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Integrated Resource Plan: Volume IV: Air Quality Report

For the Review of the Puerto Rico Energy Commission

Prepared for

Puerto Rico Electric Power Authority (PREPA)

Under contract with Siemens Industry, Inc.

Submitted by:
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Revision History

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Section

1

Introduction

PREPA partnered with Siemens Industry, Inc. (Siemens) to create an Integrated Resource Plan (IRP) as a decision-making tool to assist PREPA in providing reliable and cost-effective electric service to their customers in Puerto Rico while addressing the risks and uncertainties inherent in the electric utility business (e.g., resources, efficiency, economics, and regulation). In order to quantify the balance of metrics that PREPA will use to formulate future strategies, Siemens used the PROMOD production cost model to simulate multiple PREPA resource portfolios under several potential future conditions.

As part of their analyses, Siemens developed possible scenarios (called "Futures") that may occur in Puerto Rico over the next several decades. Within the constraints of each of those possible scenarios, Siemens additionally developed possible utilization plans (called "Portfolios") for PREPA's generation resources. In simple terms, a "Future" is the operating environment PREPA will find itself in and a "Portfolio" is what PREPA will do with its resources under that operating environment.

As part of Siemens' analysis for PREPA, "Future 2" is a scenario in which the Aguirre Offshore Gas Port (AOGP – a liquefied natural gas regasification facility) is not completed within the FY 2016-2035 planning horizon and thus will not be a source of natural gas for PREPA's Portfolios. "Future 3" is a scenario in which natural gas is available to PREPA resources through a completed AOGP and an additional North Gas Supply.

The "Portfolios" were designed to meet customer demand, and meet environmental standards and reliability requirements. Under the two Futures, Siemens analyzed the following three Portfolios:

- Portfolio 1: Repower and utilize existing equipment to the extent possible.
- Portfolio 2: Build smaller new combined cycle units.
- Portfolio 3: Build larger new combined cycle units.

Table 1-1 presents all the existing PREPA power generation resources as of the time of this report and how each unit will change or continue within the two Futures and three Portfolios.

Siemens partnered with TRC to perform an air quality regulatory review of the above three Portfolios under the Future 2 and 3 conditions (six cases in total). TRC utilized the PROMOD output provided by Siemens along with emissions data from existing PREPA resources to review the regulatory implications for each case. The following is our summary of that review.

Table 1-1: PREPA Generation Resources

Existing EGUs				Future 2			Future 3		
Owner / Location	Unit	Fuel	Type	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 1	Portfolio 2	Portfolio 3
PREPA / Aguirre	AGUIRRE1	No.6-oil	ST	Not Feasible	Replacement with F Class 1x1 Diesel CC by FY2022	Replacement with G/H Class 1x1 Diesel CC by FY2021	Dual fuel conversion (NG and No. 6-oil) by FY2017; Replacement with HFCC Repower by FY2023	Dual fuel conversion (NG and No. 6-oil) by FY2017; Replacement with F Class 1x1 NG CC by FY2024	Dual fuel conversion (NG and No. 6-oil) by FY2017; Replacement with G/H Class 1x1 NG CC by FY2023
PREPA / Aguirre	AGUIRRE2	No.6-oil	ST		Replacement with F Class 1x1 Diesel CC by FY2023	Replacement with G/H Class 1x1 Diesel CC by FY2022	Dual fuel conversion (NG and Diesel) by FY2017; Replacement with HFCC Repower by FY2024	Dual fuel conversion (NG and No. 6-oil) by FY2017; Replacement with F Class 1x1 NG CC by FY2025	Dual fuel conversion (NG and No. 6-oil) by FY2017; Replacement with G/H Class 1x1 NG CC by FY2024
PREPA / Palo Seco	PSSP1	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / Palo Seco	PSSP2	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / Palo Seco	PSSP3	No.6-oil	ST		Reduce to less than 8% annual heat input capacity or retire by FY2021 after new CC installation is completed		Reduce to less than 8% annual heat input capacity or retire by FY2021 after new CC installation is completed		
PREPA / Palo Seco	PSSP4	No.6-oil	ST		Reduce to less than 8% annual heat input capacity or retire by FY2021 after new CC installation is completed		Reduce to less than 8% annual heat input capacity or retire by FY2021 after new CC installation is completed		
PREPA / San Juan	SJSP7	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / San Juan	SJSP8	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / San Juan	SJSP9	No.6-oil	ST		Reduce to less than 8% annual heat input capacity or retire by FY2021		Reduce to less than 8% annual heat input capacity or retire by FY2021		
PREPA / San Juan	SJSP10	No.6-oil	ST		Reduce to less than 8% annual heat input capacity or retire by FY2021		Reduce to less than 8% annual heat input capacity or retire by FY2021		
PREPA / Costa Sur	SOUCOC5	NG & No.6-oil	ST		Replacement with F Class 1x1 Diesel CC by FY2028	Replacement with G/H Class 1x1 NG CC by FY2027	Replacement with HFCC Repower by FY2025	Replacement with F Class 1x1 NG CC by FY2028	Replacement with G/H Class 1x1 NG CC by FY2027
PREPA / Costa Sur	SOUCOC6	NG & No.6-oil	ST		Replacement with F Class 1x1 Diesel CC by FY2029	Replacement with G/H Class 1x1 NG CC by FY2028	Replacement with HFCC Repower by FY2026	Replacement with F Class 1x1 NG CC by FY2029	Replacement with G/H Class 1x1 NG CC by FY2028
PREPA / Costa Sur	SOUCOU3	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / Costa Sur	SOUCOU4	No.6-oil	ST		Reduce to less than 8% annual heat input capacity by FY2016		Reduce to less than 8% annual heat input capacity by FY2016		
PREPA / Aguirre	AGCC1	Diesel	CC		Repower by FY2020	Repower by FY2020	Fuel conversion to NG by FY2017; Repower by FY2021	Fuel conversion to NG by 2018; Repower by FY2021	Fuel conversion to NG by 2018; Repower by FY2021
PREPA / Aguirre	AGCC2	Diesel	CC		Repower by FY2021	Repower by FY2021	Fuel conversion to NG by FY2017; Repower by FY2022	Fuel conversion to NG by 2018; Repower by FY2022	Fuel conversion to NG by 2018; Repower by FY2022
PREPA / San Juan	SJCC5	Diesel	CC		Continue		Continue		
PREPA / San Juan	SJCC6	Diesel	CC						
PREPA / Cambalache	CAMBALACHE1	Diesel	CT						
PREPA / Cambalache	CAMBALACHE2	Diesel	CT						
PREPA / Cambalache	CAMBALACHE3	Diesel	CT						
PREPA / GT Fleet (18 units)	GSTURB	Diesel	CT						
PREPA / Mayagüez	GTMAYAG1	Diesel	CT						
PREPA / Mayagüez	GTMAYAG2	Diesel	CT						
PREPA / Mayagüez	GTMAYAG3	Diesel	CT						
PREPA / Mayagüez	GTMAYAG4	Diesel	CT						
AES / Guayama	AES1	Coal	ST						
AES / Guayama	AES2	Coal	ST						
EcoEléctrica / Peñuelas	EcoElect1	NG	CC						

1.1 Air Regulation Drivers

In addition to meeting projected power needs, each portfolio also needs to demonstrate compliance with existing and proposed air quality regulatory standards. TRC reviewed the existing and proposed Environmental Protection Agency (EPA) and Puerto Rico Environmental Quality Board (PREQB) regulations to determine which may apply to the proposed unit operations for the Future 2 and Future 3 Portfolios. The critical regulatory drivers were found to be EPA's Mercury and Air Toxics Standards (MATS; 40 CFR 63, Subpart UUUUU), proposed Clean Power Plan (CPP; 40 CFR 60, Subpart UUUU)),Greenhouse Gas Standards (GHG Standards; 40 CFR 60, Subpart TTTT), New Source Performance Standards (NSPS; 40 CFR Part 60 Subparts A, Da, GG, and KKKK), and the New Source Review/Prevention of Significant Deterioration (NSR/PSD) requirements for new major sources and major modifications to existing major sources. Each of these drivers is discussed below with emphasis on applicability to Puerto Rico and the PREPA IRP.

Table 1-2 provides a tabular summary of each existing unit's applicability to the drivers discussed below while Table 1-3 presents the air regulatory applicability to each proposed new unit within the two Future and three Portfolio scenarios described in Table 1-1. A "Yes" indicates a regulation does apply and a "no" indicates the regulation does not apply to the particular electric generating unit (EGU). A "ST" indicates a steam turbine unit, "CC" indicates a combined cycle unit, and "CT" indicates a combustion turbine unit.

Table 1-2: Existing EGUs and Applicable Air Regulatory Drivers

Existing EGUs		Fuel	Type	Capacity (MW)	MATS	CPP[3]	GHG Standards
Owner / Location	Unit ID						
PREPA / Aguirre	AGUIRRE1	No.6-oil	ST	450	Yes	Yes	No
PREPA / Aguirre	AGUIRRE2	No.6-oil	ST	450	Yes	Yes	No
PREPA / Aguirre	AGCC1	Diesel	CC	260	No	No[1]	No
PREPA / Aguirre	AGCC2	Diesel	CC	260	No	No[1]	No
PREPA / Cambalache	CAMBALACHE1	Diesel	CT	83	No	No[1]	No
PREPA / Cambalache	CAMBALACHE2	Diesel	CT	83	No	No[1]	No
PREPA / Cambalache	CAMBALACHE3	Diesel	CT	83	No	No[1]	No
PREPA / Costa / Sur	SOUCOC5	NG & No.6-oil	ST	410	Yes	Yes	No
PREPA / Costa / Sur	SOUCOC6	NG & No.6-oil	ST	410	Yes	Yes	No
PREPA / Costa / Sur	SOUCOU3	No.6-oil	ST	85	Yes	Yes	No
PREPA / Costa / Sur	SOUCOU4	No.6-oil	ST	85	Yes	Yes	No
PREPA / GT Fleet (18 units)	GSTURB1-18	Diesel	CT	21/ea.	No	No[1]	No
PREPA / Mayagüez	GTMAYAG1	Diesel	CT	50	No	No[1]	No
PREPA / Mayagüez	GTMAYAG2	Diesel	CT	50	No	No[1]	No
PREPA / Mayagüez	GTMAYAG3	Diesel	CT	50	No	No[1]	No
PREPA / Mayagüez	GTMAYAG4	Diesel	CT	50	No	No[1]	No
PREPA / Palo / Seco	PSSP1	No.6-oil	ST	85	Yes	Yes	No
PREPA / Palo / Seco	PSSP2	No.6-oil	ST	85	Yes	Yes	No
PREPA / Palo / Seco	PSSP3	No.6-oil	ST	216	Yes	Yes	No
PREPA / Palo / Seco	PSSP4	No.6-oil	ST	216	Yes	Yes	No
PREPA / San / Juan	SJSP10	No.6-oil	ST	100	Yes	Yes	No
PREPA / San / Juan	SJSP7	No.6-oil	ST	100	Yes	Yes	No
PREPA / San / Juan	SJSP8	No.6-oil	ST	100	Yes	Yes	No

