 2.7 | 0.008 | 665,893 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CA | Marsh Landing Generating Station | 3 | 20,334 | 0.9 | 0.008 | 224,282 |
| CA | Marsh Landing Generating Station | 4 | 41,543 | 1.6 | 0.007 | 447,616 |
| CA | Walnut Creek Energy Park | GT5 | 97,091 | 4.4 | 0.010 | 850,194 |
| CA | Delano Energy Center, LLC | GEN1 | 15,438 | 0.7 | 0.009 | 157,518 |
| CO | Pueblo Airport Generating Station | CT01 | 175,113 | 8.6 | 0.009 | 1,830,812 |
| CT | Wallingford Energy, LLC | CT06 | 12,066 | 0.6 | 0.010 | 121,425 |
| KY | Smith Generating Facility | SCT9 | 38,383 | 1.7 | 0.010 | 352,692 |
| MA | Exelon West Medway II | J4 | 144,717 | 6.3 | 0.009 | 1,336,850 |
| MA | Exelon West Medway II | J5 | 89,378 | 4.3 | 0.010 | 857,749 |
| ND | Lonesome Creek Station | CT1 | 104,438 | 4.5 | 0.009 | 1,021,773 |
| NJ | Kearny Generating Station | 131 | 33,178 | 1.4 | 0.008 | 356,466 |
| NJ | Kearny Generating Station | 132 | 33,789 | 1.5 | 0.008 | 362,208 |
| NJ | Kearny Generating Station | 133 | 32,037 | 1.2 | 0.007 | 342,247 |
| NJ | Kearny Generating Station | 134 | 28,355 | 1.3 | 0.008 | 296,701 |
| NJ | Kearny Generating Station | 141 | 27,804 | 1.0 | 0.007 | 300,442 |
| NJ | Kearny Generating Station | 142 | 14,847 | 0.6 | 0.007 | 156,962 |
| NJ | Cumberland Energy Center | 05001 | 86,246 | 3.7 | 0.010 | 781,876 |
| NJ | Bayonne Energy Center | GT1 | 121,384 | 3.6 | 0.006 | 1,167,665 |
| NJ | Bayonne Energy Center | GT10 | 145,745 | 5.8 | 0.008 | 1,412,314 |
| NJ | Bayonne Energy Center | GT2 | 116,568 | 3.4 | 0.006 | 1,116,773 |
| NJ | Bayonne Energy Center | GT3 | 94,358 | 2.9 | 0.006 | 920,627 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| NJ | Bayonne Energy Center | GT4 | 115,466 | 3.4 | 0.006 | 1,101,346 |
| NJ | Bayonne Energy Center | GT5 | 119,810 | 3.6 | 0.006 | 1,158,488 |
| NJ | Bayonne Energy Center | GT6 | 98,539 | 3.0 | 0.006 | 937,477 |
| NJ | Bayonne Energy Center | GT7 | 115,410 | 3.2 | 0.006 | 1,097,699 |
| NJ | Bayonne Energy Center | GT8 | 114,085 | 3.5 | 0.007 | 1,073,863 |
| NJ | Bayonne Energy Center | GT9 | 143,389 | 6.0 | 0.009 | 1,389,028 |
| NM | Rio Grande | 9 | 251,170 | 10.9 | 0.009 | 2,360,209 |
| NY | Glenwood Landing Energy Center | UGT012 | 110,182 | 5.4 | 0.010 | 1,090,452 |
| NY | Glenwood Landing Energy Center | UGT013 | 102,504 | 4.8 | 0.010 | 996,384 |
| NY | Hell Gate | HG01 | 65,197 | 3.3 | 0.010 | 659,404 |
| NY | Harlem River Yard | HR01 | 65,861 | 3.3 | 0.010 | 670,406 |
| NY | Bethpage Energy Center | GT3 | 193,865 | 7.2 | 0.007 | 1,955,934 |
| PA | Procter & Gamble Paper Products | 328002 | 200,516 | 8.7 | 0.009 | 1,942,378 |
| TN | Johnsonville | JCT20 | 818,776 | 20.6 | 0.007 | 5,978,792 |
| TX | Winchester Power Park | 2 | 22,317 | 0.4 | 0.004 | 215,776 |
| TX | Winchester Power Park | 4 | 22,970 | 1.1 | 0.010 | 216,525 |
| TX | Victoria Port Power II Peaking Facility | CT1 | 38,889 | 1.2 | 0.006 | 414,482 |
| TX | Braes Bayou Plant | CT-2 | 23,780 | 1.0 | 0.009 | 235,089 |
| TX | Braes Bayou Plant | CT-3 | 41,527 | 2.3 | 0.010 | 431,768 |
| TX | Braes Bayou Plant | CT-4 | 43,849 | 2.2 | 0.010 | 451,236 |
| TX | Braes Bayou Plant | CT-6 | 28,988 | 1.4 | 0.009 | 300,033 |
| UT | Millcreek Power | MC-2 | 105,313 | 2.0 | 0.004 | 1,019,499 |

# Appendix C

# Electric Utility Combined Cycle Combustion Turbines Equipped with Selective Catalytic Reduction that Emitted NOx at or Lower Than 2.0 ppmvd @ 15% Oxygen in 2022

**Table 1. Combined Cycle Natural Gas-Fired Combustion Turbines Equipped with Selective Catalytic Reduction (SCR) and Dry Low NOx Combustors (DLNC) or Water/Steam Injection that Achieved Annual NOx Emission Rates[1] of 0.0082 lb/MMBtu or Lower (Equivalent to 2.0 ppmvd @15% Oxygen or Lower[2]) in 2022[3]**

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| AL | Central Alabama Gen Station | CTGDB1 | 1,497,772 | 41.9 | 0.0077 | 10,892,556 |
| AL | Central Alabama Gen Station | CTGDB2 | 1,619,256 | 46.8 | 0.0078 | 11,931,946 |
| AL | Hillabee Energy Center | CT1 | 2,556,266 | 64.9 | 0.0074 | 17,533,141 |
| AL | Hillabee Energy Center | CT2 | 2,659,064 | 68.9 | 0.0076 | 18,166,313 |
| AL | Morgan Energy Center | CT-1 | 1,681,877 | 47.9 | 0.0077 | 12,414,900 |
| AL | Morgan Energy Center | CT-2 | 1,718,822 | 49.6 | 0.0077 | 12,809,273 |
| AL | Plant H. Allen Franklin | 2A | 1,998,166 | 56.5 | 0.0082 | 13,776,958 |
| AL | Tenaska Lindsay Hill Generating Station | CT1 | 1,144,841 | 31.6 | 0.0078 | 8,126,361 |
| AL | Tenaska Lindsay Hill Generating Station | CT2 | 1,268,042 | 35.2 | 0.0075 | 9,357,673 |
| AL | Tenaska Lindsay Hill Generating Station | CT3 | 665,742 | 19.2 | 0.0079 | 4,887,507 |
| AL | Theodore Cogeneration | CC1 | 1,918,774 | 34.0 | 0.0063 | 10,737,610 |

[1] Annual NOx emission rates were calculated for each unit by converting reported annual NOx emissions for 2022 from tons to pounds and divided by reported annual heat input in million British Thermal Units (MMBtu) for 2022.
