Bob Adair
Chairman, Tax Relief for Pollution Control
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December 9, 2019

Ms. Donna F. Huff, Director
Air Quality Division
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Dear Director Huff:

Subject: Advice Regarding Future Heat Recovery Steam Generator Applications
Tax Relief for Pollution Control Property

The TCEQ Tax Relief for Pollution Control Property Advisory Committee ("Committee") hereby responds to your letter dated July 19, 2019 (attached for quick reference) in which you requested advice from the Committee on how to determine use percentages for future use determination applications that include heat recovery steam generators (HRSGs). We recognize the Texas Supreme Court recently remanded HRSG cases to the Commission for further proceedings consistent with its opinion, therefore alignment with the court opinion was a primary objective as the Committee considered advice, especially in response to the three questions indicated in the above referenced letter. The Committee reviewed data provided by TCEQ and other publicly available sources and discussed this matter, with prior notice to the public, in public meetings on August 23rd, September 26th, October 17th, November 8th, November 19th, and December 2nd. Public input was solicited before and during each meeting.

At a high level, advice to each of the three questions in the July 19th letter are presented below:

1. Are the existing rules in 30 Texas Administrative Code (TAC) Section 17.17(c) adequate to determine a use percentage, in whole or in part, for new Tier III applications for HRSGs, consistent with the Court's opinions? If yes, what considerations should be given to reviewing input variables (particularly Capital Cost Old and Production Capacity Factor) used in the Cost Analysis Procedure (CAP) for HRSGs?
   Advice: No (informally agreed by Committee as alternative methods were evaluated)

2. If the existing rules are not adequate, what is an appropriate method for distinguishing the proportion of HRSGs used for pollution control from the proportion used for production that is consistent with the Texas Supreme Court's opinions?
   Advice: Add HRSGs to the Tier I Table with a pollution control use of 65% (Committee vote of 7-6).

3. Should the Commission propose rulemaking to remove HRSGs from the Expedited Review List of Section 17.17(b)?
   Advice: No (Committee vote of 12-0, with one member absent)

Additional explanations are included in the enclosed majority advice.

Committee members were reminded of Article 5.4 of Committee bylaws, which states, in part, "If there is not consensus among all members of the Committee, minority members are encouraged to submit minority reports for the Commissioners' consideration. Executive Director staff will assist minority members in drafting minority reports." A minority report may be submitted separate from this advice regarding question 2.

The Committee sincerely appreciates you and other TCEQ staff's ongoing support to the Committee, especially additional support provided during our consideration of HRSGs.

Please feel free to contact me or any member of the Advisory Committee to discuss this advice.

Respectfully,

B. G. Adair

Enclosures

c: Mr. Jon Nierman, Chairman, TCEQ
Mr. Bobby Janecka, Commissioner, TCEQ
Ms. Emily Lindley, Commissioner, TCEQ
Mr. Toby Baker, Executive Director, TCEQ
TCEQ Tax Relief for Pollution Control Property Advisory Committee members

Majority Advice Regarding Heat Recovery Steam Generators
TCEQ Tax Relief for Pollution Control Property Advisory Committee

On July 19, 2019, Donna Huff, Director, Air Quality Division on behalf of Toby Baker, Executive Director of the Texas Commission on Environmental Quality ("***TCEQ***" or "***Commission***"), issued a written request to Bob Adair, Chairman, Tax Relief for Pollution Control Property Advisory Committee (the "***Committee***"), for advice on how to determine the appropriate use percentage for future applications that include Heat Recovery Steam Generators ("***HRSGs***"). Specifically, the letter from Director Huff requested the Committee assist TCEQ with the following questions:

1) Are the existing rules in 30 Texas Administrative Code (TAC) Section 17.17(c) adequate to determine a use percentage, in whole or in part, for new Tier III applications for HRSGs, consistent with the Court's opinions? If yes, what considerations should be given to reviewing input variables (particularly Capital Cost Old and Production Capacity Factor) used in the Cost Analysis Procedure (CAP) for HRSGs?

2) If the existing rules are not adequate, what is an appropriate method for distinguishing the proportion of HRSGs used for pollution control from the proportion used for production that is consistent with the Texas Supreme Court's opinions?

3) Should the Commission propose rulemaking to remove HRSGs from the Expedited Review List of Section 17.17(b)? If yes, what compelling evidence can the Committee provide that HRSGs do not provide pollution control benefits?

This report will begin with two questions in which the Committee agrees on advice and end with the question in which we significantly differ.

Expedited Review List

Question 3: Should the Commission propose rulemaking to remove HRSGs from the Expedited Review List of Section 17.17(b)?

Advice: No. On November 8th, a quorum of the committee (only one member was absent) voted, without opposition, "No" to this question. The basis for this vote was the Committee's agreement that HRSGs provide an environmental benefit and there is no compelling evidence[1] to remove HRSGs from the Expedited Review List.

Inadequacy of Current Rules for HRSGs

Question 1: Are the existing rules in 30 Texas Administrative Code (TAC) Section 17.17(c) adequate to determine a use percentage, in whole or in part, for new Tier III applications for HRSGs, consistent with the Court's opinions? If yes, what considerations should be given to reviewing input variables (particularly Capital Cost Old and Production Capacity Factor) used in the Cost Analysis Procedure (CAP) for HRSGs?

[1] Texas Tax Code §11.31(l) states, "The Texas Commission on Environmental Quality by rule shall update the list adopted under Subsection (k) at least once every three years. An item may be removed from the list if the commission finds ***compelling evidence*** to support the conclusion that the item does not provide pollution control benefits."

Advice: No. The Committee considered many alternatives to determine the appropriate use percentage for HRSGs but ultimately considered only two formal motions. The first motion was based upon a methodology that features extensive changes in the pollution control use calculation, while the second motion (presented as a substitute motion) was based on modifications to the current version of the CAP. However, *both motions were to advise that TCEQ add HRSGs to the Tier I Table with a partial use percentage*.

The substitute motion for a modified CAP failed 6-7, while the initial motion (described below) passed 7-6. Although no vote was taken to specifically address Question 1, it is clear from both Committee motions on Question 2 that the Committee determined that yet to be identified changes would be necessary to the current CAP in order to determine an appropriate use percentage for HRSGs.

Appropriate Method to Indicate Pollution Control Use

Question 2: If the existing rules are not adequate, what is an appropriate method for distinguishing the proportion of HRSGs used for pollution control from the proportion used for production that is consistent with the Texas Supreme Court's opinions?

Advice: Expedited review listed equipment B-08 should be moved to the Tier I Table with a positive use determination of 65 percent pollution control use. The review and outcome from Committee meetings were as follows:

Majority Advice for Use Determination

After months of the Committee grappling with this issue and its desire to provide timely advice to assist TCEQ in resolving this longstanding issue, on December 2nd, the Committee presented two motions to determine formal advice. *The Committee majority concluded the proposed pollution control use of 65% is based on the most credible data, technically sound, and legally supportable*. A motion was presented by Mr. Allred and seconded by Mr. Coon to add HRSGs to the Tier I Table with a pollution control use of 65%. Mr. Nasi offered an amendment to the motion (approved by Mr. Allred and Mr. Coon) to clarify the motion. As the amended motion passed 7-6, a more detailed description of the motion is presented below.

- Add "unless otherwise designated with a partial use percentage on the Tier I Table" to the beginning of the last sentence of 30 TAC §17.14(a) to read: Unless otherwise designated with a partial use percentage on the Tier I Table, if a marketable product is recovered (not including materials that are disposed) from property listed in this subsection, a Tier III application is required.

- Add "except heat recovery steam generators listed as a partial use percentage" to the first sentence of Figure 30 TAC §17.14(a) to read: The property listed in this table is property that the executive director has determined is used wholly for pollution control purposes when used as shown in the Description section of the table and when no marketable product arises from using the property, except heat recovery steam generators listed as a partial use percentage.

- Add the following item to Figure 30 TAC §17.14(a).