Existing EGUs		Fuel	Type	Capacity (MW)	MATS	CPP[3]	GHG Standards
Owner / Location	Unit ID						
PREPA / San / Juan	SJSP9	No.6-oil	ST	100	Yes	Yes	No
PREPA / San / Juan	SJCC5	Diesel	CC	200	No	No[1]	No
PREPA / San / Juan	SJCC6	Diesel	CC	200	No	No[1]	No
AES / Guayama	AES1	Coal	ST	227	Yes[2]	Yes	No
AES / Guayama	AES2	Coal	ST	227	Yes[2]	Yes	No
EcoEléctrica / Peñuelas	EcoElect1	NG	CC	507	No	Yes	No

Source: Siemens and TRC
[1] These units (oil-fired CC/CT's) are not subject to the finalized 40 CFR 60 subpart UUUU and 79 FR 65482.
[2] PREPA is not responsible for MATS compliance of this unit.
[3] In the August 3, 2015 published rule, Puerto Rico is currently excluded from the CPP section 111(d) regulation. See Section 1.1.2.1 for extended discussion.

Table 1-3: Planned New EGUs and Applicable Air Regulatory Drivers

New EGUs	Status	Fuel	Type	Capacity (MW)	MATS	CPP[1]	GHG Standards	NSPS	NSR	
									PSD	NNSR
Aguirre CC 1 & 2 Gas Turbine Replacement/Repower	Replaces AGCC1 and AGCC2	Diesel or NG	CC	> 250	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No
Aguirre 1 & 2 HFCC Repower	Upgrades AGUIRRE1 and AGUIRRE2	Diesel or NG	CT	> 250	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No
Costa Sur 5 & 6 HFCC Repower	Upgrades SOUCOU5 and SOUCOU6	NG	CT	> 250	No	Yes	Yes	Yes	Yes	No
F Class CC (GE S107F.05)	Replaces AGUIRRE1 and AGUIRRE2 and SOUCOU5 and SOUCOU6	Diesel or NG	CC	> 250	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No
G/H Class CC (Siemens SCC6-8000H)	Replaces AGUIRRE1 and AGUIRRE2 and SOUCOU5 and SOUCOU6	Diesel or NG	CC	> 250	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No
F Class CC (GE S107F.05)	New (Palo Seco)	Diesel or NG	CC	> 250	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No
Siemens SCC-800	New	Diesel or NG	CC	< 73	No	Yes	Yes (NG) No (Diesel) [2]	Yes	Yes	No

Source: Siemens and TRC
[1] In the August 3, 2015 published CPP rule, Puerto Rico is currently excluded from the CPP section 111(d) regulation. See Section 1.1.2.1 for extended discussion.
[2] In the August 3, 2015 published GHG Standards rule, units not connected to NG pipelines are exempt.

1.1.1 MATS

EPA issued its final National Emission Standards for Hazardous Air Pollutants (NESHAPS) rule under Section 112, renamed the Mercury and Air Toxics Standards (MATS) on February 23, 2012. This rule applies to EGUs that are coal-fired or oil-fired electric utility steam generating units, and does not apply to units that burn natural gas exclusively, or that burn natural gas in combination with another fuel where natural gas constitutes 90% or more of the average annual heat input during any 3 calendar years, or 85% or more of the annual heat input during any 1 calendar year. In addition, the MATS rule does not apply to new or existing stationary combustion turbines with a rated peak power output of at least 1 MW that are located at a Major Source of hazardous air pollutants (HAPs). Table 1-4 summarizes all MATS-applicable EGUs.

Table 1-4: Description of MATS-applicable Sources

EGU Type	Is MATS Applicable?	EGU Description
Coal- or Oil-Fired	Yes	Any coal-fired or oil-fired EGU of more than 25 MW that serves as a generator to produce electricity for sale. [1]
Coal- or Oil-Fired - Cogeneration	Yes	Any coal-fired or oil-fired EGU that cogenerates steam and electricity that supplies more than 1/3 of its potential electric output capacity, and more than 25 MWe of output, to any utility power distribution system for sale. [1]
Combustion Turbines	No	New and existing stationary combustion turbines (not including integrated gasification combined cycle turbines) with a rated peak power output of at least 1 MW that are located at a Major Source of HAPs. Stationary combustion turbines include simple cycle stationary combustion turbines, regenerative/recuperative cycle stationary combustion turbines, cogeneration cycle stationary combustion turbines, and combined cycle stationary combustion turbines. A major source of HAP emissions emits or has the potential to emit any single HAP at a rate of 10 tons or more per year or any combination of HAP at a rate of 25 tons or more per year. [2]
Natural Gas-Fired	No	EGUs that are not coal- or oil-fired or IGCC, and combust natural gas for more than 90% average annual heat input for any 3 calendar years, or for more than 85% of the annual heat input during any calendar year. [1]
Limited-Use Liquid Oil-Fired	Yes [3]	EGUs with an annual capacity factor of less than 8 percent of its maximum or nameplate heat input, whichever is greater, averaged over a 24-month block contiguous period commencing April 16, 2015.
Solid Waste Fired	No	Any electric steam generating unit combusting solid waste subject to sections 129 and 111 of the Clean Air Act. [1]

[1] 40 CFR 63, Subpart UUUUU
[2] 40 CFR 63, Subpart YYYY
[3] Limited-Use Liquid Oil-Fired EGUs are subject to all MATS requirements, except for the numerical emission limits.

The MATS limits emissions of heavy metals, including mercury, arsenic, chromium, and nickel, and acid gases, including hydrogen chloride (HCl) and hydrogen fluoride (HF), among others. Starting on April 16, 2012, MATS allows three years for electric power plants to come into compliance with the possibility of an additional year if needed to complete the installation of controls. The Clean Air Act (Section 112(i)(3)(B)) allows the States (PREQB) to grant a 1st year extension of the initial compliance date for those existing units that require additional time for the installation of controls. Also, according to EPA's Enforcement Response Policy of December 16, 2011, the agency may grant an additional 2nd year extension to the initial compliance date for those existing units that may affect reliability due to delay in the installation of controls. On April 21, 2015, EPA denied all remaining requests to reconsider certain aspects of the MATS for power plants. This affirmed the agency's approach in the final MATS rule.

Table 1-5 presents the timeline of compliance with the MATS rule as it stands during the writing of this report.

Table 1-5: Finalized Timeline of MATS

Timeframe	Milestone
April 16, 2015	MATS compliance deadline for existing affected sources.
April 16, 2016	MATS compliance deadline with 1st-year extension.

Timeframe	Milestone
April 16, 2017	MATS compliance deadline with 2nd -year extension.

Source: 40 CFR 63, Subpart UUUUU

In the finalized rule, filterable particulate matter (FPM) may be used as a surrogate for the individual limits of total metallic HAP for liquid oil-fired EGUs. Also, the water content (in percent by weight units) in fuel oil may be used as a surrogate for HCl and HF emissions for the EGUs under the Non-Continental Liquid Oil-Fired category, which is the case of PREPA's units. Table 1-6 lists the finalized limits on FPM, HCl and HF for existing and new steam turbine EGUs on Puerto Rico that burn liquid oil. The timeline and limits listed in Table 1-5 and Table 1-6, respectively, are directly applicable to the PREPA IRP, and were the driving analysis factors within the following air quality regulatory review.

Table 1-6: Finalized MATS Limits for Puerto Rico EGUs

Emission Limitations for Liquid Oil-Fired Steam Turbine EGUs in Puerto Rico						
Pollutant	Filterable Particulate Matter (FPM) [1]		Hydrogen Chloride (HCl) [2] [3]		Hydrogen Fluoride (HF) [2] [3]	
Units	lb/MMBTU	lb/MWh	lb/MMBTU	lb/MWh	lb/MMBTU	lb/MWh
Subcategory						
Existing	0.030	0.30	0.00020	0.0020	0.000060	0.00050
New	-	0.20	-	0.0020	-	0.00050

[1] FPM used as surrogate for total HAPs metals and individual HAPS per Subpart UUUUU
[2] Not used in compliance analysis – no data available for these pollutants.
Source: 40 CFR 63, Subpart UUUUU
[3] A water content in fuel oil limit of 1%/wt applies to Non-Continental Liquid Oil-Fired EGUs that choose it as a surrogate for HF and HCl emission limits.

On June 29, 2015, the United States Supreme Court ruled that EPA erred by failing to consider costs when deciding whether it was "appropriate and necessary" to regulate emissions under MATS. Although EPA considered costs when deciding *how* to regulate power plants (*e.g.*, with respect to the cost of controls), the Supreme Court found that EPA was required to consider costs in the initial decision to regulate power plants.

In its decision, the Supreme Court did not invalidate the MATS rule and, as a result, all applicable power plants continue to be legally obligated to meet the MATS. The Supreme Court simply returned the rule to the DC Circuit Court of Appeals (lower court) to determine the appropriate remedy, a process that could take up to a year to complete. The lower court will either send the rule back to EPA to correct the deficiencies outlined by the Supreme Court (a remand) or invalidate the rule completely (a vacatur). Because MATS still remains in effect, PREPA will continue to work to modernize its power system and achieve permanent, consistent compliance with the Clean Air Act. For the purposes of this review report, we consider the MATS to still be in effect and applicable.