[2] *See* EPA-453/R-93-007, January 1993, Alternative Control Techniques Document – NOx Emissions for Stationary Gas Turbines, Appendix A for the conversion formula from ppm to lb/MMBtu, available at https://www3.epa.gov/airquality/ctg_act/199301_nox_epa453_r-93-007_gas_turbines.pdf.
[3] Based on data reported to EPA's Clean Air Markets Program Database, at https://campd.epa.gov/.

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| AZ | Arlington Valley Energy Facility | CTG2 | 1,396,065 | 39.2 | 0.0080 | 9,805,628 |
| AZ | Gila River Power Station | 2CTGA | 1,325,049 | 38.0 | 0.0080 | 9,494,300 |
| AZ | Gila River Power Station | 2CTGB | 1,380,988 | 37.8 | 0.0077 | 9,829,393 |
| AZ | Gila River Power Station | 3CTGB | 1,290,648 | 35.7 | 0.0077 | 9,252,942 |
| AZ | Mesquite Generating Station | 5 | 1,984,552 | 56.5 | 0.0080 | 14,034,091 |
| AZ | New Harquahala Generating Company | CTG3 | 575,874 | 24.6 | 0.0079 | 6,209,834 |
| AZ | Santan | 5A | 1,205,597 | 29.5 | 0.0067 | 8,848,051 |
| AZ | Santan | 6A | 1,403,826 | 33.5 | 0.0066 | 10,207,843 |
| CA | AES Alamitos | CT1 | 1,735,970 | 31.8 | 0.0053 | 11,909,666 |
| CA | AES Alamitos | CT2 | 1,807,273 | 33.7 | 0.0054 | 12,401,172 |
| CA | AES Huntington Beach | CT1 | 2,033,880 | 44.4 | 0.0064 | 13,809,809 |
| CA | AES Huntington Beach | CT2 | 1,982,333 | 43.0 | 0.0064 | 13,429,340 |
| CA | Blythe Energy | 1 | 610,912 | 26.3 | 0.0078 | 6,703,689 |
| CA | Blythe Energy | 2 | 483,347 | 21.0 | 0.0077 | 5,453,699 |
| CA | Calpine Sutter Energy Center | CT01 | 1,825,800 | 45.5 | 0.0074 | 12,260,500 |
| CA | Carson Power Plant | 1 | 211,543 | 6.5 | 0.0068 | 1,904,121 |
| CA | Colusa Generating Station | CT1 | 1,326,173 | 19.1 | 0.0040 | 9,490,683 |
| CA | Colusa Generating Station | CT2 | 1,299,272 | 20.2 | 0.0044 | 9,196,713 |
| CA | Delta Energy Center, LLC | 2 | 1,318,570 | 37.0 | 0.0082 | 9,086,157 |
| CA | Donald Von Raesfeld | PCT1 | 392,951 | 9.9 | 0.0066 | 3,012,841 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CA | Donald Von Raesfeld | PCT2 | 342,311 | 8.3 | 0.0063 | 2,659,271 |
| CA | El Centro | 1-Mar | 338,288 | 6.9 | 0.0054 | 2,559,616 |
| CA | El Centro | 2-Mar | 349,834 | 6.6 | 0.0050 | 2,642,090 |
| CA | El Segundo | 5 | 167,179 | 3.4 | 0.0048 | 1,418,500 |
| CA | El Segundo | 7 | 121,418 | 3.0 | 0.0059 | 1,019,112 |
| CA | Elk Hills Power | CTG-1 | 1,927,955 | 38.5 | 0.0064 | 11,997,130 |
| CA | Elk Hills Power | CTG-2 | 1,871,328 | 38.8 | 0.0065 | 11,994,897 |
| CA | Gateway Generating Station | GT1 | 1,226,276 | 29.2 | 0.0066 | 8,821,948 |
| CA | Gateway Generating Station | GT2 | 1,259,956 | 31.3 | 0.0069 | 9,129,170 |
| CA | Haynes Generating Station | 9 | 1,082,342 | 24.4 | 0.0065 | 7,531,431 |
| CA | Haynes Generating Station | 10 | 958,739 | 22.9 | 0.0069 | 6,672,084 |
| CA | La Paloma Generating Plant | CTG-3 | 458,318 | 11.4 | 0.0067 | 3,388,252 |
| CA | Lodi Energy Center | CT1 | 569,547 | 19.3 | 0.0063 | 6,090,793 |
| CA | Los Esteros Critical Energy Facility | CTG1 | 48,291 | 1.5 | 0.0074 | 406,025 |
| CA | Los Esteros Critical Energy Facility | CTG2 | 43,420 | 1.1 | 0.0064 | 345,167 |
| CA | Los Esteros Critical Energy Facility | CTG3 | 51,456 | 1.7 | 0.0077 | 444,652 |
| CA | Los Esteros Critical Energy Facility | CTG4 | 48,893 | 1.4 | 0.0069 | 419,836 |
| CA | Los Medanos Energy Center, LLC | X724 | 1,936,611 | 50.4 | 0.0076 | 13,239,895 |
| CA | Los Medanos Energy Center, LLC | X725 | 2,069,725 | 51.2 | 0.0073 | 14,116,227 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CA | Magnolia Power Project | 1 | 1,571,436 | 28.5 | 0.0051 | 11,294,434 |
| CA | Malburg Generating Station | M1 | 236,920 | 7.0 | 0.0073 | 1,919,494 |
| CA | Malburg Generating Station | M2 | 253,797 | 7.3 | 0.0071 | 2,047,108 |
| CA | Metcalf Energy Center | 1 | 1,256,829 | 36.4 | 0.0081 | 9,021,813 |
| CA | Metcalf Energy Center | 2 | 1,142,686 | 32.9 | 0.0080 | 8,189,347 |
| CA | Mountainview Generating Station | 1-Mar | 1,005,013 | 22.7 | 0.0063 | 7,169,288 |
