COMMONWEALTH OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCE PLAN	NO. CEPR-AP-2018-0001 **SUBJECT:** PREPA'S COMPLIANCE FILING

PREPA'S COMPLIANCE FILING

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COMES NOW the Puerto Rico Electric Power Authority ("PREPA") and respectfully submits, to the honorable Puerto Rico Energy Bureau (the "Energy Bureau"), PREPA's Compliance Filing in accordance with the Energy Bureau's Resolution and Order of April 26, 2019, Section V, item (i).

1. The Energy Bureau's order of April 26th requires, by today, May 17, 2019, "a compliance filing containing a description of a planned approach to analytically assess the potential to switch from coal fuel to an alternative fuel (such as, but not limited to, biomass, natural gas or oil) at the AES plant in 2020...."

2. PREPA has attached hereto a Memorandum prepared by its independent expert IRP consultants, Siemens, as compliance with the Energy Bureau's above-referenced directive.

3. PREPA respectfully request that the Energy Bureau (or its staff / consultants) provide directives and/or feedback at their earliest convenience regarding the alternatives discussed in the Siemens Memorandum.

WHEREFORE, the Puerto Rico Electric Power Authority respectfully requests that the Honorable Puerto Rico Energy Bureau accept this Compliance Filing and provide directives and/or feedback at its earliest convenience.

RESPECTFULLY SUBMITTED,

IN SAN JUAN, PUERTO RICO, THIS 17th DAY OF MAY, 2019

I HEREBY CERTIFY that on May 17, 2019, I have filed the above filing with the Puerto Rico Energy Bureau in hard copy format at the office of the Clerk of the Puerto Rico Energy Bureau; and that courtesy copies of the filing were sent via email to the Puerto Rico Energy Bureau via email to secretaria@energia.pr.gov and wcordero@energia.pr.gov, and to the office of the Energy Bureau's internal legal counsel via email to legal@energia.pr.gov and sugarte@energia.pr.gov.

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Memorandum

Date: 5/15/2019

To: Efran Paredes

CC:

From: Ken Bean / Nelson J Bacalao

RE: **Options for AES gas conversion**

1 Introduction

The Puerto Rico Energy Bureau (PREB) in its order dated April 26 Ordered PREPA to evaluate the conversion of the AES Puerto Rico coal fired generating facility (AES PR) to burn other fuels, in place of coal, such as biomass, natural gas, oil or others. In the same order PREPA is instructed to file on or before May 17th 2019, a description of a planned approach to analytically assess the potential to switch from coal to the alternative fuels.

In this memo we provide our proposed approach and we selected natural gas as the most viable fuel to be available with the required volumes and reliability to supply a based load plant like AES Coal.

2 AES PR Plant Design

AES PR uses Circulating Fluidized Bed (CFB) Boilers. This was confirmed by review of the air permit data. Also, the plant already has cooling towers, so likely no permit-driven cooling system upgrades would be required in fuel conversion or repowering scenarios.

Quite a few Coal-to-Gas conversions have been performed on US Mainland coal plants in the last 10 years, many driven by MATS. Most such plants are more than 40 years old and have conventional pulverized coal (PC) boilers. Some plants saved money by converting existing coal burners to Natural Gas (NG) firing, others installed new NG burners. A CFB boiler is quite different from a PC boiler in its design and operation, though it basically achieves the same objective of burning coal and capturing the heat in the feedwater to make superheated steam. However, the coal burns as glowing hot particles instead of a flame from a conventional burner. So, for AES PR, new NG burners would be needed. Usually there are oil-fired burners to heat the bed for startup, but more burners would be needed for 100% design heat input from NG.

AES PR boiler steam conditions are conventional, subcritical at 2,400 psig/1000F superheat; reheat is not mentioned. The plant already has Selective Non-Catalytic Reduction (SNCR) for NOx control, (i.e., direct injection of Urea into the combustion gas stream) so this may be helpful in controlling NG NOx. The CFB boiler has limestone injection into the boiler to capture SO2 directly. The AES plant also has a lime scrubber after the boiler to achieve a higher percentage reduction in SO2 than the CFB alone can provide. For NG firing, the lime scrubber probably can be eliminated. The CFB still may require a bed material for heat transfer purposes; if so, possibly this could continue to be limestone or be switched to inert material such as sand.