PREPA has 14 steam electric units located at four sites in Aguirre, Costa Sur, Palo Seco and San Juan power complexes, as can be noted in Table 1-1. These steam units are subject to MATS compliance requirements. As discussed in Section 2 below, the

compliance strategy presented within Siemens' IRP for PREPA for these units is either retirement, operate them as per MATS limited-use liquid oil-fired category (less than 8% heat input capacity factor averaged over 24 month block periods), or converting to primarily natural gas firing and thus exempting out from MATS.

PREPA's four combined cycle (CC) units (Aguirre 1&2 CC and San Juan 5&6 CC) along with the 25 CT units (Cambalache 1-3, Mayaguez 1-4 and 18 distributed CT fleet) are not subject to MATS, and are assumed to continue operation in all Portfolios and Futures. To supplement its own capacity, PREPA purchases power from two co-generators under the terms and conditions of Power Purchase Operating Agreements (PPOAs) from EcoEléctrica, L.P. and AES-Puerto Rico. PREPA is not responsible for MATS compliance of the AES-Puerto Rico units.

1.1.2 CPP and GHG Standards

1.1.2.1 CPP

On June 2, 2014, EPA issued its proposed Clean Power Plan (CPP) for reducing carbon dioxide (CO_2) emissions from existing plants, in accordance with Section 111(d) of the Clean Air Act. The proposed CPP would establish different target emission rates (lb of CO_2 per megawatt-hour; lb CO_2/MWh) for each U.S. State, due to regional variations in generation mix and electricity consumption, with an overall goal of reducing CO_2 emissions from existing power plants by 30% from 2005 CO_2 emissions levels by 2030.

The proposed regulations provide the regulated jurisdictions with flexibility to achieve compliance through the use of four building blocks: heat rate improvements at coal-fired EGUs, re-dispatch from fossil fuel steam generators to natural gas combined cycle units, reduction in EGU emissions due to increased use of renewable energy, and reductions in EGU emissions due to end-use energy efficiency.

In the Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generation Units, Proposed Rule, (Federal Register, Vol. 79, No. 213) of June 18, 2014, the agency recognizes that territories without ready access to natural gas will require special consideration. On October 28, 2014, EPA issued the *Supplemental Proposed Rulemaking of the Carbon Emission Guidelines for Existing Stationary Sources: EGUs in Indian Country and US Territories* (Supplemental Proposal), proposed pursuant to sections 111(a) and 111(d) of the Clean Air Act (CAA). After thorough review of the proposed rule, on December 19, 2014, PREPA submitted comments to the proposed rule indicating that all four of the building blocks proposed by EPA for the U.S. territories contain inaccurate data and non-feasible assumptions that must be corrected in the final rule (*Comments of the Puerto Rico Electric Power Authority (PREPA) on the Proposed Carbon Emission Guidelines for Existing Stationary Sources: EGUs in Indian Country and US Territories; Multijurisdictional Partnerships, Docket No. EPA-HQ-OAR-2013-0602, FLR-9918-54-OAR***).** As part of its evaluation, PREPA made recommendations necessary so compliance with the Proposed Rule for the U.S. territories is more feasible and achievable. The EPA proposed goals for Puerto Rico are presented in Table 1–8.

As of the writing of this report, EPA has closed the comment period of the proposed rule for Puerto Rico and is following the timeline described in Table 1-7. Under the proposed rule, state jurisdictions (PREQB in the case of Puerto Rico) are required to prepare

implementation plans by June 2016, with the possibility of a 1- or 2-year extension depending on the plan type, and EPA's acceptance of the plans scheduled for 2017. The PREQB Plan must be approved by EPA, based on modeling projections that demonstrate that the Plan will be adequate to meet the state's interim and final goals. Compliance would be phased in over the period 2020 through 2030. The timeline and goals for Puerto Rico under the proposed rule are presented in Table 1-7 and Table 1-8, respectively.

Table 1-7: Proposed Timeline of CPP

Proposed Timeframe	Proposed Milestone
Summer 2015	EPA issues final rules on CPP for existing power plants in Puerto Rico [1]
	EPA issues final rules on Carbon Pollution Standards for new, modified, and reconstructed power plants in Puerto Rico.
	EPA to propose a federal plan for Puerto Rico to meet CPP goals. Public review and comment period to follow. [1]
Summer 2016	Puerto Rico (PREQB) must submit compliance plans to EPA (these can be initial plans containing up to 2 years of extensions). [1]
	EPA issues final federal plan for Puerto Rico to meet CPP goals if Puerto Rico does not submit their own plan or EPA approves the one presented. [1]
Summer 2017	Compliance plans with 1-year extension due, if state is eligible. [1]
Summer 2018	Compliance plans with 2-year extension due, if state is eligible. [1]
Summer 2020	Beginning of CPP compliance period. [1]
Interim Performance Period 2020 to 2029	Interim emission performance required for every 2-rolling calendar years starting January 1, 2010 and ending in 2028. At the end of 2029, Puerto Rico must meet the interim limit averaged over the performance period. [1]
Final Performance Period 2030 and Beyond	Puerto Rico must meet the final emission performance level on a 3-calendar year rolling average starting on January 1, 2030. [1]

Source: 40 CFR 60, Subpart UUUU (Proposed)
[1] In the August 3, 2015 published rule, Puerto Rico is currently excluded from the CPP section 111(d) regulation. See following text for discussion.

Table 1-8: Proposed CPP Limits for Puerto Rico

Period	Years	Performance Level (lb/MWh CO_2)
Interim Performance Period	2020 - 2029	1,470
Final Performance Period	2030 & Beyond	1,413

Source: Federal Register, Vol 79, No. 213, Page 65505
Note: In the August 3, 2015 published rule, Puerto Rico is currently excluded from the CPP section 111(d) regulation. See following text for discussion.

On August 3, 2015, EPA finalized the CPP and submitted the rule for publication in the Federal Register: *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, Docket No. EPA-HQ-OAR-2013-0602*. In the finalized rule, EPA states

> *"Because the EPA does not possess all of the information or analytical tools needed to quantify the [Best System of Emission Reduction] for the two non-contiguous states with otherwise affected EGUs (Alaska and Hawaii) and the two U.S. territories with otherwise affected EGUs (Guam and Puerto Rico), these emission guidelines do not apply to those areas, and those areas will not be required to submit state plans on the schedule required by this final action."*
>
> And
>
> *"We have not in this rule applied the uniform emission performance rates to Alaska, Hawaii, Puerto Rico, or Guam -- states and territories that have otherwise affected EGUs but are isolated from the three major interconnections -- and will determine how to address the requirements of [Clean Air Act] section 111(d) with respect to these jurisdictions at a later time."*

Therefore, at the writing of this report, Puerto Rico is not obliged to create a compliance plan as the proposed rule described above suggested, and the final rule does not yet define performance rates for Puerto Rico. However, for the purposes of this review, the proposed standards for Puerto Rico are applied and used as analysis guidelines since the final rule intimates that standards will likely be developed for Puerto Rico at a later time.

1.1.2.2 GHG Standards

On August 3, 2015, EPA finalized standards of performance for new stationary combustion turbines (commenced construction after January 8, 2014) for the control of greenhouse gas (GHG) emissions from electric utility generating units that were constructed with the ability to sell at least 25 MW to a utility distribution system. This subpart applies to combustion turbine units with a design heat input capacity greater than 260 GJ/hr (250 MMBTU/hr) and created standards for three sub-categories of units based on net-electric sales and fuel types used. Oil-fired CT units that do not have natural gas supply (for instance in a Future 2 scenario) are exempt. The finalized GHG standards define CO_2 as the GHG to be regulated with emissions limits specified as those presented in Table 1-9 below. Since all new applicable NGCC units in this Project will be operated as base load units, the 1,000 lb CO_2/MWh compliance standard applies to each unit.

Table 1-9: Finalized GHG Standards for Affected Combustion Turbines

Affected EGUs	Emission Standard (12-operating-month rolling average basis)
New and reconstructed base load natural-gas fired units [1]	1,000 lb/MWh CO_2
Non-base load natural gas-fired units [1]	120 lb CO_2/MMBtu input [2]
Multi-fuel-fired units [3]	120 -160 lb CO_2/MMBtu input [2]

[1] Combust > 90% natural gas on a heat input basis on a 12-operating month rolling average basis
[2] Non-base load units need to meet a clean fuels input-based standard.
[3] Combusts ≤ 90% natural gas on a heat input basis on a 12-operating-month rolling average basis. Units not connected to NG pipeline are exempt.

1.1.3 NSPS

EPA has set standards of performance for new stationary sources (i.e., new source performance standards; NSPS) for specific source categories. These standards are contained in 40 CFR Part 60, and apply to new, modified, and reconstructed facilities as defined in the regulation. The following is a discussion of the NSPS issued for sources that combust fossil fuels and their applicability to the PREPA IRP.

1.1.3.1 40 CFR Part 60 Subpart A – General Provisions

These general provisions apply to owners or operators of any stationary source subject to a NSPS subpart, as referenced by the applicable subpart.

1.1.3.2 40 CFR 60 Subpart Da – Standards of Performance for Electric Utility Steam Generating Units

This regulation applies to electric steam generating units for which construction, modification, or reconstruction is commenced after June 9, 1989 which have a maximum design heat input capacity of greater than 72 MW (250 MMBTU/hr). There are proposed units with heat input capacities greater than this threshold and the subpart is applicable to those units. Units subject to subpart KKKK (see discussion below) are exempt from subpart Da.

1.1.3.3 40 CFR 60 Subpart GG – Standards of Performance for Stationary Gas Turbines

This regulation applies to stationary combustion turbines (CTs) with a heat input at peak load equal to or greater than 10.7 gigajoules per hour [10 Million British thermal units per hour (MMBTU/hr)], based on the lower heating value of the fuel fired, which commence construction, modification, or reconstruction after October 3, 1977. 40 CFR 60 Subpart KKKK (see discussion below) states that stationary CTs regulated under Subpart KKKK are exempt from the requirements of Subpart GG. The PREPA IRP CTs would be subject to Subpart KKKK, and hence are exempt from the requirements of Subpart GG.