No.	Media	Property	Description	%
A-90	Air	Heat Recovery Steam Generators	A boiler designed to capture waste heat from combustion turbine exhaust for the generation of steam while reducing unit output-based emissions.	65

Support for Majority Advice

What follows describes the support behind the Committee majority advice, which are calculations of both the environment benefit and the productive benefit and averaging the two calculations to derive a specific partial exemption percentage for HRSGs in the Tier 1 Table.[2] These calculations were primarily developed by Mr. Allred, Independent Technical Expert, and checked for technical accuracy and math by Mr. Coon, the member representing the Association of Electric Companies of Texas. Other Committee members represented by this majority advice reviewed the logic of the methodology and sufficiency of data versus the minority proposal as described in "Other Considered Use Determination."

Calculation 1: Pollution control benefit component

In an attempt to provide a data driven basis for differentiating between the pollution control use and the productive use of HRSGs, Mr. Allred developed a methodology using information from Gas Turbine World[3] with regard to actual heat rates and production statistics from operating power plants. He assumed simple-cycle facilities could achieve the low end of the BACT emissions limits as part of this methodology.[4] **Mr. Allred calculated a pollution control benefit of 71%**.

Calculation 2: Production benefit component

The most straight-forward methodology for deriving the productive benefit component first is to document and specify the efficiency gains from using a combined-cycle facility as compared to a simple-cycle facility. Based on Gas Turbine World data, combined-cycle facilities on average have a 31.96% improvement in heat rate compared to simple-cycle facilities. Mr. Allred also calculated the average percent increase in a plant's megawatt output attributable to combined-cycle operations. Ultimately, **Mr. Allred calculated a productive benefit of 41%, thereby resulting in a 59% pollution control benefit.**

Mr. Allred then averaged the pollution control benefit from both calculations (71% and 59%) to propose a 65% overall pollution control benefit from the use of HRSGs.

[2] The calculations and input information developed by Mr. Allred in support of the proposal are provided in the enclosed spreadsheets.

[3] Gas Turbine World was brought to the attention of the Committee by Committee member Daryl Attaway, with Pritchard & Abbott Inc.

[4] The range of emissions reductions results from the TCEQ's Best Available Control Technology (BACT) limits, which range from 5.0-9.0 parts per million (ppm) for simple-cycle facilities as compared to 2.0 ppm for combined-cycle facilities. As a conservative assumption for these calculations, it is assumed the simple-cycle facilities can achieve the low end of the BACT limits.

Each Committee member vote on the motion that passed was recorded as follows:

	Yes	No
Bob Adair (Chair), representing Texas Oil and Gas Association	√	
Charles Allred, independent technical expert	√	
Daryl Attaway, with Pritchard & Abbott Inc.		√
Roland Bieber, retired Chief Appraiser for Jefferson County Appraisal District		√
Paul Coon, representing Association of Electric Companies of Texas	√	
Mike Ford, representing Texas Chemical Council	√	
Lloyd Graham, Superintendent of La Porte Independent School District		√
Ted Jones, representing Texas Association of Manufacturers	√	
Don Lee, with the Texas Conference of Urban Counties		√
Bill Longley, with the Texas Municipal League		√
Greg Maxim, with Cummings Westlake LLC, representing Industry	√	
Mike Nasi, representing Clean Coal Technology Foundation	√	
Cyrus Reed, with the Sierra Club		√

The Committee majority acknowledges TCEQ staff may recommend additional revisions in other parts of 30 TAC Chapter 17 to appropriately implement the intent of this advice that HRSGs should be added to the Tier I Table with a pollution control use of 65%.

The Committee majority also recognizes the minority members for their professional deliberations and interaction with all members, TCEQ staff, and the public.

Submitted December 9, 2019 by Committee Majority on the Above Advice

Bob Adair (Chairman), representing Texas Oil and Gas Association
Charles Allred, independent technical expert
Paul Coon, representing Association of Electric Companies of Texas
Mike Ford, representing Texas Chemical Council
Ted Jones, representing Texas Association of Manufacturers
Greg Maxim, with Cummings Westlake LLC, representing Industry
Mike Nasi, representing Clean Coal Technology Foundation

Other Considered Use Determination

On December 2nd, all 13 Committee members were present (either in the TCEQ agenda room or on the telephone) at a public meeting recorded by TCEQ staff. After additional discussion and public input, a substitute motion was presented by Mr. Lee and seconded by Dr. Reed to add HRSGs to the Tier I Table with a pollution control use of 47%. The motion failed 6-7. The majority will defer to the minority to elaborate on the merits of this proposal, if they so choose.

Proposed % Environmental Use for Heat Recovery Steam Generators

Average % Increase in Plant Output Attributable to Combined Cycle Operation	=	*49.39%*	=	*Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines*
Average % Improvement in Heat Rate Attributable to Combined Cycle Operation	=	*31.96%*	=	*Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines*
Average Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines	=	*40.67%*	=	*Average of % Increase in Plant Output Attributable to Combined Cycle Operation and % Improvement in Heat Rate Attributable to Combined Cycle Operation*
Indicated % Nonproductive Use	=	*59.33%*	=	*1 - Average Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines*

NOx lbs per MWh Output Basis for Simple Cycle Plants at BACT NOx Concentration of 5.0 ppmvd at 15% O2	=	*0.15388*	*NOx lbs per MWh Output Basis for Combined Cycle Plants at BACT NOx Concentration of 2.0 ppmvd at 15% O2*	=	*0.04421*	
Reduction in NOx lbs per MWh Output Basis for Combined Cycle Plants	=	*0.10967*	=	*NOx lbs per MWh Output Basis for Simple Cycle Plants - NOx lbs per MWh Output Basis for Combined Cycle Plants*		
% Reduction in NOx lbs per MWh Output Basis	=	*71.27%*	=	*Reduction in NOx lbs per MWh Output Basis for Combined Cycle Plants / NOx lbs per MWh Output Basis for Simple Cycle Plants*		
Indicated % Environmental Use	=	*71.27%*	=	*Average of % Reduction in NOx Concentration and % Reduction in NOx lbs per MWh Output Basis*		

Indicated % Nonproductive Use:	=	*59.33%*
Indicated % Environmental Use:	=	*71.27%*
Average:	=	*65.30%*

Proposed % Environmental Use:	=	*65%*	*For Heat Recovery Steam Generators (HRSG)*

Productive Use Analysis for Combined Cycle Plants-Plant Output Increase

Average Output for Combustion Turbines = 318 MW

Average Output for Steam Turbines = 157 MW

Average % Increase in Plant Output Attributable to Combined Cycle Operation = Average Output for Steam Turbines / Average Output for Combustion Turbines

Average % Increase in Plant Output Attributable to Combined Cycle Operation = 49.39% = Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines

Combined Cycle Specifications from 2019 Gas Turbine World Handbook

Gas Turbine Manufacturer	No. & Model Gas Turbine	Total Combined Cycle Net Plant Output		Steam Turbine Output		Combustion Turbine Output w/o HRSG		Net % Improvement in Plant Output Attributable to Combined Cycle Operation
MAN Energy Solutions	2 x THM 1304-12N	34.0	MW	11.0	MW	23.0	MW	47.83%
Siemens Energy	1 x SGT-600	35.9	MW	12.6	MW	24.5	MW	51.43%
PW Power Systems	1 x FT8 SP 30	41.1	MW	12.0	MW	30.9	MW	38.83%
Siemens Energy	1 x SGT-A35 RB211 DLE	42.6	MW	12.6	MW	31.9	MW	39.50%
Siemens Energy	1 x SGT-700	45.2	MW	14.4	MW	32.8	MW	43.90%
GE Power	1 x LM2500+ G4 DLE	47.7	MW	14.2	MW	34.5	MW	41.16%
Siemens Energy	1 x SGT-750	51.6	MW	13.5	MW	39.8	MW	33.92%
GE Power	1 x LM6000 DLE (50)	58.0	MW	14.4	MW	45.0	MW	32.00%
Siemens Energy	1 x SGT-800	66.6	MW	21.0	MW	47.5	MW	44.21%
GE Power	1 x 6B.03	68.0	MW	25.6	MW	44.0	MW	58.18%
Siemens Energy	2 x SGT-600	73.3	MW	26.5	MW	49.0	MW	54.08%
PW Power Systems	2 x FT8 SP-30	83.1	MW	24.6	MW	61.8	MW	39.81%
Siemens Energy	2 x SGT-700	91.6	MW	30.0	MW	65.6	MW	45.73%
Ansaldo Energia	1 x AE64.3A	118.0	MW	40.5	MW	80.0	MW	50.63%
GE Power	2 x LM6000 DLE (50)	117.0	MW	29.1	MW	90.0	MW	32.33%
GE Power	1 x 6F.03	135.0	MW	49.4	MW	88.0	MW	56.14%
GE Power	2 x 6B.03	137.0	MW	51.6	MW	88.0	MW	58.64%
Siemens Energy	2 x SGT-800	135.4	MW	44.2	MW	95.0	MW	46.53%
GE Power	1 x LMS100 (50Hz)	141.0	MW	25.8	MW	118.0	MW	21.86%
GE Power	1 x 7E.03	142.0	MW	53.6	MW	91.0	MW	58.90%
Mitsubishi Hitachi Power Systems	1 x H-100 (50Hz)	171.0	MW	58.3	MW	116.5	MW	50.04%
Siemens Energy	1 x SGT6-2000E	174.0	MW	60.0	MW	117.0	MW	51.28%
Mitsubishi Hitachi Power Systems	1 x M701DA	212.5	MW	70.4	MW	144.1	MW	48.85%