| CA | Mountainview Generating Station | 2-Mar | 934,101 | 17.2 | 0.0052 | 6,596,989 |
| CA | Mountainview Generating Station | 1-Apr | 992,658 | 23.0 | 0.0065 | 7,118,857 |
| CA | Mountainview Generating Station | 2-Apr | 958,929 | 18.7 | 0.0055 | 6,827,542 |
| CA | Otay Mesa Energy Center, LLC | CTG-1 | 1,323,081 | 28.0 | 0.0061 | 9,200,634 |
| CA | Otay Mesa Energy Center, LLC | CTG-2 | 1,340,023 | 28.4 | 0.0061 | 9,344,498 |
| CA | Palomar Energy Center | CTG1 | 1,035,310 | 20.9 | 0.0058 | 7,162,541 |
| CA | Palomar Energy Center | CTG2 | 1,394,314 | 28.6 | 0.0059 | 9,623,728 |
| CA | Pastoria Energy Facility | CT001 | 863,121 | 26.4 | 0.0069 | 7,628,323 |
| CA | Pastoria Energy Facility | CT002 | 847,991 | 25.9 | 0.0070 | 7,360,831 |
| CA | Pastoria Energy Facility | CT004 | 1,370,654 | 37.4 | 0.0072 | 10,305,978 |
| CA | Procter and Gamble Power Plant | 1A | 347,156 | 10.0 | 0.0071 | 2,832,883 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CA | Procter and Gamble Power Plant | 1B | 338,873 | 10.5 | 0.0071 | 2,944,720 |
| CA | Roseville Energy Park | CT001 | 316,033 | 7.3 | 0.0059 | 2,493,972 |
| CA | Roseville Energy Park | CT002 | 307,555 | 8.1 | 0.0063 | 2,540,462 |
| CA | Russell City Energy Company LLC | CT1 | 512,099 | 13.5 | 0.0075 | 3,609,042 |
| CA | Russell City Energy Company LLC | CT2 | 563,789 | 15.4 | 0.0076 | 4,053,428 |
| CA | Scattergood Generating Station | 4 | 1,779,556 | 36.1 | 0.0057 | 12,667,884 |
| CA | Sunrise Power Company | CTG1 | 1,470,179 | 29.1 | 0.0058 | 10,079,394 |
| CA | Sunrise Power Company | CTG2 | 1,425,429 | 26.9 | 0.0056 | 9,600,155 |
| CA | Valley Generating Station | 7 | 1,128,026 | 31.9 | 0.0081 | 7,916,625 |
| CA | Walnut Energy Center | 1 | 731,915 | 19.5 | 0.0066 | 5,880,138 |
| CA | Walnut Energy Center | 2 | 786,218 | 20.9 | 0.0066 | 6,350,459 |
| CA | Woodland Generation Station | 2 | 201,775 | 5.1 | 0.0058 | 1,759,593 |
| CO | Pueblo Airport Generating Station | CT04 | 153,201 | 4.4 | 0.0054 | 1,649,055 |
| CO | Pueblo Airport Generating Station | CT05 | 155,635 | 3.6 | 0.0043 | 1,667,794 |
| CO | Pueblo Airport Generating Station | CT06 | 185,746 | 3.5 | 0.0035 | 2,021,117 |
| CO | Pueblo Airport Generating Station | CT07 | 182,069 | 2.9 | 0.0029 | 1,988,620 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| CT | Bridgeport Harbor Station | BHB5 | 3,583,157 | 68.9 | 0.0060 | 22,907,338 |
| CT | CPV Towantic Energy Center | 1 | 2,496,887 | 46.7 | 0.0058 | 16,178,973 |
| CT | CPV Towantic Energy Center | 2 | 2,575,496 | 45.7 | 0.0054 | 16,794,234 |
| CT | Kleen Energy Systems Project | U1 | 1,289,309 | 35.6 | 0.0080 | 8,857,083 |
| CT | Kleen Energy Systems Project | U2 | 1,198,471 | 26.9 | 0.0066 | 8,215,840 |
| CT | Lake Road Generating Company | LRG1 | 1,222,615 | 45.2 | 0.0068 | 13,361,367 |
| CT | Lake Road Generating Company | LRG2 | 1,258,403 | 48.8 | 0.0069 | 14,205,269 |
| CT | Lake Road Generating Company | LRG3 | 1,246,559 | 39.5 | 0.0061 | 12,997,057 |
| CT | Milford Power Company LLC | CT01 | 1,972,125 | 45.5 | 0.0064 | 14,258,542 |
| CT | Milford Power Company LLC | CT02 | 1,816,128 | 41.1 | 0.0063 | 12,951,375 |
| DE | Energy Center Dover LLC | 2 | 76,995 | 2.6 | 0.0078 | 671,066 |
| FL | Cane Island | 4 | 2,138,993 | 44.5 | 0.0060 | 14,791,339 |
| FL | Cape Canaveral | CCCT3A | 1,520,005 | 40.0 | 0.0082 | 9,752,720 |
| FL | Cape Canaveral | CCCT3B | 2,504,554 | 58.3 | 0.0073 | 16,016,914 |
| FL | Cape Canaveral | CCCT3C | 1,424,814 | 36.0 | 0.0078 | 9,193,322 |
| FL | Curtis H. Stanton Energy Center | CCB | 1,622,625 | 25.3 | 0.0040 | 12,776,476 |
| FL | Hines Energy Complex | 4A | 1,082,315 | 46.3 | 0.0080 | 11,516,973 |
| FL | Hines Energy Complex | 4B | 765,787 | 32.3 | 0.0079 | 8,201,198 |
| FL | Lauderdale | PFL7A | 1,787,853 | 38.8 | 0.0069 | 11,322,394 |
| FL | Lauderdale | PFL7B | 2,035,617 | 44.4 | 0.0069 | 12,889,783 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| FL | Manatee | MTCT3A | 1,813,311 | 44.1 | 0.0074 | 11,975,002 |