1.1.3.4 40 CFR 60 Subpart KKKK – Standards of Performance for Stationary CT

Subpart KKKK applies to stationary CTs with heat input ratings greater than or equal to 10 MMBTU/hr, which commence construction, reconstruction, or modification after February 18, 2005. Subpart KKKK would apply to all CTs proposed as part of the IRP. The standards are as follows:

- The NSPS for Nitrogen Oxides (NO_x) allow the CT owner or operator the choice of a concentration-based or output-based emission standard. The concentration-based limit is expressed in units of parts per million by volume, dry basis at 15 percent oxygen (ppmvd @ 15% O2). The output-based emission limit is expressed in units of mass per unit of useful recovered energy; either nanograms per Joule (ng/J), or pounds per megawatt-hour (lb/MWh). For electric generating units, the limits are as follows:

Table 1-10: Limits to NO_x Emissions for Electric Generating Units

Heat Input at Peak Load (MMBTU/hr)	Natural Gas		Oil	
	ppmvd @ 15% O_2	lb/MW-hr	ppmvd @ 15% O_2	lb/MW-hr
≤ 50	42	2.3	96	5.5
> 50 and ≤ 850	25	1.2	74	3.6
> 850	15	0.43	42	1.3

- The NSPS for sulfur dioxide (SO_2) are the same for all CTs regardless of size or fuel type. The standard for CTs located in non-continental areas of the United States prohibits the discharge into the atmosphere of any gases that contain SO_2 in excess of 780 ng/J (6.2 lb/MWh) gross energy output. The owner of a CT can choose to comply either with the SO_2 limit itself or with a limit on the sulfur content of the fuel. For a CT located in a non-continental area, the emission limit is 180 ng SO_2/J (0.42 lb SO_2/MMBTU) heat input.

1.1.4 NSR/PSD/NNSR

New Source Review (NSR) is a preconstruction permitting program that includes Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NNSR).

1.1.4.1 NNSR

NNSR applies to new major sources or major modifications at existing major sources for pollutants where the area in which the source is located is not in attainment with a National Ambient Air Quality Standard (NAAQS).

On June 3, 2011, the Puerto Rico Environmental Quality Board (PREQB) sent a letter to EPA recommending that EPA designate several areas within Puerto Rico as “nonattainment” with respect to the 1-hour average SO2 NAAQS. Later, on March 26, 2012, PREQB revised their recommendation to EPA for a designation of “unclassifiable” for the same areas with respect to SO_2. Regarding this determination, the areas classified as “unclassifiable” are treated by EPA as “attainment” areas. Therefore, EPA responded to these recommendations on February 3, 2013, by stating that no change from the previous designation of “attainment” with respect to SO_2 NAAQS would be made. Thus, Puerto Rico remains in attainment of the SO_2 NAAQS.

At the time of this report, EPA is considering whether to establish a previously proposed 8-hour average NAAQS for ozone at a concentration ranging from 65 to 70 ppb. Presently, all of Puerto Rico is in attainment with respect to the current ozone NAAQS (75 ppb). Puerto Rico’s monitoring data from the two ozone stations [Cataño (monitor 72-033-0008) and Juncos (monitor 72-077-0001); http://www.epa.gov/airdata/] was downloaded for years 2012 through 2014. The statistical ozone concentration values (annual fourth-highest daily maximum 8-hr concentration, averaged over these three years) at the Cataño and Juncos monitoring stations are 32 and 39 ppb respectively. These concentrations are well below the low end of that proposed ozone standard range. Since in the design of the analyzed cases within this report, older power plants will be either upgraded, operationally reduced, retired, or replaced with newer plants having applied Best Available Control Technology (BACT), implementation of the

Portfolio options discussed in this regard would not impede Puerto Rico's continued compliance with proposed ozone NAAQS.

With respect to other criteria pollutants, the only nonattainment area in Puerto Rico is the Arecibo Municipality, which is listed as nonattainment for lead. The Project facilities would have no (in the case of natural gas-fired units) or at worse insignificant (in the case of oil-fired units) lead emissions. Consequently, NNSR is not an issue for the Project.

1.1.4.2 NSR/PSD

PSD applies to new major sources or major modifications to existing major sources for pollutants where the area in which the source is located is in attainment or unclassifiable with a NAAQS. A major source is a source that:

- emits or has the potential to emit (PTE) 250 tons per year (tpy) or more of any pollutant regulated under the Clean Air Act (CAA), or
- emits or has the PTE 100 tpy or more of any pollutant regulated under the CAA if the source belongs to one of the 28 source types with a 100 tpy major source threshold.

The source types or categories with a 100 tpy major source threshold include fossil fuel-fired boilers (or a combination thereof) with a heat input capacity totaling 250 MMBTU/hr or greater, and fossil fuel-fired steam electric plants (including combined-cycle turbines) with heat input capacity of 250 MMBTU/hr or greater.

A project at an existing major source is considered a major modification for a regulated NSR pollutant if it causes:

- a significant emissions increase, and
- a significant net emissions increase at the source.

Electric Utility Steam Generating Units (EUSGUs) may apply the Wisconsin Electric Power Company (WEPCO) test to determine if a modification to an existing emission unit is a major modification. For the WEPCO test, future actual annual emissions minus baseline actual emissions are compared to the significant emissions increases. For EUSGUs, baseline actual emissions are based on any consecutive two-year period within the 5 years immediately preceding the project.

The future actual emissions are the post-modification hourly emission rate (taking into account any legally enforceable restrictions) multiplied by the projected annual utilization level, considering both the expected and highest projections of the business activity that could be expected to be achieved and that are consistent with information the company publishes for business-related purposes.

A project or modification that is subject to PSD review is required to consider:

- Installation of the BACT for each affected emissions unit and pollutant. BACT is an emissions limitation which is based on the maximum degree of control that can be achieved, considering energy, environmental, and economic impacts.

- An air quality impact analysis to demonstrate that new emissions from a proposed major stationary source or major modification, in conjunction with other applicable emissions increases and decreases from existing sources, will not cause or contribute to a violation of any applicable NAAQS or PSD allowable increment concentration.

- An additional impacts analysis to assess the impacts of air, ground and water pollution on soils, vegetation, and visibility caused by any increase in emissions of any regulated pollutant from the source or modification under review, and from associated growth.

- Opportunities for members of the public to comment on and request a public hearing on a permit before it is issued, and appeal a permit after it is issued.

Based on the Siemens-provided emission rates for the new combustion turbines, PSD permitting could be required for each of the projects being proposed and noted in Table 1-11. Based on those emission rates, that result would pertain to each project whether it could be configured and classified as a new major source or as a major modification to an existing major source. It should be noted, however, that the calculations and inferences presented in Table 1-11 are based on rough emission rate estimates and technology that will likely evolve in future years, allowing for lower emission rates with improved controls. In addition, netting of new project potential emissions with qualifying reductions in actual emissions from existing units could result in net tons per year emission increases that are below the applicable PSD thresholds. A conservative review of the data implies that no simple path is available to determine the likelihood of avoiding PSD permitting for these projects. Further analysis should be done for each proposed site during the pre-permitting process to evaluate strategies with the possibility of netting out of PSD.

Table 1-11: New Combine Cycle Units and Estimated PSD Applicable Thresholds

New Combine Cycle Units	Fuel	No. of New Units	Unit Capacity	Heat Rate	Total Capacity	Siemens-Provided Emission Rates				Potential Emission Totals				Exceed a PSD threshold for at least one criteria pollutant?
						FPM	NO_X	SO_X	CO	FPM[1]	NO_X	SO_X[2]	CO	
			MW/unit	Btu/kWh HHv	MW	lb/MMBTU	lb/MMBTU	lb/MMBTU	lb/MMBTU	tpy	tpy	tpy	tpy	Yes/No
Aguirre CC 1 & 2 Gas Turbine Replacement/Repower	Natural Gas	2	263	7582	527	0.004	0.009	0.000	N/A	70	160	0	N/A	Yes
	Diesel		255	7368	510	0.020	0.016	0.051	N/A	329	267	840	N/A	Yes
Aguirre F Class CC (GE S107F.05) (Duct Fired)	Natural Gas	1	369	7310	369	0.004	0.009	0.000	N/A	47	108	0	N/A	Yes
	Diesel		359	7065	359	0.020	0.016	0.051	N/A	222	180	566	N/A	Yes
Aguirre H Class CC (Siemens SCC6-8000H) (Duct Fired)	Natural Gas	1	393	6979	393	0.004	0.009	0.000	N/A	48	110	0	N/A	Yes
	Diesel		342	7361	342	0.020	0.016	0.051	N/A	221	179	562	N/A	Yes
Costa Sur F Class CC (GE S107F.05) (Duct Fired)	Natural Gas	1	369	7310	369	0.004	0.009	0.000	N/A	47	108	0	N/A	Yes
	Diesel		359	7065	359	0.020	0.016	0.051	N/A	222	180	566	N/A	Yes
Costa Sur H Class CC (Siemens SCC6-8000H) (Duct Fired)	Natural Gas	1	393	6979	393	0.004	0.009	0.000	N/A	48	110	0	N/A	Yes
	Diesel		342	7361	342	0.020	0.016	0.051	N/A	221	179	562	N/A	Yes
Palo Seco F Class CC (GE S107F.05) (Duct Fired)	Natural Gas	1	369	7310	369	0.004	0.009	0.000	N/A	47	108	0	N/A	Yes
	Diesel		359	7065	359	0.020	0.016	0.051	N/A	222	180	566	N/A	Yes
Palo Seco Siemens SCC-800 (Duct Fired)	Natural Gas	3	72	8031	216	0.004	0.009	0.000	N/A	30	70	0	N/A	Yes
	Diesel		66	7764	198	0.020	0.016	0.051	N/A	135	109	343	N/A	Yes
Aguirre HFCC Repower CT	Diesel	2	93[3]	9200	1085	0.020	0.016	0.051	N/A	149	121	381	N/A	Yes
	Natural Gas		93[3]	9200	1085	0.004	0.009	0.000	N/A	30	68	0	N/A	Yes
Costa Sur HFCC Repower CT	Natural Gas	2	93[4]	9200	1005	0.004	0.009	0.000	N/A	30	68	0	N/A	Yes
							New major source threshold for combined cycle power generation			**100**	**100**	**100**	**100**	
							Modification at existing major source threshold			**10**	**40**	**40**	**100**	

Source: Siemens provided the emission rates, heat rate, and capacity data via email from PACE and via PROMOD "MATS & Rep" sheet. N/A indicates the data was not available for analysis.
[1] Assumed the lower PSD threshold associated with $PM_{2.5}$ as applicable to FPM. Emission limits of 0.03 and 0.014 lb/MMBTU, to account for both filterable and condensable $PM_{2.5}$, may be more appropriate for diesel and natural gas firing, respectively.
[2] For diesel, the PACE SOx emission rate is based on a fuel sulfur content of 0.05% by weight; a fuel sulfur content limit of 0.0015% may be required. For natural gas, the PACE SOx emission rate is assumed to be zero; a fuel sulfur content of 0.0012%, which is equivalent to a fuel sulfur content of 10 mg/Nm^3 would be more appropriate.
[3] New capacity (543 MW) - Original capacity (450 MW)
[4] New capacity (503 MW) – Original capacity (410 MW)

Section

2

Air Quality Review

The following review on the proposed portfolios for the Future 2 and 3 conditions is based on the "Final" versions of the Siemens-supplied PROMOD output results summary sheets. Any discussion of compliance with respect to a regulatory limit is based solely on data extracted from the "Final" PROMOD data-sets and is applicable only to those output analyses.