The specifics of fuel conversion always require a boiler-specific study of heat transfer surfaces, fans, burner controls, etc., often performed by the original boiler supplier. This would be especially true for a CFB boiler. Also, if the converted unit with higher marginal costs operates in a dispatchable mode instead of baseload, this requires study of the possible effects of frequent starts/stops and load changes on overall plant reliability and maintenance.

It is likely the fuel conversion can be done, and we assume for now that the costs would be similar to a PC boiler conversion.

3 Fuel Conversion and Repowering Options:

There are 3 main approaches to Coal-to-Gas conversion that could be considered for AES PR:

1. Convert existing coal boilers to NG firing. This is the most straightforward alternative.

2. Heavily Fired Combined Cycle (HFCC) using a new gas turbine's (GT) exhaust as preheated combustion air to the existing boiler. This option may add 15% to overall plant output and improve heat rate. We evaluated HFCC options for the conversion of the Aguirre 1 & 2 Heavy Oil Fired unit in the 2015 IRP.

3. Combined Cycle Repowering using a large new GT and Heat Recovery Steam Generator (HRSG.) In this case the existing boiler is abandoned or demolished, while STG and other site facilities are integrated into the Repowered CC.

Variations on approach 1 include NG co-firing to displace only part of the coal firing, and Dual Fuel by maintaining capability to switch between coal and NG. It is not very common in fuel conversion, but for an island system one also might consider Dual Fuel with NG as primary fuel and diesel/distillate oil as backup in case of LNG interruption. This would add to capital cost but maintain some security of fuel supply.

Direct boiler fuel conversion usually results in a reduction in overall plant thermal efficiency of 3-5% on an HHV basis. This is mainly because CH4 has much more hydrogen than coal, resulting in more water vapor in the exhaust with associated loss of its latent heat of vaporization. Partially offsetting this is the reduction in plant auxiliary loads by eliminating coal unloading, conveying and crushing, ash handling, flue gas scrubbing, etc.

HFCC will give a few points in efficiency improvement to offset partially the potentially higher fuel cost of NG vs. coal. Conversion capital costs would include the boiler fuel conversion and the extra GT, along with possible combustion air system upgrades to handle higher temperatures from GT exhaust vs. fresh air.

For Repowered CC, added GT capacity nominally would be about twice the existing STG capacity, resulting in overall tripling of unit output. E.g., for the two AES units of about 225 MW each, a fully Repowered CC implementation for the site would result in two NG fired units of about 675 MW each, which could be too large for the system as envisioned, with smaller distributed units closer to the load.

The steam turbine would need substantial changes as a CC does not use the 5-7 stages of feedwater heating that a Rankine cycle uses. So, most FW heating extractions from the STG are closed off and the steam path re-evaluated or modified to handle higher downstream steam flows. This can affect the condenser, as well, depending on how the GT and HRSG are sized.

Sizing also depends on whether a GT model is available in just the right size to fit the existing STG. Given the available GT sizes in "F" technology, each of the two AES STGs most likely would be integrated into a 2x1 CC block with 2 GTs and one STG. If designed properly so that the largest loss of generation is either one GT train and its associated portion of the STG capacity, or the STG alone, without tripping the GTs, then the largest loss of generation would be similar to the new 1x1 CC plants evaluated in the IRP. So, the issue is really of size and location.

Usually the Repowered CC heat rate will be 2-5% worse than that of a completely new CC because the existing steam turbine is not optimized to the same conditions used in a completely new CC.

The HFCC and Repowered CC options are likely to have considerably longer implementation schedules than fuel conversion alone. The latter may take 1-2 years, whereas the other may take 3-5 years.

Based on the above we recommend assessing Approach 1 but Approaches 2 and 3 could be considered if of interest, as described below.

4 Financial Screening Study:

To perform a high level financial screening study, we can make assumptions about cost and performance. Coal-to-gas conversions reported in the press seem to be running $150-200 per kW of plant capacity. For AES, we will need to consider offsite costs of bringing NG to the site as well as onsite gas receiving station and in-plant conversion costs. O&M estimates can account for reduced plant staffing that is likely without coal handling and scrubbers. Output and efficiency differences are discussed above.

For the NG delivery costs, we could use similar costs as those for the ship-based LNG terminals considered in the IRP.

For HFCC or Repowered CC options, we can look at available GT sizes and determine how close we can get to a good fit in sizing. Then we can use GT Pro to approximate the performance with the existing STG and use our tool PEACE to estimate costs.

Guidance is requested with respect of which Approach to consider in the analysis.