| FL | Manatee | MTCT3B | 1,772,963 | 48.1 | 0.0082 | 11,723,847 |
| FL | Martin | PMR8A | 1,519,106 | 38.6 | 0.0076 | 10,196,044 |
| FL | Martin | PMR8B | 1,403,176 | 38.5 | 0.0082 | 9,431,911 |
| FL | Martin | PMR8C | 1,756,683 | 42.1 | 0.0072 | 11,766,723 |
| FL | Martin | PMR8D | 1,727,650 | 41.6 | 0.0072 | 11,503,077 |
| FL | Okeechobee Clean Energy Center | OCEC1A | 3,509,986 | 72.7 | 0.0070 | 20,633,806 |
| FL | Okeechobee Clean Energy Center | OCEC1B | 3,271,165 | 67.0 | 0.0070 | 19,220,847 |
| FL | Okeechobee Clean Energy Center | OCEC1C | 3,379,507 | 70.9 | 0.0071 | 19,892,427 |
| FL | Polk | **2 | 1,601,368 | 43.5 | 0.0079 | 10,969,082 |
| FL | Polk | **3 | 1,696,562 | 41.7 | 0.0073 | 11,483,838 |
| FL | Polk | **4 | 1,733,766 | 37.9 | 0.0065 | 11,696,425 |
| FL | Polk | **5 | 1,674,569 | 34.1 | 0.0067 | 10,199,808 |
| FL | Port Everglades | PECT5A | 2,452,299 | 57.5 | 0.0074 | 15,479,944 |
| FL | Port Everglades | PECT5B | 2,483,325 | 58.2 | 0.0075 | 15,549,891 |
| FL | Port Everglades | PECT5C | 2,530,755 | 61.5 | 0.0077 | 15,897,671 |
| FL | Riviera Beach Energy Center | RBCT5A | 2,542,314 | 65.3 | 0.0082 | 15,882,230 |
| FL | Riviera Beach Energy Center | RBCT5B | 2,294,292 | 55.8 | 0.0078 | 14,264,751 |
| FL | Treasure Coast Energy Center | 1 | 2,033,824 | 40.6 | 0.0055 | 14,759,389 |
| FL | Turkey Point | TPCT5A | 1,669,842 | 40.8 | 0.0074 | 11,002,401 |
| FL | Turkey Point | TPCT5B | 1,526,713 | 38.2 | 0.0076 | 10,106,176 |
| FL | Turkey Point | TPCT5C | 1,730,620 | 41.7 | 0.0073 | 11,491,652 |
| FL | Turkey Point | TPCT5D | 1,562,022 | 38.8 | 0.0075 | 10,368,706 |
| FL | West County Energy Center | WCCT1A | 2,228,525 | 53.1 | 0.0075 | 14,118,569 |
| FL | West County Energy Center | WCCT1B | 2,508,927 | 60.5 | 0.0076 | 15,927,641 |
| FL | West County Energy Center | WCCT1C | 1,977,958 | 49.9 | 0.0079 | 12,573,673 |
| FL | West County Energy Center | WCCT2A | 2,126,207 | 51.1 | 0.0076 | 13,511,593 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| FL | West County Energy Center | WCCT2C | 1,980,039 | 49.4 | 0.0079 | 12,571,520 |
| FL | West County Energy Center | WCCT3B | 2,796,034 | 65.4 | 0.0073 | 17,814,609 |
| FL | West County Energy Center | WCCT3C | 2,493,948 | 60.8 | 0.0078 | 15,654,232 |
| GA | Bobby C. Smith Jr. Energy Facility | 1 | 717,776 | 32.1 | 0.0080 | 8,035,384 |
| GA | Bobby C. Smith Jr. Energy Facility | 2 | 932,965 | 40.6 | 0.0079 | 10,282,340 |
| GA | Jack McDonough | 4A | 3,237,855 | 80.9 | 0.0076 | 21,416,190 |
| GA | Jack McDonough | 4B | 3,314,317 | 82.2 | 0.0076 | 21,664,207 |
| GA | Jack McDonough | 5A | 2,964,226 | 80.1 | 0.0081 | 19,701,526 |
| GA | Jack McDonough | 5B | 3,143,297 | 85.7 | 0.0081 | 21,172,278 |
| GA | Jack McDonough | 6A | 3,036,043 | 77.1 | 0.0077 | 20,087,656 |
| GA | Jack McDonough | 6B | 2,985,910 | 76.1 | 0.0076 | 19,913,991 |
| GA | McIntosh Combined Cycle Facility | 10A | 2,192,677 | 41.8 | 0.0060 | 13,871,455 |
| GA | McIntosh Combined Cycle Facility | 10B | 2,147,759 | 41.6 | 0.0060 | 13,923,457 |
| GA | McIntosh Combined Cycle Facility | 11A | 2,158,846 | 42.0 | 0.0061 | 13,824,109 |
| GA | McIntosh Combined Cycle Facility | 11B | 2,249,285 | 42.4 | 0.0058 | 14,580,560 |
| GA | Wansley CC (55965) | 6A | 2,337,579 | 64.8 | 0.0082 | 15,750,290 |
| IA | Marshalltown Generating Station | CT2 | 1,372,913 | 40.4 | 0.0081 | 9,980,138 |
| ID | Langley Gulch Power Plant | CT1 | 1,584,070 | 34.1 | 0.0064 | 10,645,434 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| IL | Jackson Generation, LLC | CTG-01 | 2,719,054 | 51.8 | 0.0058 | 17,811,374 |
| IL | Jackson Generation, LLC | CTG-02 | 2,629,128 | 48.7 | 0.0057 | 17,177,317 |
| IN | IPL - Eagle Valley Generating Station | GT1 | 2,235,105 | 37.2 | 0.0052 | 14,327,646 |
| IN | IPL - Eagle Valley Generating Station | GT2 | 2,175,507 | 35.8 | 0.0052 | 13,864,942 |
| IN | St. Joseph Energy Center LLC | CTG01A | 2,561,197 | 54.9 | 0.0064 | 17,221,842 |