Gas Turbine Manufacturer	No. & Model Gas Turbine	Total Combined Cycle Net Plant Output		Steam Turbine Output		Combustion Turbine Output w/o HRSG		Net % Improvement in Plant Output Attributable to Combined Cycle Operation
Ansaldo Energia	2 x AE64.3A	240.0	MW	82.6	MW	160.0	MW	51.63%
GE Power	2 x 6F.03	272.0	MW	100.9	MW	176.0	MW	57.33%
Siemens Energy	1 x SGT5-2000E	275.0	MW	93.0	MW	187.0	MW	49.73%
GE Power	2 x 7E.03	287.0	MW	110.0	MW	182.0	MW	60.44%
Mitsubishi Hitachi Power Systems	1 x M501F	285.1	MW	102.4	MW	185.4	MW	55.23%
GE Power	1 x GT13E2	305.0	MW	100.3	MW	210.0	MW	47.76%
Mitsubishi Hitachi Power Systems	2 x H-100 (50Hz)	346.0	MW	120.6	MW	232.9	MW	51.78%
GE Power	1 x 7F.05	376.0	MW	144.7	MW	243.0	MW	59.55%
Siemens Energy	1 x SGT6-5000F	387.0	MW	133.0	MW	260.0	MW	51.15%
Mitsubishi Hitachi Power Systems	1 x M501GAC	427.0	MW	146.2	MW	283.0	MW	51.66%
Mitsubishi Hitachi Power Systems	1 x M501J	484.0	MW	157.8	MW	330.0	MW	47.82%
GE Power	1 x 9F.05	493.0	MW	186.0	MW	314.0	MW	59.24%
Ansaldo Energia	1 x GT26-1	505.0	MW	160.0	MW	370.0	MW	43.24%
Siemens Energy	2 x SGT5-2000E	551.0	MW	186.0	MW	374.0	MW	49.73%
Mitsubishi Hitachi Power Systems	1 x M701F	566.0	MW	186.7	MW	385.0	MW	48.49%
Mitsubishi Hitachi Power Systems	2 x M501F	572.2	MW	206.8	MW	370.8	MW	55.77%
GE Power	2 x GT13E2-2	613.0	MW	203.7	MW	420.0	MW	48.50%
Mitsubishi Hitachi Power Systems	1 x M501JAC	614.0	MW	193.7	MW	425.0	MW	45.58%
Mitsubishi Hitachi Power Systems	1 x M701JAC (2018)	650.0	MW	208.3	MW	448.0	MW	46.50%
GE Power	1 x 9HA.01	660.0	MW	213.0	MW	446.0	MW	47.76%
Mitsubishi Hitachi Power Systems	1 x M701J	701.0	MW	228.7	MW	478.0	MW	47.85%
GE Power	2 x 7F.05	756.0	MW	293.0	MW	486.0	MW	60.29%
Siemens Energy	2 x SGT6-5000F	775.0	MW	267.0	MW	520.0	MW	51.35%
Mitsubishi Hitachi Power Systems	1 x M701JAC 2015	818.0	MW	260.5	MW	563.0	MW	46.27%
GE Power	1 x 9HA.02	838.0	MW	289.7	MW	571.0	MW	50.74%
Mitsubishi Hitachi Power Systems	2 x M501GAC	856.0	MW	294.4	MW	566.0	MW	52.01%
GE Power	2 x 7HA.01	880.0	MW	316.2	MW	580.0	MW	54.52%
Siemens Energy	2 x SGT6-8000H	930.0	MW	325.0	MW	620.0	MW	52.42%
Mitsubishi Hitachi Power Systems	2 x M501J	971.0	MW	318.6	MW	660.0	MW	48.27%
GE Power	2 x 9F.05	989.0	MW	374.7	MW	628.0	MW	59.67%
Ansaldo Energia	2 x GT26-2	1,010.0	MW	320.0	MW	740.0	MW	43.24%
Mitsubishi Hitachi Power Systems	2 x M501JAC	1,231.0	MW	364.8	MW	850.0	MW	42.92%
GE Power	2 x 7HA.02	1,148.0	MW	397.2	MW	768.0	MW	51.72%
Siemens Energy	2 x SGT5-8000HL	1,416.0	MW	464.0	MW	962.0	MW	48.23%
Ansaldo Energia	2 x GT36-S5	1,444.0	MW	444.0	MW	1,076.0	MW	41.26%
GE Power	2 x 9HA.02	1,680.0	MW	557.6	MW	1,142.0	MW	48.83%
	Average:	**467.3**	**MW**	**157.1**	**MW**	**318.1**	**MW**	

Productive Use Analysis for Combined Cycle Plants-Heat Rate Improvement

Average Heat Rate for Simple Cycle Plants = 8,823 Btu/kWh

Average Heat Rate for Combined Cycle Plants = 6,003 Btu/kWh

Average Improvement in Heat Rate Attributable to Combined Cycle Operation = Average Heat Rate for Simple Cycle Plants - Average Heat Rate for Combined Cycle Plants

Average Improvement in Heat Rate Attributable to Combined Cycle Operation = 2,820 Btu/kWh

Average % Improvement in Heat Rate Attributable to Combined Cycle Operation = Average Improvement in Heat Rate Attributable to Combined Cycle Operation / Average Heat Rate for Simple Cycle Plants

Average % Improvement in Heat Rate Attributable to Combined Cycle Operation = 31.96% = Indicated % Productive Use Due to Recovery of Exhaust Heat from Combustion Turbines

Combined & Simple Cycle Specifications Obtained from 2019 Gas Turbine World Handbook