In the following analyses, "Total Puerto Rico Generation" in CO_2 pounds per megawatt-hour (lb/MWh) was calculated as total CO_2 emissions (lb) from all purchased-power, new-build, and existing PREPA EGUs divided by the total gross electrical generation (MWh) from all EGUs (including renewables). This rate was then compared to the proposed performance level in Table 1-8. As the proposed CPP rule for Puerto Rico did not define mass-based goals, and the final rule defines neither rate nor mass-based goals for Puerto Rico, the CPP analysis focused on rate-based comparisons to the proposed rule. Likewise, individual units' CO_2 emissions were compared on a rate basis against the finalized GHG standards by dividing total CO_2 emissions (lb) by the associated generation (MWh) for each unit.

The calculated rates (lb/MWh CO_2) used in the comparisons can be found in Appendix C of Volume I. Although mass-based calculations were not analyzed, as no comparison standard for Puerto Rico has been defined, PREPA calculated mass of CO_2 (tons) associated with each unit as requested by the Puerto Rico Energy Commission. This information can be found in Appendix C of Volume I.

Discussion is offered at the end of this section by Siemens regarding cases where new units are non-compliant with the applicable GHG standards.

2.1 Selection of Portfolio and Futures to Be Reviewed

All Portfolios under all Futures comply with MATS rules by design and the key consideration in selecting the combination of portfolios and futures to be reviewed in detail in this volume is compliance with the GHG regulation (40 CFR 60 subpart UUUU and TTTT, see section 1.1.2 above). The GHG regulation defines individual unit limits based on the ratio of lb of CO_2 per MWh, and this ratio, for the same machine, is higher with a lower dispatch level. This is due to the double impact of a higher heat rate at partial load and more frequent starts. The GHG regulation does not apply to new CC or CT units burning distillate (LFO).

The table below shows for each combination of Portfolio and Future, the new generation that is proposed both at the north and the south of the island, as well as the fuel that will be burning and the dispatch level (higher or lower than in other Futures) from the PROMOD runs. Based on this, the table indicates the risk of finding compliance issues.

The table also indicates the cases where the other total emissions of other pollutants (NO_x, SO_x and FPM) are likely to be higher.

As can be observed in Table 2-1, under Future 1, the GHG regulation does not apply to the units in the north of the island, since those units do not burn natural gas. In the south, the units are expected to have a much higher dispatch than in Future 3. In Future 3, where there is gas in the north, the southern units would have to compete with the units in the north, resulting in a lower dispatch and higher risk of non-compliance with the GHG standards. This means that, if there are issues identified in Future 3 with respect to GHG standards, these are expected to be less severe in Future 1.

Finally, the total emissions of other pollutants (NO_x, SO_x and FPM) in tons are higher when the machines burn LFO and run longer periods of time (higher dispatch). This situation arises on Future 2 where LFO is the prevalent fuel in Puerto Rico, forcing higher dispatch levels for the units burning this fuel across the island.

Based on the above, the discussion in this document will center on Future 2 and Future 3. For an overview of emission results for all combinations of Futures and Portfolios, please see Volume I.

Table 2-1: Expected Performance by Combination of Portfolios and Futures

	Generation						Risk of worse Performance				
	North		South				North		South		
	SSC 800	F-Class	Repower	AG CC Repower	F-Class	H-Class	CO2	SOX,NOX,FPM	CO2	SOX,NOX,FPM	Dicussed
P1F1	Y-LFO-Low D	No	Y-NG-Higher D	Y-NG-HigherD	No	No	N/A	Lower (Low D)	Lower (High D)	Lower (NG)	NO
P1F3	Y-NG-Higher D	No	Y-NG-Lower D	Y-NG-Lower D	No	No	Only Case	Lower (NG)	Higher (Low D)	Lower (NG)	Yes
P1F4	Y-LFO-Low D	No	Y-NG-Higher D	Y-NG-Higher D	No	No	Similar to P1F1				NO
P2F1	Y-LFO-Low D	No	No	Y-NG-Higher D	Y-NG-Higher D	No	N/A	Lower (Low D)	Lower (High D)	Lower (NG)	NO
P2F2	Y-LFO-Higher D	No	No	Y-LFO-HigherD	Y- Higher D; NG CS 5&6, LFO AG 1&2	No	N/A	Higher (LFO - High D)	Lower (High D)	Higher (LFO - High D)	YES
P2F3	Y-NG-Higher D	No	No	Y-NG-Lower D	Y-NG-Lower D	No	Only Case	Lower (NG)	Higher (Low D)	Lower (NG)	YES
P2F4	Y-LFO-Low D	No	No	Y-NG-Higher D	Y-NG-Higher D	No	Similar to P2F1				
P3F1	No	Y-LFO-Low D	No	Y-NG-Higher D	No	Y-NG-HigherD	N/A	Lower (Low D)	Lower (High D)	Lower (NG)	NO
P3F2	No	Y-LFO-Higher D	No	Y-LFO-HigherD	No	Y- Higher D; NG CS 5&6, LFO AG 1&2	N/A	Higher (LFO - High D)	Lower (High D)	Higher (LFO - High D)	Yes
P3F3	No	Y-NG-Higher D	No	Y-NG-Lower D	No	Y-NG-Lower D	Only Case	Lower (NG)	Higher (Low D)	Lower (NG)	YES
P3F4	No	Y-LFO-Low D	No	Y-NG-Higher D	No	Y-NG-Higher D	Similar to P3F1				

Note: Higher D = Higher Dispatch Levels than in other futures. Lower D = Lower Dispatch Levels than in other futures

2.2 Future 2

In the Future 2 scenario, natural gas is not available from either the north or the AOGP facility (which is not constructed in this scenario). The repowering option (Portfolio 1) for this Future is an untenable solution given the non-feasibility of repowering without natural gas availability. However, the options of building combined cycle units (Portfolios 2 and 3) as replacements for the Aguirre and Costa Sur steam units are considered feasible by Siemens and are analyzed below.

2.2.1 Portfolio 1 Future 2 (P1F2)

This case of repowering the Aguirre and Costa Sur steam units is not feasible and is excluded from this air quality review.

2.2.2 Portfolio 2 Future 2 (P2F2)

2.2.2.1 MATS

Of the 14 MATS-affected EGUs, six will be operationally limited to less than 8% heat input capacity over a 24-month period (Costa Sur 3&4, Palo Seco 1&2, and San Juan 7&8), and thus be exempt from MATS FPM emission limits compliance, two will already be in compliance with MATS (Costa Sur 5&6), and six will be considered as to be in non-compliance with the MATS limit of 0.030 lb FPM per MMBTU after the 2015 (Palo Seco 3&4 and San Juan 9&10) and 2016 (Aguirre 1&2) compliance deadlines, and must be addressed.

Table 2–2 presents the P2F2 strategy to address the non-compliant MATS-affected EGUs. In this case, the six EGUs considered non-compliant will either undergo retirement and replacement with new F Class 1x1 combined cycle technology running on diesel (Aguirre 1&2), replacement with new combined cycle technology running on diesel (Palo Seco 3 or 4), retirement or limited use operation and replacement with three 1x1 SCC-800 trains (San Juan 9&10 and Palo Seco 3 or 4).

Table 2-2: MATS Compliance Strategy – P2F2 Applicable Units

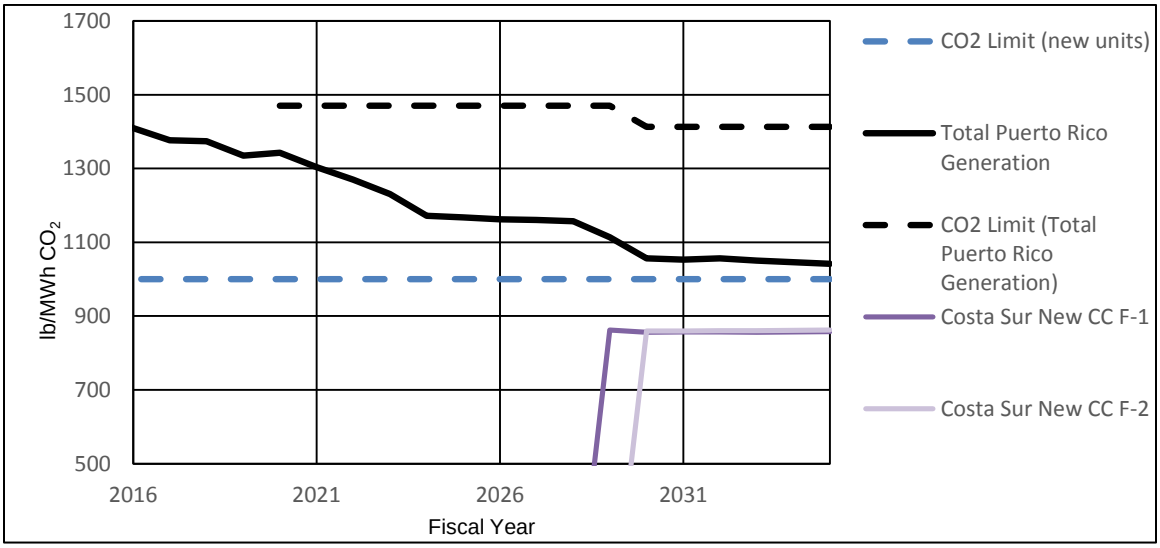
MATS-affected Non-compliant EGU	Compliance Strategy
Aguirre 1	Replacement with MATS-exempt F Class 1x1 CC by FY2022
Aguirre 2	Replacement with MATS exempt F Class 1x1 CC by FY2023
San Juan 9	Retirement or limited use operation by FY2021
San Juan 10	Retirement or limited use operation by FY2021
Palo Seco 3	Retirement or limited use operation by FY2021 upon installation of the new CC.
Palo Seco 4	Retirement or limited use operation by FY2021 upon installation of the new CC.