| IN | St. Joseph Energy Center LLC | CTG01B | 2,537,067 | 55.3 | 0.0065 | 17,101,327 |
| IN | Whiting Clean Energy, Inc. | CT1 | 941,141 | 45.3 | 0.0081 | 11,186,154 |
| IN | Whiting Clean Energy, Inc. | CT2 | 1,096,984 | 51.0 | 0.0081 | 12,613,221 |
| LA | Lake Charles Power Station | 1A | 3,193,024 | 70.0 | 0.0064 | 21,871,903 |
| LA | Lake Charles Power Station | 1B | 3,028,380 | 63.6 | 0.0065 | 19,637,820 |
| LA | St. Charles Power Station | 1A | 2,787,091 | 76.2 | 0.0079 | 19,411,288 |
| LA | St. Charles Power Station | 1B | 2,879,367 | 72.7 | 0.0073 | 20,040,552 |
| MA | Blackstone Power Generation LLC | 1 | 862,630 | 38.9 | 0.0082 | 9,518,765 |
| MA | Blackstone Power Generation LLC | 2 | 911,934 | 38.7 | 0.0078 | 9,878,553 |
| MA | Kendall Green Energy LLC | 4 | 1,845,054 | 41.8 | 0.0070 | 11,978,548 |
| MA | Mystic | 81 | 433,213 | 11.9 | 0.0076 | 3,123,601 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| MA | Mystic | 82 | 472,118 | 12.9 | 0.0075 | 3,422,189 |
| MA | Mystic | 93 | 375,815 | 10.5 | 0.0076 | 2,743,009 |
| MA | Mystic | 94 | 371,887 | 9.9 | 0.0074 | 2,690,630 |
| MA | Salem Harbor Station NGCC | 1 | 327,043 | 9.1 | 0.0077 | 2,383,976 |
| MA | Salem Harbor Station NGCC | 2 | 239,678 | 6.8 | 0.0078 | 1,732,695 |
| MD | CPV St. Charles Energy Center | GT1 | 1,584,183 | 32.6 | 0.0049 | 13,326,164 |
| MD | CPV St. Charles Energy Center | GT2 | 1,623,848 | 27.8 | 0.0041 | 13,567,234 |
| MD | Keys Energy Center | 11 | 2,315,580 | 47.8 | 0.0057 | 16,652,512 |
| MD | Wildcat Point Generation Facility | CT1 | 2,037,517 | 52.8 | 0.0077 | 13,764,536 |
| MD | Wildcat Point Generation Facility | CT2 | 1,987,785 | 52.3 | 0.0076 | 13,830,260 |
| MI | Blue Water Energy Center | 11 | 2,392,339 | 55.1 | 0.0072 | 15,415,247 |
| MI | Blue Water Energy Center | 12 | 2,458,594 | 57.1 | 0.0072 | 15,793,349 |
| MI | Covert Generating Station | 001 | 2,390,595 | 66.1 | 0.0069 | 19,286,856 |
| MI | Covert Generating Station | 002 | 2,149,161 | 59.0 | 0.0067 | 17,541,351 |
| MI | Covert Generating Station | 003 | 2,011,599 | 52.2 | 0.0067 | 15,652,347 |
| MI | Indeck-Niles Energy Center | EUCT1 | 1,691,729 | 32.0 | 0.0060 | 10,683,544 |
| MI | Indeck-Niles Energy Center | EUCT2 | 1,674,434 | 30.7 | 0.0058 | 10,607,473 |
| MS | Daniel Electric Generating Plant | 3A | 2,033,092 | 48.5 | 0.0070 | 13,791,556 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| MS | Daniel Electric Generating Plant | 3B | 2,006,611 | 52.6 | 0.0079 | 13,340,862 |
| MS | Daniel Electric Generating Plant | 4A | 2,128,956 | 49.0 | 0.0070 | 13,961,512 |
| MS | Daniel Electric Generating Plant | 4B | 2,224,823 | 51.0 | 0.0070 | 14,528,325 |
| MS | Moselle Generation Complex | 6 | 681,179 | 20.3 | 0.0072 | 5,655,931 |
| MS | Moselle Generation Complex | 7 | 428,157 | 14.3 | 0.0078 | 3,646,053 |
| NC | Kings Mountain Energy Center | ES-1 | 3,130,724 | 66.7 | 0.0063 | 21,260,392 |
| NC | Richmond County Plant | 7 | 1,089,206 | 39.1 | 0.0069 | 11,330,302 |
| NC | Richmond County Plant | 8 | 1,110,380 | 45.9 | 0.0079 | 11,568,491 |
| NC | Richmond County Plant | 9 | 2,382,244 | 52.0 | 0.0063 | 16,528,815 |
| NC | Richmond County Plant | 10 | 2,381,711 | 51.2 | 0.0062 | 16,413,932 |
| NJ | Linden Cogeneration Facility | 004001 | 1,750,425 | 34.0 | 0.0060 | 11,367,738 |
| NJ | Linden Generating Station | 1201 | 1,394,569 | 37.9 | 0.0075 | 10,111,431 |
| NJ | Newark Energy Center | U001 | 2,289,554 | 47.1 | 0.0064 | 14,801,470 |
| NJ | Newark Energy Center | U002 | 2,333,336 | 45.8 | 0.0061 | 14,946,126 |
| NJ | Sewaren Generating Station | 7 | 2,792,525 | 57.5 | 0.0062 | 18,451,196 |
| NJ | West Deptford Energy Station | E101 | 930,655 | 23.0 | 0.0069 | 6,696,482 |
| NJ | West Deptford Energy Station | E102 | 1,031,139 | 25.9 | 0.0069 | 7,491,810 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| NJ | Woodbridge Energy Center | 0001 | 2,201,919 | 41.5 | 0.0059 | 14,125,870 |
| NJ | Woodbridge Energy Center | 0002 | 2,349,176 | 45.1 | 0.0058 | 15,516,985 |