Gas Turbine Manufacturer	No. & Model Gas Turbine	Total Combined Cycle Net Plant Output	Steam Turbine Output	Combustion Turbine Output w/o HRSG	Simple Cycle Mode Heat Rate	Combined Cycle Mode Heat Rate	Improvement in Heat Rate Attributable to Combined Cycle Operation	% Improvement in Heat Rate Attributable to Combined Cycle Operation
MAN Energy Solutions	2 x THM 1304-12N	34.0 MW	11.0 MW	23.0 MW	11,460 Btu / kWh	7,720 Btu / kWh	3,740 Btu / kWh	32.64%
Siemens Energy	1 x SGT-600	35.9 MW	12.6 MW	24.5 MW	10,161 Btu / kWh	6,843 Btu / kWh	3,318 Btu / kWh	32.65%
PW Power Systems	1 x FT8 SP 30	41.1 MW	12.0 MW	30.9 MW	9,327 Btu / kWh	6,950 Btu / kWh	2,377 Btu / kWh	25.49%
Siemens Energy	1 x SGT-A35 RB211 DLE	42.6 MW	12.6 MW	31.9 MW	9,141 Btu / kWh	6,464 Btu / kWh	2,677 Btu / kWh	29.29%
Siemens Energy	1 x SGT-700	45.2 MW	14.4 MW	32.8 MW	9,170 Btu / kWh	6,517 Btu / kWh	2,653 Btu / kWh	28.93%
GE Power	1 x LM2500+ G4 DLE	47.7 MW	14.2 MW	34.5 MW	8,709 Btu / kWh	6,343 Btu / kWh	2,366 Btu / kWh	27.17%
Siemens Energy	1 x SGT-750	51.6 MW	13.5 MW	39.8 MW	8,456 Btu / kWh	6,407 Btu / kWh	2,049 Btu / kWh	24.23%
GE Power	1 x LM6000 DLE (50)	58.0 MW	14.4 MW	45.0 MW	8,097 Btu / kWh	6,179 Btu / kWh	1,918 Btu / kWh	23.69%
Siemens Energy	1 x SGT-800	66.6 MW	21.0 MW	47.5 MW	9,048 Btu / kWh	6,344 Btu / kWh	2,704 Btu / kWh	29.89%
GE Power	1 x 6B.03	68.0 MW	25.6 MW	44.0 MW	10,180 Btu / kWh	6,614 Btu / kWh	3,566 Btu / kWh	35.03%
Siemens Energy	2 x SGT-600	73.3 MW	26.5 MW	49.0 MW	10,161 Btu / kWh	6,702 Btu / kWh	3,459 Btu / kWh	34.04%
PW Power Systems	2 x FT8 SP-30	83.1 MW	24.6 MW	61.8 MW	9,327 Btu / kWh	6,878 Btu / kWh	2,449 Btu / kWh	26.26%
Siemens Energy	2 x SGT-700	91.6 MW	30.0 MW	65.6 MW	9,170 Btu / kWh	6,424 Btu / kWh	2,746 Btu / kWh	29.95%
Ansaldo Energia	1 x AE64.3A	118.0 MW	40.5 MW	80.0 MW	9,374 Btu / kWh	6,215 Btu / kWh	3,159 Btu / kWh	33.70%
GE Power	2 x LM6000 DLE (50)	117.0 MW	29.1 MW	90.0 MW	8,097 Btu / kWh	6,161 Btu / kWh	1,936 Btu / kWh	23.91%
GE Power	1 x 6F.03	135.0 MW	49.4 MW	88.0 MW	9,277 Btu / kWh	5,998 Btu / kWh	3,279 Btu / kWh	35.35%
GE Power	2 x 6B.03	137.0 MW	51.6 MW	88.0 MW	10,180 Btu / kWh	6,551 Btu / kWh	3,629 Btu / kWh	35.65%
Siemens Energy	2 x SGT-800	135.4 MW	44.2 MW	95.0 MW	9,048 Btu / kWh	6,239 Btu / kWh	2,809 Btu / kWh	31.05%
GE Power	1 x LMS100 (50Hz)	141.0 MW	25.8 MW	118.0 MW	7,833 Btu / kWh	6,399 Btu / kWh	1,434 Btu / kWh	18.31%
GE Power	1 x 7E.03	142.0 MW	53.6 MW	91.0 MW	10,060 Btu / kWh	6,505 Btu / kWh	3,555 Btu / kWh	35.34%
Mitsubishi Hitachi Power Systems	1 x H-100 (50Hz)	171.0 MW	58.3 MW	116.5 MW	8,909 Btu / kWh	5,945 Btu / kWh	2,964 Btu / kWh	33.27%
Siemens Energy	1 x SGT6-2000E	174.0 MW	60.0 MW	117.0 MW	9,639 Btu / kWh	6,533 Btu / kWh	3,106 Btu / kWh	32.22%
Mitsubishi Hitachi Power Systems	1 x M701DA	212.5 MW	70.4 MW	144.1 MW	9,810 Btu / kWh	6,635 Btu / kWh	3,175 Btu / kWh	32.36%
Ansaldo Energia	2 x AE64.3A	240.0 MW	82.6 MW	160.0 MW	9,374 Btu / kWh	6,093 Btu / kWh	3,281 Btu / kWh	35.00%
GE Power	2 x 6F.03	272.0 MW	100.9 MW	176.0 MW	9,277 Btu / kWh	5,944 Btu / kWh	3,333 Btu / kWh	35.93%
Siemens Energy	1 x SGT5-2000E	275.0 MW	93.0 MW	187.0 MW	9,349 Btu / kWh	6,403 Btu / kWh	2,946 Btu / kWh	31.51%
GE Power	2 x 7E.03	287.0 MW	110.0 MW	182.0 MW	10,060 Btu / kWh	6,439 Btu / kWh	3,621 Btu / kWh	35.99%
Mitsubishi Hitachi Power Systems	1 x M501F	285.1 MW	102.4 MW	185.4 MW	9,230 Btu / kWh	5,976 Btu / kWh	3,254 Btu / kWh	35.25%
GE Power	1 x GT13E2	305.0 MW	100.3 MW	210.0 MW	8,980 Btu / kWh	6,189 Btu / kWh	2,791 Btu / kWh	31.08%
Mitsubishi Hitachi Power Systems	2 x H-100 (50Hz)	346.0 MW	120.6 MW	232.9 MW	8,909 Btu / kWh	5,884 Btu / kWh	3,025 Btu / kWh	33.95%
GE Power	1 x 7F.05	376.0 MW	144.7 MW	243.0 MW	8,570 Btu / kWh	5,660 Btu / kWh	2,910 Btu / kWh	33.96%
Siemens Energy	1 x SGT6-5000F	387.0 MW	133.0 MW	260.0 MW	8,530 Btu / kWh	5,725 Btu / kWh	2,805 Btu / kWh	32.88%
Mitsubishi Hitachi Power Systems	1 x M501GAC	427.0 MW	146.2 MW	283.0 MW	8,531 Btu / kWh	5,640 Btu / kWh	2,891 Btu / kWh	33.89%
Mitsubishi Hitachi Power Systems	1 x M501J	484.0 MW	157.8 MW	330.0 MW	8,105 Btu / kWh	5,504 Btu / kWh	2,601 Btu / kWh	32.09%
GE Power	1 x 9F.05	493.0 MW	186.0 MW	314.0 MW	8,846 Btu / kWh	5,619 Btu / kWh	3,227 Btu / kWh	36.48%
Ansaldo Energia	1 x GT26-1	505.0 MW	160.0 MW	370.0 MW	8,322 Btu / kWh	5,640 Btu / kWh	2,682 Btu / kWh	32.23%