The new F Class and SCC-800 CC units will not fall under the MATS since they are exempt as CC units. PREPA estimates that MATS compliance will be achieved by FY2023. Since this date is beyond the deadlines for MATS compliance, a negotiated timeline of compliance will have to be agreed upon between PREPA and EPA for these units.

2.2.2.2 CPP and GHG Standards

Figure 2-1 presents the CO_2 emission rate compared to applicable standards Subparts UUUU (Proposed Rule) and TTTT. As can be noted, the total generation within Puerto Rico falls below the interim and final compliance limits starting at 2020 and extending through the future scenario. In addition, the new EGUs that will be affected by the GHG Standard fall below their applicable limit (1,000 lb/MWh). Thus, the P2F2 case is estimated to be in compliance with respect to the proposed CPP and the GHG Standards.

Figure 2-1: CPP and GHG Standards Compliance Evaluation – P2F2 Applicable Units



Note: See Appendix C in Volume I for data presented above.

2.2.3 Portfolio 3 Future 2 (P3F2)

2.2.3.1 MATS

Of the 14 MATS-affected EGUs, six will be operationally limited to less than 8% heat input capacity (Costa Sur 3&4, Palo Seco 1&2, and San Juan 7&8) and thus be exempt from MATS FPM emission limit compliance, two will already be in compliance with MATS (Costa Sur 5&6), and six will be considered as to be in non-compliance with the MATS limit of 0.030 lb FPM per MMBTU after the 2015 (Palo Seco 3&4 and San Juan 9&10) and 2016 (Aguirre 1&2) compliance deadlines, and must be addressed.

Table 2-3 presents the P3F2 strategy to address the non-compliant MATS-affected EGUs. In this case, the six EGUs considered non-compliant will either undergo replacement with new G/H Class 1x1 combined cycle technology running on diesel (Aguirre 1&2 and Palo Seco 3 or 4), retirement or limited use operation (San Juan 9&10 and Palo Seco 3 or 4) after replacement with one train of 1x1 CC technology.

Table 2-3: MATS Compliance Strategy – P3F2 Applicable Units

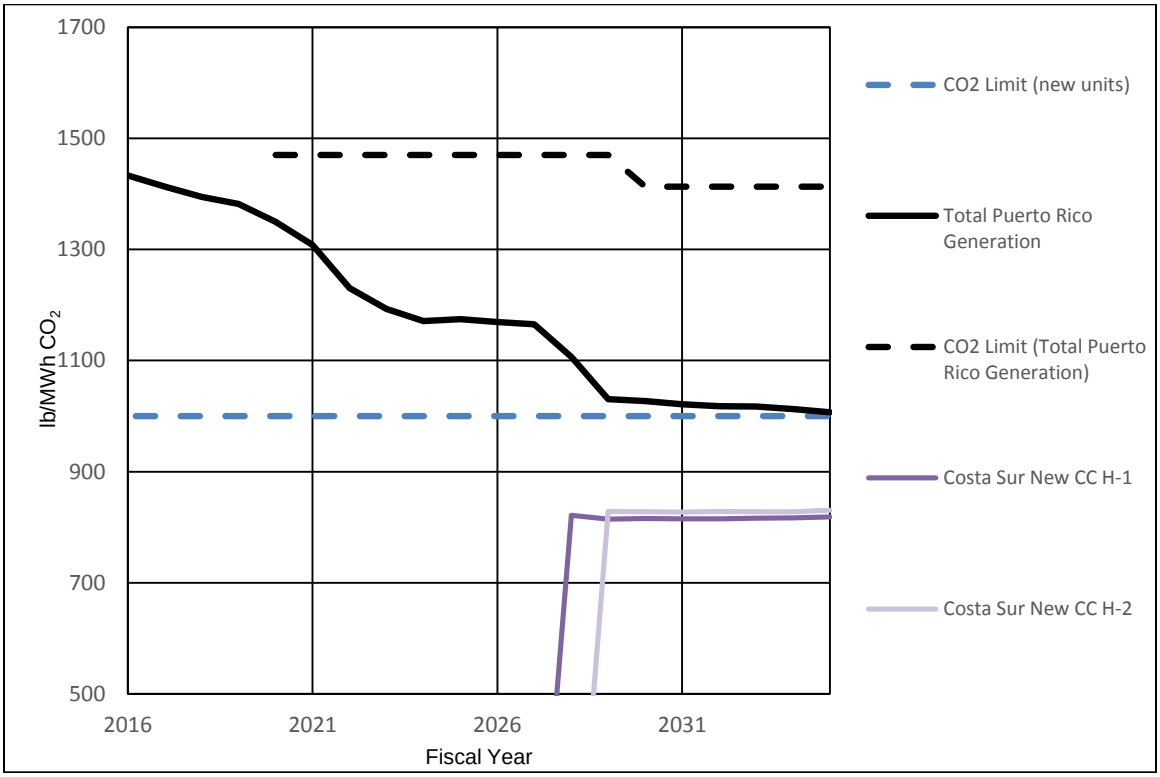
MATS-affected Non-compliant EGU	Compliance Strategy
Aguirre 1	Replacement with MATS-exempt G/H Class 1x1 CC by FY2021
Aguirre 2	Replacement with MATS exempt G/H Class 1x1 CC by FY2022
San Juan 9	Retirement or limited use operation by FY2021
San Juan 10	Retirement or limited use operation by FY2021
Palo Seco 3	Retirement or limited use operation by FY2021 upon installation of the new CC.
Palo Seco 4	Retirement or limited use operation by FY2021 upon installation of the new CC.

The new G/H Class CC units will not fall under the MATS rule since they are exempt as CC units. PREPA estimates that MATS compliance will be achieved by FY2022. Since this date is beyond the deadlines for MATS compliance, a negotiated timeline of compliance will have to be agreed upon between PREPA and EPA.

2.2.3.2 CPP and GHG Standards

Figure 2-2 presents the CO_2 emission rate compared to applicable standards Subparts UUUU (Proposed Rule) and TTTT. As can be noted, the total generation on Puerto Rico falls below the interim and final compliance limits starting at 2020 and extending through the future scenario. In addition, the new EGUs that will be affected by the GHG Standard fall below their applicable limit (1000 lb/MWh). Thus, the P3F2 case is estimated to be in compliance with respect to the proposed CPP and the GHG Standards.

Figure 2-2: CPP and GHG Standards Compliance Evaluation – P3F2 Applicable Units



Note: See Appendix C in Volume I for data presented above.

2.3 Future 3

Future 3 describes an anticipated scenario where the AOGP facility is constructed and online in 2017. In addition, the North Gas Supply is available by 2022. This fuel availability allows for repowering, fuel conversion, and replacement of units with combined cycle technology to achieve improved efficiency and environmental compliance.

2.3.1 Portfolio 1 Future 3 (P1F3)

2.3.1.1 MATS

Of the 14 MATS-affected EGUs, six will be operationally limited to less than 8% heat input capacity (Costa Sur 3&4, Palo Seco 1&2, and San Juan 7&8), and thus be exempt from MATS FPM emission limits compliance, two will already be in compliance with MATS (Costa Sur 5&6), and six will be considered as to be in non-compliance with the MATS limit of 0.030 lb FPM per MMBTU after the 2015 (Palo Seco 3&4 and San Juan 9&10) and 2016 (Aguirre 1&2) compliance deadlines, and must be addressed.

Table 2-4 presents the P1F3 strategy to address the non-compliant MATS-affected EGUs. In this case, the six EGUs considered non-compliant will either undergo conversion to natural gas and become exempt from MATS (Aguirre 1&2), replacement with new combined cycle technology running on natural gas (Palo Seco 3 or 4), retirement or limited use operation (San Juan 9&10 and Palo Seco 3 or 4).