| NM | Hobbs Generating Station | HOBB1 | 1,807,793 | 42.7 | 0.0064 | 13,289,692 |
| NM | Hobbs Generating Station | HOBB2 | 1,705,326 | 40.8 | 0.0066 | 12,363,611 |
| NV | Tracy | 8 | 1,446,329 | 30.4 | 0.0055 | 11,069,046 |
| NV | Tracy | 9 | 1,495,373 | 28.6 | 0.0050 | 11,392,308 |
| NY | Astoria Energy | CT1 | 1,918,271 | 40.7 | 0.0063 | 12,953,790 |
| NY | Astoria Energy | CT2 | 1,824,303 | 39.0 | 0.0063 | 12,399,172 |
| NY | Astoria Energy | CT3 | 1,817,575 | 46.7 | 0.0068 | 13,646,415 |
| NY | Astoria Energy | CT4 | 1,880,978 | 49.9 | 0.0072 | 13,961,111 |
| NY | Athens Generating Company | 1 | 1,628,076 | 40.1 | 0.0071 | 11,262,261 |
| NY | Athens Generating Company | 2 | 1,453,577 | 36.5 | 0.0072 | 10,097,612 |
| NY | Athens Generating Company | 3 | 1,356,457 | 36.5 | 0.0077 | 9,476,502 |
| NY | Bethlehem Energy Center (Albany) | 10001 | 1,136,054 | 33.8 | 0.0059 | 11,397,485 |
| NY | Bethlehem Energy Center (Albany) | 10002 | 1,220,472 | 37.4 | 0.0060 | 12,463,146 |
| NY | Bethlehem Energy Center (Albany) | 10003 | 1,121,665 | 36.2 | 0.0064 | 11,354,094 |
| NY | Bethpage Energy Center | GT4 | 78,097 | 2.4 | 0.0062 | 772,427 |
| NY | Brooklyn Navy Yard Cogeneration | 1 | 865,239 | 30.9 | 0.0070 | 8,833,968 |
| NY | Brooklyn Navy Yard Cogeneration | 2 | 755,468 | 26.4 | 0.0069 | 7,696,321 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| NY | Caithness Long Island Energy Center | 0001 | 2,412,758 | 52.6 | 0.0068 | 15,432,438 |
| NY | Cornell University Ithaca Campus | CT1 | | 1.1 | 0.0070 | 325,702 |
| NY | Cornell University Ithaca Campus | CT2 | | 1.3 | 0.0069 | 380,390 |
| NY | Cricket Valley Energy Center | U001 | 1,752,583 | 27.1 | 0.0045 | 11,952,847 |
| NY | Cricket Valley Energy Center | U002 | 1,923,130 | 30.8 | 0.0047 | 13,145,838 |
| NY | Cricket Valley Energy Center | U003 | 1,899,275 | 31.6 | 0.0049 | 12,922,158 |
| NY | East River | 1 | 1,126,527 | 42.7 | 0.0072 | 11,897,235 |
| NY | East River | 2 | 1,173,517 | 45.7 | 0.0074 | 12,291,198 |
| NY | Empire Generating Co, LLC | CT-2 | 1,747,613 | 50.3 | 0.0080 | 12,575,797 |
| NY | Pinelawn Power | 00001 | 178,167 | 5.3 | 0.0078 | 1,369,376 |
| NY | Ravenswood Generating Station | UCC001 | 1,581,308 | 42.4 | 0.0075 | 11,382,090 |
| NY | Riverbay Corp. - Co-Op City | 00006 | 31,357 | 0.6 | 0.0033 | 371,644 |
| NY | Valley Energy Center | 1 | 2,443,159 | 53.8 | 0.0064 | 16,921,042 |
| NY | Valley Energy Center | 2 | 2,393,479 | 51.9 | 0.0063 | 16,484,656 |
| OH | Carroll County Energy | 1 | 2,744,943 | 53.6 | 0.0055 | 19,643,715 |
| OH | Carroll County Energy | 2 | 2,720,407 | 53.6 | 0.0055 | 19,527,563 |
| OH | Clean Energy Future - Lordstown, LLC | 1 | 3,232,714 | 63.6 | 0.0059 | 21,541,095 |
| OH | Clean Energy Future - Lordstown, LLC | 2 | 3,322,745 | 68.2 | 0.0061 | 22,211,472 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| OH | Hanging Rock Power Company LLC | CTG1 | 2,614,591 | 62.4 | 0.0069 | 18,079,743 |
| OH | Hanging Rock Power Company LLC | CTG2 | 2,591,628 | 69.2 | 0.0077 | 18,012,972 |
| OH | Hanging Rock Power Company LLC | CTG3 | 2,606,319 | 67.8 | 0.0075 | 18,172,416 |
| OH | Hanging Rock Power Company LLC | CTG4 | 2,572,267 | 66.4 | 0.0074 | 17,887,231 |
| OH | Long Ridge Energy Generation | CC1 | 2,641,780 | 46.2 | 0.0057 | 16,339,177 |
| OH | Middletown Energy Center | 1 | 3,643,913 | 70.8 | 0.0059 | 23,989,630 |
| OH | Oregon Clean Energy Center | 01 | 2,935,126 | 55.6 | 0.0057 | 19,357,312 |
| OH | Oregon Clean Energy Center | 02 | 2,922,872 | 55.9 | 0.0058 | 19,375,860 |
| OH | South Field Energy, LLC | 1 | 4,443,177 | 83.6 | 0.0059 | 28,123,292 |
| OH | South Field Energy, LLC | 2 | 4,363,527 | 90.0 | 0.0065 | 27,754,848 |
| OH | Washington Power Company LLC | CT1 | 2,555,583 | 73.4 | 0.0080 | 18,268,332 |
| OH | Washington Power Company LLC | CT2 | 2,539,961 | 72.2 | 0.0080 | 18,021,046 |
| OK | Chouteau Power Plant | 3 | 1,380,607 | 20.0 | 0.0043 | 9,304,504 |