Gas Turbine Manufacturer	No. & Model Gas Turbine	Total Combined Cycle Net Plant Output	Steam Turbine Output	Combustion Turbine Output w/o HRSG	Simple Cycle Mode Heat Rate	Combined Cycle Mode Heat Rate	Improvement in Heat Rate Attributable to Combined Cycle Operation	% Improvement in Heat Rate Attributable to Combined Cycle Operation
Siemens Energy	2 x SGT5-2000E	551.0 MW	186.0 MW	374.0 MW	9,349 Btu / kWh	6,403 Btu / kWh	2,946 Btu / kWh	31.51%
Mitsubishi Hitachi Power Systems	1 x M701F	566.0 MW	186.7 MW	385.0 MW	8,144 Btu / kWh	5,504 Btu / kWh	2,640 Btu / kWh	32.42%
Mitsubishi Hitachi Power Systems	2 x M501F	572.2 MW	206.8 MW	370.8 MW	9,230 Btu / kWh	5,955 Btu / kWh	3,275 Btu / kWh	35.48%
GE Power	2 x GT13E2-2	613.0 MW	203.7 MW	420.0 MW	8,980 Btu / kWh	6,153 Btu / kWh	2,827 Btu / kWh	31.48%
Mitsubishi Hitachi Power Systems	1 x M501JAC	614.0 MW	193.7 MW	425.0 MW	7,775 Btu / kWh	5,332 Btu / kWh	2,443 Btu / kWh	31.42%
Mitsubishi Hitachi Power Systems	1 x M701JAC (2018)	650.0 MW	208.3 MW	448.0 MW	7,755 Btu / kWh	5,332 Btu / kWh	2,423 Btu / kWh	31.24%
GE Power	1 x 9HA.01	660.0 MW	213.0 MW	446.0 MW	7,910 Btu / kWh	5,378 Btu / kWh	2,532 Btu / kWh	32.01%
Mitsubishi Hitachi Power Systems	1 x M701J	701.0 MW	228.7 MW	478.0 MW	8,067 Btu / kWh	5,477 Btu / kWh	2,590 Btu / kWh	32.11%
GE Power	2 x 7F.05	756.0 MW	293.0 MW	486.0 MW	8,570 Btu / kWh	5,640 Btu / kWh	2,930 Btu / kWh	34.19%
Siemens Energy	2 x SGT6-5000F	775.0 MW	267.0 MW	520.0 MW	8,530 Btu / kWh	5,715 Btu / kWh	2,815 Btu / kWh	33.00%
Mitsubishi Hitachi Power Systems	1 x M701JAC 2015	818.0 MW	260.5 MW	563.0 MW	7,826 Btu / kWh	5,332 Btu / kWh	2,494 Btu / kWh	31.87%
GE Power	1 x 9HA.02	838.0 MW	289.7 MW	571.0 MW	7,740 Btu / kWh	5,320 Btu / kWh	2,420 Btu / kWh	31.27%
Mitsubishi Hitachi Power Systems	2 x M501GAC	856.0 MW	294.4 MW	566.0 MW	8,531 Btu / kWh	5,622 Btu / kWh	2,909 Btu / kWh	34.10%
GE Power	2 x 7HA.01	880.0 MW	316.2 MW	580.0 MW	8,120 Btu / kWh	5,453 Btu / kWh	2,667 Btu / kWh	32.84%
Siemens Energy	2 x SGT6-8000H	930.0 MW	325.0 MW	620.0 MW	8,530 Btu / kWh	5,602 Btu / kWh	2,928 Btu / kWh	34.33%
Mitsubishi Hitachi Power Systems	2 x M501J	971.0 MW	318.6 MW	660.0 MW	8,105 Btu / kWh	5,486 Btu / kWh	2,619 Btu / kWh	32.31%
GE Power	2 x 9F.05	989.0 MW	374.7 MW	628.0 MW	8,846 Btu / kWh	5,603 Btu / kWh	3,243 Btu / kWh	36.66%
Ansaldo Energia	2 x GT26-2	1,010.0 MW	320.0 MW	740.0 MW	8,322 Btu / kWh	5,640 Btu / kWh	2,682 Btu / kWh	32.23%
Mitsubishi Hitachi Power Systems	2 x M501JAC	1,231.0 MW	364.8 MW	850.0 MW	7,775 Btu / kWh	5,315 Btu / kWh	2,460 Btu / kWh	31.64%
GE Power	2 x 7HA.02	1,148.0 MW	397.2 MW	768.0 MW	8,009 Btu / kWh	5,365 Btu / kWh	2,644 Btu / kWh	33.01%
Siemens Energy	2 x SGT5-8000HL	1,416.0 MW	464.0 MW	962.0 MW	8,034 Btu / kWh	< 5,416 Btu / kWh	2,618 Btu / kWh	32.59%
Ansaldo Energia	2 x GT36-S5	1,444.0 MW	444.0 MW	1,076.0 MW	7,972 Btu / kWh	5,548 Btu / kWh	2,424 Btu / kWh	30.41%
GE Power	2 x 9HA.02	1,680.0 MW	557.6 MW	1,142.0 MW	7,740 Btu / kWh	5,306 Btu / kWh	2,434 Btu / kWh	31.45%
				Average:	**8,823** Btu / kWh	**6,003** Btu / kWh	**2,820** Btu / kWh	31.87%

Environmental Use Analysis for Combined Cycle Plants

Average Simple Cycle Output Based NOx	=	**0.1539**	**lbs / MWh**	
Average Combined Cycle Output Based NOx	=	**0.0442**	**lbs / MWh**	
Reduction in Output Based NOx for Combined Cycle Plants	=	**0.1097**	=	**Average Simple Cycle Output Based NOx - Average Combined Cycle Output Based NOx**
% Reduction in NOx lbs per MWh Output Basis	=	**71.27%**	=	**Reduction in Output Based NOx for Combined Cycle Plants / Average Simple Cycle Output Based NOx**
Indicated % Environmental Use	=	***71.27%***		

Combined Cycle Specifications Data from 2019 Gas Turbine World Handbook

[1] EPA NSPS Method 19 specifies a stoichiometric flue gas volume of 8,710 dscf/MMBtu of nominal natural gas.

Gas Turbine Manufacturer	No. & Model Gas Turbine	Net Plant Output		Heat Rate Btu/kWh		Efficiency	Steam Turbine Output		Hourly Heat Input Rate in MMBtu / hour	EPA Method 19[1] Flue Gas Exhaust Volume in dscf / hour	BACT NOx Concentration in ppmvd @ 15% O2	NOx Mass Emissions in lbs / hour	NOx Input-Based Emissions in lbs /MMBtu	NOx Output-Based Emissions in lbs / MWh
MAN Energy Solutions	2 x THM 1304-12N	34.0	MW	7,720	Btu	44.2%	11.0	MW	262.48	2,286,200.80	2.0	1.93	0.007365	0.0569
Siemens Energy	1 x SGT-600	35.9	MW	6,843	Btu	49.9%	12.6	MW	245.66	2,139,730.83	2.0	1.81	0.007365	0.0504
PW Power Systems	1 x FT8 SP 30	41.1	MW	6,950	Btu	49.1%	12.0	MW	285.65	2,487,967.95	2.0	2.10	0.007365	0.0512
Siemens Energy	1 x SGT-A35 RB211 DLE	42.6	MW	6,464	Btu	52.8%	12.6	MW	275.37	2,398,441.34	2.0	2.03	0.007365	0.0476
Siemens Energy	1 x SGT-700	45.2	MW	6,517	Btu	52.4%	14.4	MW	294.57	2,565,690.76	2.0	2.17	0.007365	0.0480
GE Power	1 x LM2500+ G4 DLE	47.7	MW	6,343	Btu	53.8%	14.2	MW	302.56	2,635,307.18	2.0	2.23	0.007365	0.0467
Siemens Energy	1 x SGT-750	51.6	MW	6,407	Btu	53.3%	13.5	MW	330.60	2,879,536.45	2.0	2.43	0.007365	0.0472
GE Power	1 x LM6000 DLE (50)	58.0	MW	6,179	Btu	55.2%	14.4	MW	358.38	3,121,507.22	2.0	2.64	0.007365	0.0455
Siemens Energy	1 x SGT-800	66.6	MW	6,344	Btu	53.8%	21.0	MW	422.51	3,680,065.58	2.0	3.11	0.007365	0.0467
GE Power	1 x 6B.03	68.0	MW	6,614	Btu	51.6%	25.6	MW	449.75	3,917,339.92	2.0	3.31	0.007365	0.0487
Siemens Energy	2 x SGT-600	73.3	MW	6,702	Btu	50.9%	26.5	MW	491.26	4,278,844.99	2.0	3.62	0.007365	0.0494
PW Power Systems	2 x FT8 SP-30	83.1	MW	6,878	Btu	49.6%	24.6	MW	571.56	4,978,303.28	2.0	4.21	0.007365	0.0507
Siemens Energy	2 x SGT-700	91.6	MW	6,424	Btu	53.1%	30.0	MW	588.44	5,125,298.46	2.0	4.33	0.007365	0.0473
Ansaldo Energia	1 x AE64.3A	118.0	MW	6,215	Btu	54.9%	40.5	MW	733.37	6,387,652.70	2.0	5.40	0.007365	0.0458
GE Power	2 x LM6000 DLE (50)	117.0	MW	6,161	Btu	55.4%	29.1	MW	720.84	6,278,490.27	2.0	5.31	0.007365	0.0454
GE Power	1 x 6F.03	135.0	MW	5,998	Btu	56.9%	49.4	MW	809.73	7,052,748.30	2.0	5.96	0.007365	0.0442
GE Power	2 x 6B.03	137.0	MW	6,551	Btu	52.1%	51.6	MW	897.49	7,817,111.77	2.0	6.61	0.007365	0.0482
Siemens Energy	2 x SGT-800	135.4	MW	6,239	Btu	54.7%	44.2	MW	844.76	7,357,864.83	2.0	6.22	0.007365	0.0459
GE Power	1 x LMS100 (50Hz)	141.0	MW	6,399	Btu	53.3%	25.8	MW	902.26	7,858,675.89	2.0	6.65	0.007365	0.0471
GE Power	1 x 7E.03	142.0	MW	6,505	Btu	52.5%	53.6	MW	923.71	8,045,514.10	2.0	6.80	0.007365	0.0479
Mitsubishi Hitachi Power Systems	1 x H-100 (50Hz)	171.0	MW	5,945	Btu	57.4%	58.3	MW	1,016.60	8,854,542.45	2.0	7.49	0.007365	0.0438
Siemens Energy	1 x SGT6-2000E	174.0	MW	6,533	Btu	52.2%	60.0	MW	1,136.74	9,901,022.82	2.0	8.37	0.007365	0.0481
Mitsubishi Hitachi Power Systems	1 x M701DA	212.5	MW	6,635	Btu	51.4%	70.4	MW	1,409.94	12,280,555.63	2.0	10.38	0.007365	0.0489
Ansaldo Energia	2 x AE64.3A	240.0	MW	6,093	Btu	56.0%	82.6	MW	1,462.32	12,736,807.20	2.0	10.77	0.007365	0.0449
GE Power	2 x 6F.03	272.0	MW	5,944	Btu	57.4%	100.9	MW	1,616.77	14,082,049.28	2.0	11.91	0.007365	0.0438
Siemens Energy	1 x SGT5-2000E	275.0	MW	6,403	Btu	53.3%	93.0	MW	1,760.83	15,336,785.75	2.0	12.97	0.007365	0.0472
GE Power	2 x 7E.03	287.0	MW	6,439	Btu	53.0%	110.0	MW	1,847.99	16,096,019.03	2.0	13.61	0.007365	0.0474
Mitsubishi Hitachi Power Systems	1 x M501F	285.1	MW	5,976	Btu	57.1%	102.4	MW	1,703.76	14,839,728.70	2.0	12.55	0.007365	0.0440
GE Power	1 x GT13E2	305.0	MW	6,189	Btu	55.1%	100.3	MW	1,887.65	16,441,387.95	2.0	13.90	0.007365	0.0456
Mitsubishi Hitachi Power Systems	2 x H-100 (50Hz)	346.0	MW	5,884	Btu	58.0%	120.6	MW	2,035.86	17,732,375.44	2.0	14.99	0.007365	0.0433
GE Power	1 x 7F.05	376.0	MW	5,660	Btu	60.3%	144.7	MW	2,128.16	18,536,273.60	2.0	15.67	0.007365	0.0417
Siemens Energy	1 x SGT6-5000F	387.0	MW	5,725	Btu	59.6%	133.0	MW	2,215.58	19,297,658.25	2.0	16.32	0.007365	0.0422
Mitsubishi Hitachi Power Systems	1 x M501GAC	427.0	MW	5,640	Btu	60.5%	146.2	MW	2,408.28	20,976,118.80	2.0	17.74	0.007365	0.0415