Table 2-4: MATS Compliance Strategy – P1F3 Applicable Units

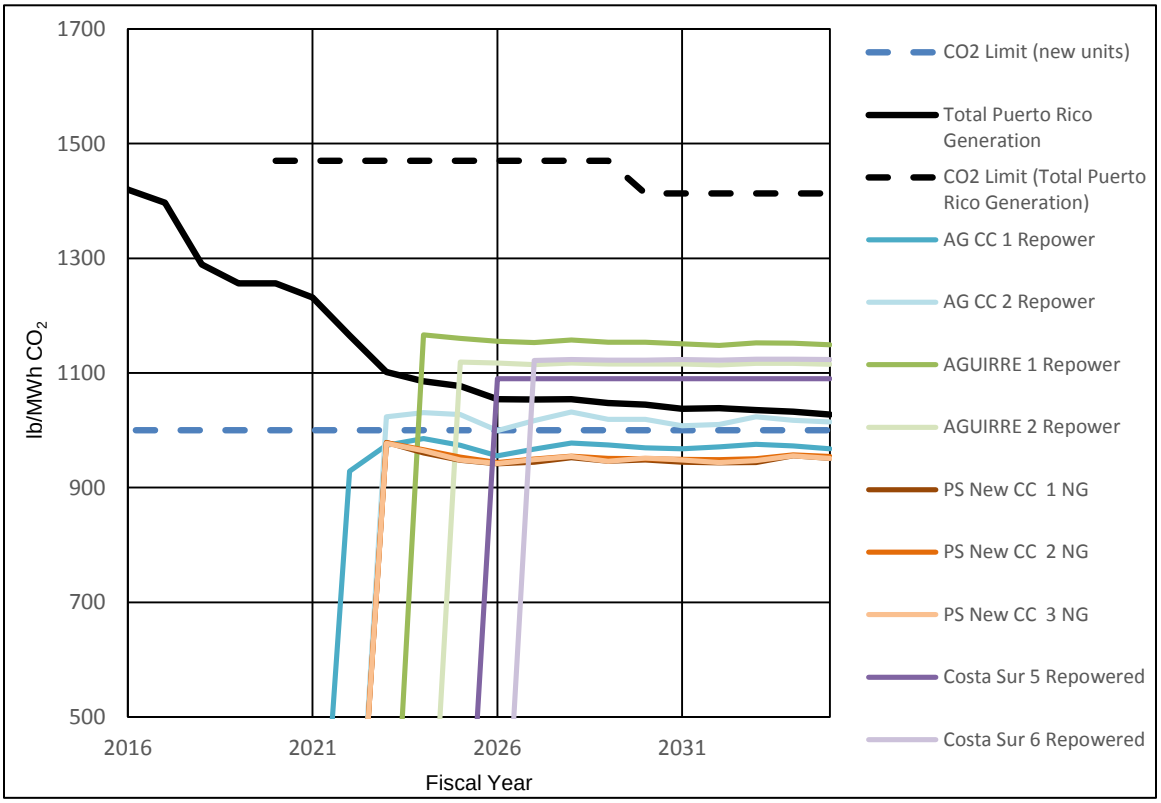
MATS-affected Non-compliant EGU	Compliance Strategy
Aguirre 1	Convert to dual fuel firing (NG and No. 6 Oil) by FY2017
Aguirre 2	Convert to dual fuel firing (NG and No. 6 Oil) by FY2017.
San Juan 9	Retirement or limited use operation by FY2021
San Juan 10	Retirement or limited use operation by FY2021
Palo Seco 3	Retirement or limited use operation by FY2021 upon installation of the new CC.
Palo Seco 4	Retirement or limited use operation by FY2021 upon installation of the new CC.

With the retirement or limited use operation of the San Juan and Palo Seco steam units, PREPA estimates that MATS compliance will be achieved by FY2021. Since this date is beyond the compliance deadlines for MATS, a negotiated timeline of compliance will have to be agreed upon between PREPA and EPA.

2.3.1.2 CPP and GHG Standards

Figure 2-3 presents the CO_2 emission rate compared to applicable standards Subparts UUUU (Proposed Rule) and TTTT. As can be noted, the total generation on Puerto Rico falls below the interim and final compliance limits starting at 2020 and extending through the future scenario. With respect to the new larger units, the Aguirre CC 2 Repower units in addition to the HFCC repowering units installed at Aguirre and Costa Sur exceed the 1,000 lb CO_2/MWh standard and must be addressed. The small Palo Seco units are compliant.

Figure 2-3: CPP and GHG Standards Compliance Evaluation – P1F3 Applicable Units



Note: See Appendix C in Volume I for data presented above.

It is important to note that the finalized GHG standards rule is unclear with respect to HFCC (Heavy Fired Combined Cycle or Hot Wind Box) repowering (e.g. Aguirre 1&2 and Costa Sur 5&6 repowering scenarios). The HFCC may be interpreted as a modification to an existing steam EGU under the finalized GHG standards rule. Under this interpretation, if the modified source's hourly, mass-based CO_2 emissions increase by more than 10%, the GHG standard would be the existing source's best annual CO_2 emission rate since 2002, expressed as lb CO_2/MWh-gross. However, since the HFCC repowering would improve the design heat rate, it is likely the HFCC CO_2 emission rate would meet this standard. Alternatively, if the HFCC units are considered new NGCC, as is suggested in this report, then a permitting strategy could be developed to reach compliance. The new CT that makes up the repowering of these units could be permitted as a component of a combined cycle unit, taking credit for the generation from

the existing unit steam turbine generator attributable to the CT exhaust heat injected into the existing boiler, based on the proportionate amount of steam generated from CT exhaust vs. boiler fuel. This approach likely would allow the new CT to meet the 1,000 lb/MWh CO_2 standard.

2.3.2 Portfolio 2 Future 3 (P2F3)

2.3.2.1 MATS

Of the 14 MATS-affected EGUs, six will be operationally limited to less than 8% heat input capacity (Costa Sur 3&4, Palo Seco 1&2, and San Juan 7&8), and thus be exempt from MATS FPM emission limits compliance, two will already be in compliance with MATS (Costa Sur 5&6), and six will be considered as to be in non-compliance with the MATS limit of 0.030 lb FPM per MMBTU after the 2015 (Palo Seco 3&4 and San Juan 9&10) and 2016 (Aguirre 1&2) compliance deadlines, and must be addressed.

Table 2-5 presents the P2F3 strategy to address the non-compliant MATS-affected EGUs. In this case, the six EGUs considered non-compliant will either undergo conversion to natural gas and become exempt from MATS (Aguirre 1&2), replacement with new combined cycle technology running on natural gas (Palo Seco 3 or 4), retirement or limited use operation (San Juan 9&10 and Palo Seco 3 or 4).

Table 2-5: MATS Compliance Strategy – P2F3 Applicable Units

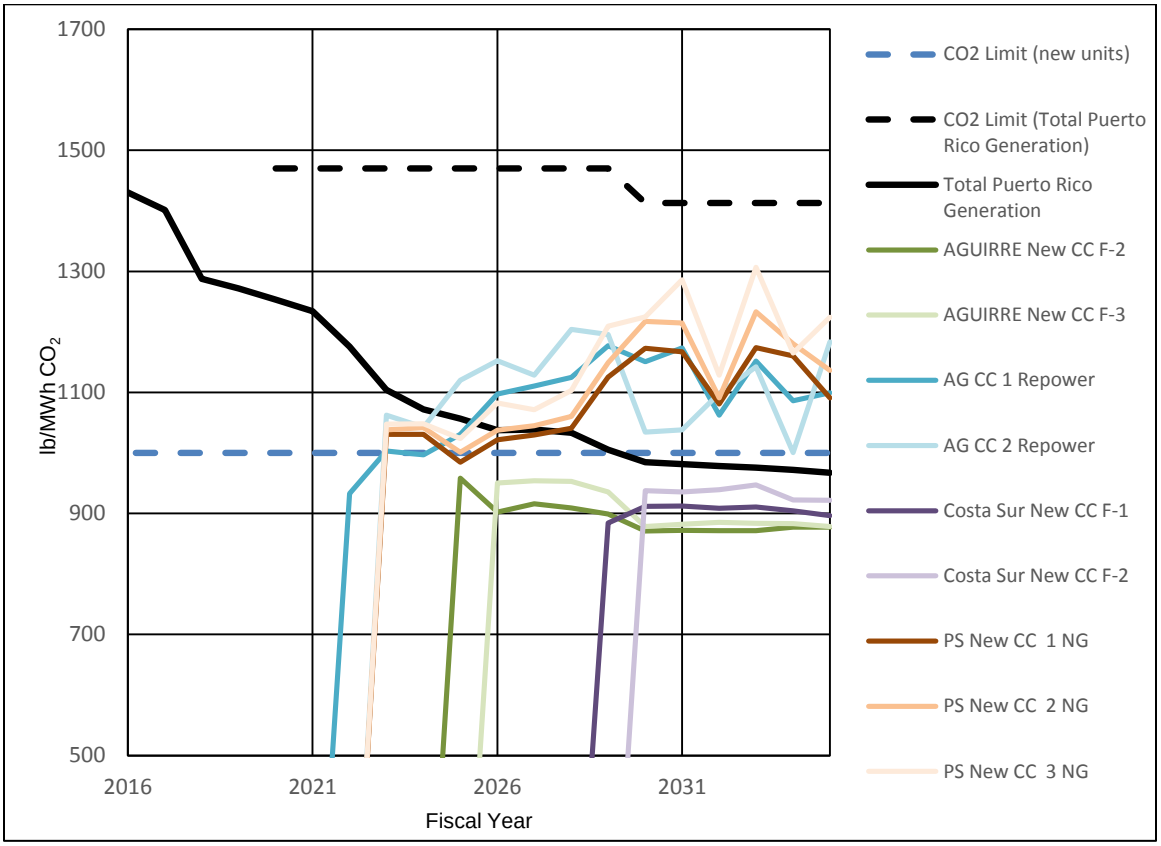
MATS-affected Non-compliant EGU	Compliance Strategy
Aguirre 1	Convert to dual fuel (NG and No. 6 Oil) by FY2017.
Aguirre 2	Convert to dual fuel (NG and No. 6 Oil) by FY2017.
San Juan 9	Retirement or limited use operation by FY2021
San Juan 10	Retirement or limited use operation by FY2021
Palo Seco 3	Retirement or limited use operation by FY2021 upon installation of the new CC.
Palo Seco 4	Retirement or limited use operation by FY2021 upon installation of the new CC.

With the retirement or limited use operation of the San Juan and Palo Seco steam units, PREPA estimates that MATS compliance will be achieved by FY2021. Since this date is beyond the compliance deadlines for MATS, a negotiated timeline of compliance will have to be agreed upon between PREPA and EPA.

2.3.2.2 CPP and GHG Standards

Figure 2-4 presents the CO_2 emission rate compared to applicable standards Subparts UUUU (Proposed Rule) and TTTT. As can be noted, the total generation on Puerto Rico falls below the interim and final compliance limits starting at 2020 and extending through the future scenario. The larger units installed at Aguirre for repowering the CC units are non-compliant and must be addressed. The other larger units are compliant with the standard. The smaller units at Palo Seco exceed the applicable limit beginning in year and must be addressed.

Figure 2-4: CPP and GHG Standards Compliance Evaluation – P2F3 Applicable Units



Note: See Appendix C in Volume I for data presented above.