| OK | Chouteau Power Plant | 4 | 1,455,204 | 20.4 | 0.0041 | 9,891,861 |
| OR | Carty Generating Station | CTEU1 | 3,071,352 | 84.3 | 0.0076 | 22,189,325 |
| OR | Klamath Cogeneration Project | CT2 | 1,213,927 | 29.5 | 0.0067 | 8,845,417 |
| PA | Bethlehem Power Plant | 1 | 802,318 | 18.2 | 0.0058 | 6,317,474 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| PA | Bethlehem Power Plant | 2 | 737,555 | 17.0 | 0.0060 | 5,701,540 |
| PA | Bethlehem Power Plant | 3 | 696,215 | 15.6 | 0.0057 | 5,498,774 |
| PA | Bethlehem Power Plant | 5 | 828,691 | 19.4 | 0.0061 | 6,348,274 |
| PA | Bethlehem Power Plant | 6 | 789,715 | 16.7 | 0.0055 | 6,038,735 |
| PA | Bethlehem Power Plant | 7 | 638,729 | 15.6 | 0.0062 | 5,009,452 |
| PA | Birdsboro Power | 01 | 3,078,232 | 59.3 | 0.0061 | 19,385,510 |
| PA | CPV Fairview, LLC | CT-1 | 3,837,507 | 71.8 | 0.0059 | 24,252,445 |
| PA | CPV Fairview, LLC | CT-2 | 3,897,404 | 73.7 | 0.0060 | 24,706,458 |
| PA | Fairless Energy Center | 1B | 1,966,343 | 51.6 | 0.0078 | 13,249,668 |
| PA | Fairless Energy Center | 2A | 1,949,855 | 53.5 | 0.0081 | 13,213,189 |
| PA | Fairless Energy Center | 2B | 1,978,420 | 52.0 | 0.0076 | 13,647,190 |
| PA | Fayette Power Company LLC | CTG1 | 2,549,157 | 58.5 | 0.0066 | 17,687,236 |
| PA | Fayette Power Company LLC | CTG2 | 2,531,096 | 53.3 | 0.0062 | 17,277,271 |
| PA | Hamilton Liberty Generation Plant | CT1 | 2,993,934 | 70.5 | 0.0070 | 20,076,178 |
| PA | Hamilton Liberty Generation Plant | CT2 | 3,135,421 | 64.1 | 0.0061 | 21,039,623 |
| PA | Hamilton Patriot Generation Plant | CT1 | 3,304,672 | 65.9 | 0.0062 | 21,430,474 |
| PA | Hamilton Patriot Generation Plant | CT2 | 3,171,001 | 62.4 | 0.0060 | 20,761,415 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| PA | Hickory Run Energy Station | CT1 | 3,231,871 | 65.5 | 0.0061 | 21,496,297 |
| PA | Hickory Run Energy Station | CT2 | 3,092,964 | 66.1 | 0.0063 | 20,829,442 |
| PA | Hill Top Energy Center | 01 | 4,238,087 | 61.8 | 0.0045 | 27,465,762 |
| PA | Hummel Station | CT1 | 2,606,439 | 54.0 | 0.0060 | 17,873,586 |
| PA | Hummel Station | CT2 | 2,609,617 | 54.4 | 0.0061 | 17,933,101 |
| PA | Hummel Station | CT3 | 2,665,772 | 54.8 | 0.0060 | 18,173,699 |
| PA | Hunterstown Combined Cycle | CT101 | 1,259,061 | 24.8 | 0.0036 | 13,602,800 |
| PA | Hunterstown Combined Cycle | CT201 | 1,306,675 | 43.6 | 0.0062 | 14,127,127 |
| PA | Hunterstown Combined Cycle | CT301 | 1,297,036 | 21.3 | 0.0030 | 14,139,184 |
| PA | Lackawanna Energy Center | 1 | 3,078,801 | 48.7 | 0.0049 | 20,021,941 |
| PA | Lackawanna Energy Center | 2 | 3,407,338 | 56.4 | 0.0051 | 22,208,487 |
| PA | Lackawanna Energy Center | 3 | 2,861,017 | 35.9 | 0.0038 | 18,892,460 |
| PA | Moxie Freedom Generation Plant | 201 | 2,884,188 | 57.1 | 0.0060 | 18,970,277 |
| PA | Moxie Freedom Generation Plant | 202 | 1,626,425 | 32.7 | 0.0061 | 10,717,949 |
| PA | Ontelaunee Energy Center | CT1 | 2,108,101 | 51.5 | 0.0069 | 14,956,533 |
| PA | Ontelaunee Energy Center | CT2 | 2,093,862 | 46.0 | 0.0063 | 14,639,093 |
| PA | Springdale Generating Station (55710) | 3 | 1,502,909 | 56.6 | 0.0081 | 14,045,599 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| PA | Springdale Generating Station (55710) | 4 | 1,484,938 | 56.8 | 0.0080 | 14,211,195 |
| PA | Tenaska Westmoreland Generating Station | 101 | 3,599,563 | 58.7 | 0.0048 | 24,314,813 |
| PA | Tenaska Westmoreland Generating Station | 102 | 3,558,009 | 58.3 | 0.0048 | 24,071,860 |
| PA | York Energy Center | 1 | 672,690 | 17.1 | 0.0065 | 5,288,451 |
| PA | York Energy Center | 2 | 673,901 | 16.4 | 0.0062 | 5,289,337 |
| PA | York Energy Center | 3 | 695,145 | 15.8 | 0.0057 | 5,512,012 |
| PA | York Energy Center | 5 | 2,665,093 | 53.1 | 0.0057 | 18,760,037 |
| PA | York Energy Center | 6 | 2,657,594 | 60.0 | 0.0064 | 18,794,007 |
| RI | Rhode Island State Energy Center | RISEP1 | 1,690,479 | 37.9 | 0.0066 | 11,552,502 |
| RI | Rhode Island State Energy Center | RISEP2 | 1,679,125 | 36.6 | 0.0063 | 11,544,717 |