Gas Turbine Manufacturer	No. & Model Gas Turbine	Net Plant Output		Heat Rate Btu/kWh		Efficiency	Steam Turbine Output		Hourly Heat Input Rate in MMBtu / hour	EPA Method 19[1] Flue Gas Exhaust Volume in dscf / hour	BACT NOx Concentration in ppmvd @ 15% O2	NOx Mass Emissions in lbs / hour	NOx Input-Based Emissions in lbs /MMBtu	NOx Output-Based Emissions in lbs / MWh
Mitsubishi Hitachi Power Systems	1 x M501J	484.0	MW	5,504	Btu	62.0%	157.8	MW	2,663.94	23,202,882.56	2.0	19.62	0.007365	0.0405
GE Power	1 x 9F.05	493.0	MW	5,619	Btu	60.7%	186.0	MW	2,770.17	24,128,154.57	2.0	20.40	0.007365	0.0414
Ansaldo Energia	1 x GT26-1	505.0	MW	5,640	Btu	60.5%	160.0	MW	2,848.20	24,807,822.00	2.0	20.98	0.007365	0.0415
Siemens Energy	2 x SGT5-2000E	551.0	MW	6,403	Btu	53.3%	186.0	MW	3,528.05	30,729,341.63	2.0	25.98	0.007365	0.0472
Mitsubishi Hitachi Power Systems	1 x M701F	566.0	MW	5,504	Btu	62.0%	186.7	MW	3,115.26	27,133,949.44	2.0	22.94	0.007365	0.0405
Mitsubishi Hitachi Power Systems	2 x M501F	572.2	MW	5,955	Btu	57.3%	206.8	MW	3,407.45	29,678,898.21	2.0	25.10	0.007365	0.0439
GE Power	2 x GT13E2-2	613.0	MW	6,153	Btu	55.5%	203.7	MW	3,771.79	32,852,282.19	2.0	27.78	0.007365	0.0453
Mitsubishi Hitachi Power Systems	1 x M501JAC	614.0	MW	5,332	Btu	64.0%	193.7	MW	3,273.85	28,515,216.08	2.0	24.11	0.007365	0.0393
Mitsubishi Hitachi Power Systems	1 x M701JAC (2018)	650.0	MW	5,332	Btu	64.0%	208.3	MW	3,465.80	30,187,118.00	2.0	25.53	0.007365	0.0393
GE Power	1 x 9HA.01	660.0	MW	5,378	Btu	63.5%	213.0	MW	3,549.48	30,915,970.80	2.0	26.14	0.007365	0.0396
Mitsubishi Hitachi Power Systems	1 x M701J	701.0	MW	5,477	Btu	62.3%	228.7	MW	3,839.38	33,440,973.67	2.0	28.28	0.007365	0.0403
GE Power	2 x 7F.05	756.0	MW	5,640	Btu	60.5%	293.0	MW	4,263.84	37,138,046.40	2.0	31.40	0.007365	0.0415
Siemens Energy	2 x SGT6-5000F	775.0	MW	5,715	Btu	59.7%	267.0	MW	4,429.13	38,577,678.75	2.0	32.62	0.007365	0.0421
Mitsubishi Hitachi Power Systems	1 x M701JAC 2015	818.0	MW	5,332	Btu	64.0%	260.5	MW	4,361.58	37,989,326.96	2.0	32.12	0.007365	0.0393
GE Power	1 x 9HA.02	838.0	MW	5,320	Btu	64.1%	289.7	MW	4,458.16	38,830,573.60	2.0	32.83	0.007365	0.0392
Mitsubishi Hitachi Power Systems	2 x M501GAC	856.0	MW	5,622	Btu	60.7%	294.4	MW	4,812.43	41,916,282.72	2.0	35.44	0.007365	0.0414
GE Power	2 x 7HA.01	880.0	MW	5,453	Btu	62.6%	316.2	MW	4,798.64	41,796,154.40	2.0	35.34	0.007365	0.0402
Siemens Energy	2 x SGT6-8000H	930.0	MW	5,602	Btu	60.9%	325.0	MW	5,209.86	45,377,880.60	2.0	38.37	0.007365	0.0413
Mitsubishi Hitachi Power Systems	2 x M501J	971.0	MW	5,486	Btu	62.2%	318.6	MW	5,326.91	46,397,351.26	2.0	39.23	0.007365	0.0404
GE Power	2 x 9F.05	989.0	MW	5,603	Btu	60.9%	374.7	MW	5,541.37	48,265,306.57	2.0	40.81	0.007365	0.0413
Ansaldo Energia	2 x GT26-2	1,010.0	MW	5,640	Btu	60.5%	320.0	MW	5,696.40	49,615,644.00	2.0	41.95	0.007365	0.0415
Mitsubishi Hitachi Power Systems	2 x M501JAC	1,231.0	MW	5,315	Btu	64.2%	364.8	MW	6,542.77	56,987,483.15	2.0	48.19	0.007365	0.0391
GE Power	2 x 7HA.02	1,148.0	MW	5,365	Btu	63.6%	397.2	MW	6,159.02	53,645,064.20	2.0	45.36	0.007365	0.0395
Siemens Energy	2 x SGT5-8000HL	1,416.0	MW	< 5,416	Btu	> 63.0%	464.0	MW	7,669.06	66,797,477.76	2.0	56.48	0.007365	0.0399
Ansaldo Energia	2 x GT36-S5	1,444.0	MW	5,548	Btu	61.5%	444.0	MW	8,011.31	69,778,527.52	2.0	59.00	0.007365	0.0409
GE Power	2 x 9HA.02	1,680.0	MW	5,306	Btu	64.3%	557.6	MW	8,914.08	77,641,636.80	2.0	65.65	0.007365	0.0391
													Average:	**0.0442**

Environmental Use Analysis for Combined Cycle Plants

Average Simple Cycle Output Based NOx	=	**0.1539**	**lbs / MWh**	
Average Combined Cycle Output Based NOx	=	**0.0442**	**lbs / MWh**	
Reduction in Output Based NOx for Combined Cycle Plants	=	**0.1097**	=	**Average Simple Cycle Output Based NOx - Average Combined Cycle Output Based NOx**
% Reduction in NOx lbs per MWh Output Basis	=	**71.27%**	=	**Reduction in Output Based NOx for Combined Cycle Plants / Average Simple Cycle Output Based NOx**
Indicated % Environmental Use	=	***71.27%***		

Simple Cycle Specifications Data from 2019 Gas Turbine World Handbook
Identified Simple Cycle Equipment with Comparable Output to the Plant Output for the Combined Cycle Plants Listed in the 2019 Gas Turbine World Handbook

[1] EPA NSPS Method 19 specifies a stoichiometric flue gas volume of 8,710 dscf/MMBtu of nominal natural gas.