2.3.3 Portfolio 3 Future 3 (P3F3)

2.3.3.1 MATS

Of the 14 MATS-affected EGUs, six will be operationally limited to less than 8% heat input capacity (Costa Sur 3&4, Palo Seco 1&2, and San Juan 7&8), and thus be exempt from MATS FPM emission limits compliance, two will already be in compliance with MATS (Costa Sur 5&6), and six will be considered as to be in non-compliance with the MATS limit of 0.030 lb FPM per MMBTU after the 2015 (Palo Seco 3&4 and San Juan 9&10) and 2016 (Aguirre 1&2) compliance deadlines, and must be addressed.

Table 2-6 presents the P3F3 strategy to address the non-compliant MATS-affected EGUs. In this case, the six EGUs considered non-compliant will either undergo fuel conversion to dual-fire natural gas and No 6 oil (Aguirre 1&2), replacement with new F Class 1X1 combined cycle technology running on natural gas (Palo Seco 3 or 4), retirement or limited use operation (San Juan 9&10 and Palo Seco 3 or 4).

Table 2-6: MATS Compliance Strategy – P3F3 Applicable Units

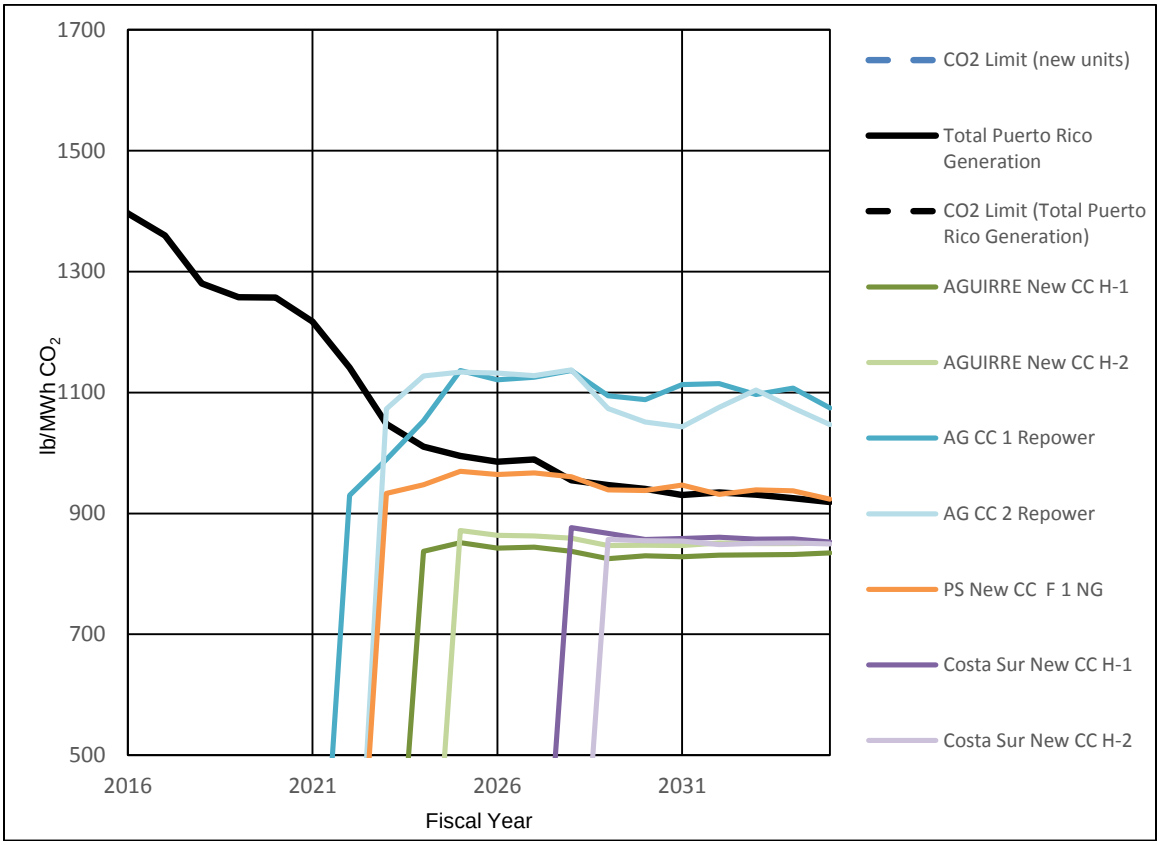
MATS-affected Non-compliant EGU	Compliance Strategy
Aguirre 1	Convert to dual fuel (NG and No. 6 Oil) by FY2017.
Aguirre 2	Convert to dual fuel (NG and No. 6 Oil) by FY2017.
San Juan 9	Retirement or limited use operation by FY2021
San Juan 10	Retirement or limited use operation by FY2021
Palo Seco 3	Retirement or limited use operation by FY2021 upon installation of the new CC.
Palo Seco 4	Retirement or limited use operation by FY2021 upon installation of the new CC.

With the retirement or limited use operation of the San Juan and Palo Seco steam units, PREPA estimates that MATS compliance will be achieved by FY2021. Since this date is beyond the compliance deadlines for MATS, a negotiated timeline of compliance will have to be agreed upon between PREPA and EPA.

2.3.3.2 CPP and GHG Standards

Figure 2-5 presents the CO_2 emission rate compared to applicable standards Subparts UUUU (Proposed Rule) and TTTT. As can be noted, the total generation on Puerto Rico falls below the interim and final compliance limits starting at 2020 and extending through the future scenario. The new larger units installed as the Aguirre CC repowered units exceed the standard and must be addressed. All other units are compliant.

Figure 2-5: CPP and GHG Standards Compliance Evaluation – P3F3 Applicable Units



Note: See Appendix C in Volume I for data presented above.

2.4 Compliance Summary

Table 2-7 summarizes the MATS, CPP, and GHG new source standards for the Future 2 and 3 portfolios. All the cases show planned compliance/exemption with respect to MATS by fiscal year 2024, which is beyond the MATS compliance deadlines. In addition, all the cases show compliance with the Clean Power Plan (CPP) proposed standards for Puerto Rico. The Aguirre CC units and the Aguirre and Costa Sur HFCC units undergoing an upgrade or repowering show non-compliance with respect to the combustion turbine GHG standard (40 CFR 60 subpart TTTT) across multiple cases. In addition, the smaller Palo Seco units are expected to be non-compliant with the applicable Subpart TTTT standard across multiple cases.

Table 2-7: Summary of MATS, CPP, and GHG Compliance

Case	MATS Compliance	CPP Compliance	GHG New Source Standard
P1F2	N/A	N/A	N/A
P2F2	Compliant/Exempt starting in FY2023	Compliant	Compliant
P3F2	Compliant/Exempt starting in FY2022	Compliant	Compliant
P1F3	Compliant/Exempt starting in FY2021	Compliant	Partially-compliant*
P2F3	Compliant/Exempt starting in FY2021	Compliant	Partially-compliant*
P3F3	Compliant/Exempt starting in FY2021	Compliant	Partially-compliant*

* All units comply except Aguirre CC 1&2 repowered, which are non-compliant with respect to the GHG standards. These portfolios can readily achieve compliance as described in Section 2.5, Compliance Strategy.

In the above table, and as stated in the opening paragraphs of Section 2, CPP compliance was determined using a rate-based analysis (lb/MWh) as no mass based standard has been proposed for Puerto Rico under the proposed CPP. In addition, in the final rule, EPA has specifically not published a performance standard for Puerto Rico at this time. See Section 1.1.2.1 for more on the CPP rulings.

Renewable energy and energy efficiency were considered in the study as detailed in the PREPA IRP Volume I, thus its impact in reductions in EGU emissions was factored explicitly in the determination of the emissions and compliance assessed in this report.

2.5 Compliance Strategy

As shown in Table 2-7 above, there are potential compliance issues with all portfolios, with respect of the GHG New Source Standard. In this section we provide strategies to make the portfolios compliant.

As can be observed in Section 2.3, there are potential non-compliance issues due to the Aguirre CC 1&2 repowered that have emission rates above 1,000 lb/MWh. These units are expected to have relatively high heat rates at partial load, as compared with an entirely new combined cycle plant. This is shown in the table below, where we added the expected CO_2 emission rates at the different loading levels. As can be observed, for loading below 70%, the generating units would exceed the CO_2 limits defined by the

GHG New Source Standard. In the PROMOD simulations, the optimization seeks to minimize production costs subject to security constraints, and emission rate limits were not entered as criteria. Thus, as these units had higher heat rates than the H-Class Combined Cycle Plants, they tended to dispatch at partial load in favor of higher production at the H-Class Combined Cycle and start more often, which implies additional fuel consumption. We examined the hourly production for the Aguirre CC 1&2 and, in average, they were dispatched at 53% of its rated capacity.

A strategy to address this issue, which is present in all Portfolios, is forcing the Aguirre Repower units to dispatch higher than 70%, and this can be achieved by including emission's limits in the PROMOD optimization solution. This will result in higher production costs than currently reported, but less production of CO_2 and compliance.

Table 2-8: Average Heat Rate at Various Load Levels and Estimated CO_2 Production

% Loading of Rated Capacity	Average Heat Rate MMBTU/MWh	CO_2 lb/MWh
40%	10.222	1196
50%	9.384	1098
60%	8.804	1030
70%	8.384	981
80%	8.060	943
90%	7.811	914
100%	7.582	887

Regarding Portfolio 1, the finalized GHG standards rule is unclear with respect to HFCC (Heavy Fired Combined Cycle or Hot Wind Box) repowering (e.g. Aguirre 1&2 and Costa Sur 5&6 repowering scenarios). The HFCC may be interpreted as a modification to an existing steam EGU under the finalized GHG standards rule. Under this interpretation, if the modified source's hourly mass-based CO_2 emissions increase by more than 10%, the GHG standard would be the existing source's best annual CO_2 emission rate since 2002, expressed as lb CO_2/MWh-gross. However, since the HFCC repowering would improve the design heat rate, it is likely the HFCC CO_2 emission rate would meet this standard. Alternatively, if the HFCC units are considered new NGCC, as is suggested in this report, then a permitting strategy could be developed to reach compliance. The new CT that makes up the repowering of these units could be permitted as a component of a combined cycle unit, taking credit for the generation from the existing unit steam turbine generator attributable to the CT exhaust heat injected into the existing boiler, based on the proportionate amount of steam generated from CT exhaust vs. boiler fuel. This approach likely would allow the new CT to meet the 1,000 lb/MWh CO_2 standard.