| SC | Jasper County Generating Facility | CT02 | 1,765,320 | 50.9 | 0.0082 | 12,411,579 |
| TX | Channel Energy Center | CTG3 | 1,940,180 | 42.0 | 0.0061 | 13,837,401 |
| TX | Colorado Bend II | CT7 | 3,474,762 | 47.3 | 0.0042 | 22,382,697 |
| TX | Colorado Bend II | CT8 | 3,129,217 | 43.9 | 0.0043 | 20,200,484 |
| TX | Deer Park Energy Center | CTG5 | 1,505,331 | 38.2 | 0.0058 | 13,083,093 |
| TX | Jack County Generation Facility | CT-3 | 1,493,538 | 31.7 | 0.0062 | 10,217,754 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| TX | Jack County Generation Facility | CT-4 | 1,467,000 | 32.2 | 0.0064 | 10,006,244 |
| TX | Montgomery County Power Station | CT1 | 3,269,084 | 70.1 | 0.0064 | 22,030,797 |
| TX | Montgomery County Power Station | CT2 | 3,349,619 | 70.9 | 0.0063 | 22,645,434 |
| TX | Rayburn Energy Station | CTG1 | 1,661,308 | 42.9 | 0.0072 | 11,850,981 |
| TX | Rayburn Energy Station | CTG2 | 1,655,191 | 41.0 | 0.0069 | 11,888,937 |
| TX | T C Ferguson Power Plant | CT-1 | 1,035,950 | 31.7 | 0.0059 | 10,681,978 |
| TX | T C Ferguson Power Plant | CT-2 | 1,009,615 | 33.1 | 0.0063 | 10,439,139 |
| TX | Temple Power Station | CTG1 | 1,968,439 | 52.4 | 0.0071 | 14,797,062 |
| TX | Temple Power Station | CTG2 | 1,942,500 | 51.4 | 0.0071 | 14,540,838 |
| TX | Temple Power Station | CTG3 | 1,652,084 | 45.1 | 0.0071 | 12,710,000 |
| TX | Temple Power Station | CTG4 | 1,662,904 | 45.3 | 0.0072 | 12,569,352 |
| TX | Wolf Hollow II | CGT4 | 3,059,849 | 51.9 | 0.0051 | 20,449,553 |
| TX | Wolf Hollow II | CGT5 | 3,142,024 | 53.4 | 0.0051 | 20,868,508 |
| UT | Lake Side Power Plant | CT01 | 1,653,209 | 40.9 | 0.0069 | 11,861,229 |
| UT | Lake Side Power Plant | CT02 | 1,488,528 | 36.3 | 0.0069 | 10,564,372 |
| UT | Lake Side Power Plant | CT03 | 1,782,965 | 38.4 | 0.0063 | 12,245,131 |
| UT | Lake Side Power Plant | CT04 | 1,830,988 | 41.6 | 0.0065 | 12,767,383 |
| VA | Bear Garden Generating Station | 1B | 1,079,321 | 28.9 | 0.0077 | 7,498,215 |
| VA | Brunswick County Power Station | 1A | 2,497,245 | 48.8 | 0.0056 | 17,347,692 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| VA | Brunswick County Power Station | 1B | 2,458,999 | 52.0 | 0.0061 | 17,053,684 |
| VA | Brunswick County Power Station | 1C | 2,422,443 | 48.6 | 0.0058 | 16,783,522 |
| VA | Greensville County Power Station | 1A | 3,966,299 | 61.8 | 0.0051 | 24,374,991 |
| VA | Greensville County Power Station | 1B | 3,735,009 | 69.8 | 0.0058 | 23,908,292 |
| VA | Greensville County Power Station | 1C | 3,712,968 | 69.5 | 0.0058 | 23,839,187 |
| VA | Potomac Energy Center, LLC | CT1 | 1,596,526 | 29.1 | 0.0053 | 10,923,941 |
| VA | Potomac Energy Center, LLC | CT2 | 1,989,328 | 35.3 | 0.0051 | 13,717,590 |
| VA | Warren County Power Station | 1A | 2,668,755 | 52.0 | 0.0057 | 18,198,382 |
| VA | Warren County Power Station | 1B | 2,644,441 | 51.2 | 0.0057 | 17,824,151 |
| VA | Warren County Power Station | 1C | 2,488,612 | 47.5 | 0.0056 | 16,848,336 |
| WA | Goldendale Generating Station | CT-1 | 1,594,158 | 45.3 | 0.0082 | 11,042,562 |
| WA | Grays Harbor Energy Center | 1 | 1,747,670 | 40.8 | 0.0067 | 12,151,101 |
| WA | Grays Harbor Energy Center | 2 | 1,487,237 | 34.8 | 0.0068 | 10,268,645 |
| WI | Fox Energy Center | CTG-2 | 2,155,696 | 60.0 | 0.0082 | 14,688,811 |
| WI | Riverside Energy Center | CT-01 | 1,473,443 | 30.0 | 0.0061 | 9,790,814 |
| WI | Riverside Energy Center | CT-02 | 1,352,433 | 29.8 | 0.0066 | 9,022,055 |

| State | Facility | Unit ID | Gross Load (MWh) | NOx Mass (tons/year) | Annual NOx, Calculated (lb/MMBtu) | Heat Input (MMBtu/year) |
|---|---|---|---|---|---|---|
| WI | Riverside Energy Center | CT-03 | 1,638,355 | 40.6 | 0.0074 | 10,973,002 |
| WI | Riverside Energy Center | CT-04 | 1,525,377 | 37.4 | 0.0071 | 10,505,029 |
| WY | Cheyenne Prairie Generating Station | CT01 | 105,579 | 4.2 | 0.0080 | 1,040,610 |
| WY | Cheyenne Prairie Generating Station | CT02 | 104,375 | 4.3 | 0.0081 | 1,059,705 |