Gas Turbine Manufacturer	No. & Model Gas Turbine	Frequency Hz	ISO Base Output			Combustion Turbine Output		Heat Rate Btu/kWh		Efficiency	Hourly Heat Input Rate in MMBtu / hour	EPA Method 19[1] Flue Gas Exhaust Volume in dscf / hour	BACT NOx Concentration in ppmvd @ 15% O2	NOx Mass Emissions in lbs / hour	NOx Input-Based Emissions in lbs /MMBtu	NOx Output-Based Emissions in lbs / MWh
GE Power	LM2500+ G4 DLE	60	34,500	kW	=	34.5	MW	8,709	Btu	39.2%	300.46	6,788.61	5.0	5.53	0.018412	0.1604
Siemens Energy	SGT-750	50/60	37,031	kW	=	37.0	MW	8,456	Btu	40.4%	313.13	7,074.96	5.0	5.77	0.018412	0.1557
GE Power	LM6000PF DLE	60	45,000	kW	=	45.0	MW	8,097	Btu	42.1%	364.37	8,232.48	5.0	6.71	0.018412	0.1491
GE Power	LM6000PF DLE	60	45,000	kW	=	45.0	MW	8,097	Btu	42.1%	364.37	8,232.48	5.0	6.71	0.018412	0.1491
GE Power	LM6000PF Sprint	60	50,000	kW	=	50.0	MW	8,109	Btu	42.1%	405.45	9,160.75	5.0	7.47	0.018412	0.1493
GE Power	LM6000PF Sprint	60	50,000	kW	=	50.0	MW	8,109	Btu	42.1%	405.45	9,160.75	5.0	7.47	0.018412	0.1493
GE Power	LM6000 SAC (57)	60	54,000	kW	=	54.0	MW	8,162	Btu	41.8%	440.75	9,958.28	5.0	8.12	0.018412	0.1503
Siemens Energy	SGT-A65 DLE (TRENT)	50	61,900	kW	=	61.9	MW	7,874	Btu	43.3%	487.40	11,012.35	5.0	8.97	0.018412	0.1450
PW Power Systems	1 x FT4000 SP60	50/60	68,747	kW	=	68.7	MW	8,305	Btu	41.1%	570.94	12,899.92	5.0	10.51	0.018412	0.1529
PW Power Systems	1 x FT4000 SP60	50/60	68,747	kW	=	68.7	MW	8,305	Btu	41.1%	570.94	12,899.92	5.0	10.51	0.018412	0.1529
Ansaldo Energia	AE64.3A	50/60	80,000	kW	=	80.0	MW	9,374	Btu	36.4%	749.92	16,943.72	5.0	13.81	0.018412	0.1726
GE Power	6F.03	50/60	88,000	kW	=	88.0	MW	9,277	Btu	36.8%	816.38	18,445.23	5.0	15.03	0.018412	0.1708
Mitsubishi Hitachi Power Systems	M501DA	60	113,950	kW	=	114.0	MW	9,780	Btu	34.9%	1,114.43	25,179.49	5.0	20.52	0.018412	0.1801
GE Power	LMS100 Wet	60	118,000	kW	=	118.0	MW	7,628	Btu	44.7%	900.10	20,336.98	5.0	16.57	0.018412	0.1404
GE Power	LMS100 Wet	60	118,000	kW	=	118.0	MW	7,628	Btu	44.7%	900.10	20,336.98	5.0	16.57	0.018412	0.1404
Mitsubishi Hitachi Power Systems	M701DA	50	144,090	kW	=	144.1	MW	9,810	Btu	34.8%	1,413.52	31,937.18	5.0	26.03	0.018412	0.1806
Mitsubishi Hitachi Power Systems	M701DA	50	144,090	kW	=	144.1	MW	9,810	Btu	34.8%	1,413.52	31,937.18	5.0	26.03	0.018412	0.1806
Mitsubishi Hitachi Power Systems	M701DA	50	144,090	kW	=	144.1	MW	9,810	Btu	34.8%	1,413.52	31,937.18	5.0	26.03	0.018412	0.1806
Mitsubishi Hitachi Power Systems	M701DA	50	144,090	kW	=	144.1	MW	9,810	Btu	34.8%	1,413.52	31,937.18	5.0	26.03	0.018412	0.1806
Mitsubishi Hitachi Power Systems	M701DA	50	144,090	kW	=	144.1	MW	9,810	Btu	34.8%	1,413.52	31,937.18	5.0	26.03	0.018412	0.1806
Ansaldo Energia	AE94.2	50	190,000	kW	=	190.0	MW	9,400	Btu	36.3%	1,786.00	40,352.94	5.0	32.88	0.018412	0.1731
Ansaldo Energia	AE94.2	50	190,000	kW	=	190.0	MW	9,400	Btu	36.3%	1,786.00	40,352.94	5.0	32.88	0.018412	0.1731
GE Power	7F.05	60	241,000	kW	=	241.0	MW	8,580	Btu	39.8%	2,067.78	46,719.49	5.0	38.07	0.018412	0.1580
GE Power	7F.05	60	241,000	kW	=	241.0	MW	8,580	Btu	39.8%	2,067.78	46,719.49	5.0	38.07	0.018412	0.1580
Mitsubishi Hitachi Power Systems	M501GAC	60	283,000	kW	=	283.0	MW	8,531	Btu	40.0%	2,414.27	54,548.17	5.0	44.45	0.018412	0.1571
Mitsubishi Hitachi Power Systems	M501GAC	60	283,000	kW	=	283.0	MW	8,531	Btu	40.0%	2,414.27	54,548.17	5.0	44.45	0.018412	0.1571
Siemens Energy	SGT6-8000H	60	310,000	kW	=	310.0	MW	< 8,530	Btu	40.0%	2,644.30	59,745.40	5.0	48.69	0.018412	0.1571
Siemens Energy	SGT6-8000H	60	310,000	kW	=	310.0	MW	< 8,530	Btu	40.0%	2,644.30	59,745.40	5.0	48.69	0.018412	0.1571
Siemens Energy	SGT6-8000H	60	310,000	kW	=	310.0	MW	< 8,530	Btu	40.0%	2,644.30	59,745.40	5.0	48.69	0.018412	0.1571
Ansaldo Energia	GT36-S6	60	369,000	kW	=	369.0	MW	8,067	Btu	42.3%	2,976.72	67,256.18	5.0	54.81	0.018412	0.1485
GE Power	7HA.02	60	384,000	kW	=	384.0	MW	8,009	Btu	42.6%	3,075.46	69,486.96	5.0	56.63	0.018412	0.1475
Siemens Energy	SGT6-9000HL	60	405,000	kW	=	405.0	MW	8,010	Btu	42.6%	3,244.05	73,296.18	5.0	59.73	0.018412	0.1475
Mitsubishi Hitachi Power Systems	M701JAC	50	448,000	kW	=	448.0	MW	7,755	Btu	44.0%	3,474.24	78,497.10	5.0	63.97	0.018412	0.1428
Ansaldo Energia	GT36-S5	50	538,000	kW	=	538.0	MW	7,972	Btu	42.8%	4,288.94	96,904.36	5.0	78.97	0.018412	0.1468
Ansaldo Energia	GT36-S5	50	538,000	kW	=	538.0	MW	7,972	Btu	42.8%	4,288.94	96,904.36	5.0	78.97	0.018412	0.1468
Ansaldo Energia	GT36-S5	50	538,000	kW	=	538.0	MW	7,972	Btu	42.8%	4,288.94	96,904.36	5.0	78.97	0.018412	0.1468

Gas Turbine Manufacturer	No. & Model Gas Turbine	Frequency Hz	ISO Base Output			Combustion Turbine Output			Heat Rate Btu/kWh		Efficiency	Hourly Heat Input Rate in MMBtu / hour	EPA Method 19[1] Flue Gas Exhaust Volume in dscf / hour	BACT NOx Concentration in ppmvd @ 15% O2	NOx Mass Emissions in lbs / hour	NOx Input-Based Emissions in lbs /MMBtu	NOx Output-Based Emissions in lbs / MWh
Mitsubishi Hitachi Power Systems	M701JAC (2015)	50	563,000	kW	=	563.0	MW		7,826	Btu	43.6%	4,406.04	99,550.17	5.0	81.13	0.018412	0.1441
GE Power	9HA.02	50	571,000	kW	=	571.0	MW		7,740	Btu	44.1%	4,419.54	99,855.24	5.0	81.37	0.018412	0.1425
Siemens Energy	SGT5-9000HL	50	593,000	kW	=	593.0	MW		7,972	Btu	42.8%	4,727.40	106,810.94	5.0	87.04	0.018412	0.1468
Siemens Energy	2 x SGT6-8000H	60	620,000	kW	=	620.0	MW	<	8,530	Btu	40.0%	5,288.60	119,490.81	5.0	97.38	0.018412	0.1571
Siemens Energy	2 x SGT6-8000H	60	620,000	kW	=	620.0	MW	<	8,530	Btu	40.0%	5,288.60	119,490.81	5.0	97.38	0.018412	0.1571
Siemens Energy	2 x SGT5-4000F	50	658,000	kW	=	658.0	MW		8,322	Btu	41.0%	5,475.88	123,722.13	5.0	100.82	0.018412	0.1532
Mitsubishi Hitachi Power Systems	2 x M501J	60	660,000	kW	=	660.0	MW		8,105	Btu	42.1%	5,349.30	120,862.26	5.0	98.49	0.018412	0.1492
Ansaldo Energia	2 x GT36-S6	60	738,000	kW	=	738.0	MW		8,067	Btu	42.3%	5,953.45	134,512.36	5.0	109.62	0.018412	0.1485
GE Power	2 x 7HA.02	60	768,000	kW	=	768.0	MW		8,009	Btu	42.6%	6,150.91	138,973.91	5.0	113.25	0.018412	0.1475
Siemens Energy	2 x SGT6-9000HL	60	810,000	kW	=	810.0	MW		8,010	Btu	42.6%	6,488.10	146,592.35	5.0	119.46	0.018412	0.1475
Mitsubishi Hitachi Power Systems	2 x M501JAC	60	850,000	kW	=	850.0	MW		7,775	Btu	44.0%	6,608.75	149,318.32	5.0	121.68	0.018412	0.1432
Mitsubishi Hitachi Power Systems	2 x M501JAC	60	850,000	kW	=	850.0	MW		7,775	Btu	44.0%	6,608.75	149,318.32	5.0	121.68	0.018412	0.1432
Mitsubishi Hitachi Power Systems	2 x M701JAC	50	896,000	kW	=	896.0	MW		7,755	Btu	44.0%	6,948.48	156,994.19	5.0	127.94	0.018412	0.1428
Mitsubishi Hitachi Power Systems	2 x M701JAC	50	896,000	kW	=	896.0	MW		7,755	Btu	44.0%	6,948.48	156,994.19	5.0	127.94	0.018412	0.1428
Mitsubishi Hitachi Power Systems	2 x M701J	50	956,000	kW	=	956.0	MW		8,067	Btu	42.3%	7,712.05	174,246.36	5.0	142.00	0.018412	0.1485
Ansaldo Energia	2 x GT36-S5	50	1,076,000	kW	=	1,076.0	MW		7,972	Btu	42.8%	8,577.87	193,808.73	5.0	157.94	0.018412	0.1468
Ansaldo Energia	2 x GT36-S5	50	1,076,000	kW	=	1,076.0	MW		7,972	Btu	42.8%	8,577.87	193,808.73	5.0	157.94	0.018412	0.1468
Ansaldo Energia	2 x GT36-S5	50	1,076,000	kW	=	1,076.0	MW		7,972	Btu	42.8%	8,577.87	193,808.73	5.0	157.94	0.018412	0.1468
Mitsubishi Hitachi Power Systems	3 x M501JAC	60	1,275,000	kW	=	1,275.0	MW		7,775	Btu	44.0%	9,913.13	223,977.48	5.0	182.52	0.018412	0.1432
Siemens Energy	2 x SGT5-9000HL	50	1,186,000	kW	=	1,186.0	MW		7,972	Btu	42.8%	9,454.79	213,621.89	5.0	174.09	0.018412	0.1468
Mitsubishi Hitachi Power Systems	3 x M701J	50	1,434,000	kW	=	1,434.0	MW		8,067	Btu	42.3%	11,568.08	261,369.54	5.0	213.00	0.018412	0.1485
Ansaldo Energia	3 x GT36-S5	50	1,614,000	kW	=	1,614.0	MW		7,972	Btu	42.8%	12,866.81	290,713.09	5.0	236.91	0.018412	0.1468
Mitsubishi Hitachi Power Systems	3 x M701JAC (2015)	50	1,689,000	kW	=	1,689.0	MW		7,826	Btu	43.6%	13,218.11	298,650.51	5.0	243.38	0.018412	0.1441
																Average:	**0.1539**

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

July 19, 2019

Mr. Bob Adair
Chairman, Tax Relief for Pollution Control Property Advisory Committee
c/o Phillips 66
2331 CityWest Blvd.
S1362-01 Headquarters Building
Houston, Texas 77042

Via email

Re: Request for Advice Regarding Future Heat Recovery Steam Generator Applications

Dear Mr. Adair:

On May 3, 2019, the Texas Supreme Court determined that the Commission abused its discretion in issuing negative determinations for Heat Recovery Steam Generators (HRSG) and remanded cases to the Commission for further proceedings consistent with its opinion. During the June 12, 2019 Commission Agenda, Chairman Niermann and Commissioner Lindley directed Tax Relief for Pollution Control Property program staff to solicit advice from the Tax Relief for Pollution Control Property Advisory Committee ("the Committee") on how to determine use percentages for future use determination applications that include HRSGs.

In order to resolve longstanding issues and consider options for proceeding with new HRSG applications in an expeditious manner, the TCEQ is requesting that the Committee assist us with the following questions:

1) Are the existing rules in 30 Texas Administrative Code (TAC) Section 17.17(c) adequate to determine a use percentage, in whole or in part, for new Tier III applications for HRSGs, consistent with the Court's opinions? If yes, what considerations should be given to reviewing input variables (particularly Capital Cost Old and Production Capacity Factor) used in the Cost Analysis Procedure (CAP) for HRSGs?

2) If the existing rules are not adequate, what is an appropriate method for distinguishing the proportion of HRSGs used for pollution control from the proportion used for production that is consistent with the Texas Supreme Court's opinions?

3) Should the Commission propose rulemaking to remove HRSGs from the Expedited Review List of Section 17.17(b)? If yes, what compelling evidence can the Committee provide that HRSGs do not provide pollution control benefits?

We appreciate your help with determining use percentages for future applications and look forward to discussing these issues at the next meeting on August 23, 2019. The remanded applications will be reviewed and processed in accordance with the rules that existed at the time they were originally submitted and consistent with the court's opinions.

If you have questions regarding this letter or need further assistance, please contact Walker Williamson, Manager of the Air Quality Planning Section by telephone at (512) 239-3181, by e-mail at Walker.Williamson@tceq.texas.gov, or write to the Texas Commission on Environmental Quality, Tax Relief for Pollution Control Property Program, MC-110, P.O. Box 13087, Austin, Texas 78711-3087.

Sincerely,

Donna F. Huff, Director
Air Quality Division