**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

**CASE NO.**: CEPR-AP-2018-0001

**SUBJECT:** MOTION SUBMITTING
SUPPLEMENTAL WRITTEN TESTIMONY
OF BRIAN T. FLADGER ON BEHALF OF
WÄRTSILÄ NORTH AMERICA, INC.

## MOTION SUBMITTING SUPPLEMENTAL
## WRITTEN TESTIMONY OF BRIAN T. FLADGER
## ON BEHALF OF WÄRTSILÄ NORTH AMERICA, INC.

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COMES NOW Wärtsilä North America, Inc. ("Wärtsilä"), represented by appearing

counsel and respectfully alleges and prays:

1.     Pursuant to the procedural calendar set forth in the October 29, 2019

Resolution and Order issued by the Puerto Rico Energy Bureau (the "Bureau") in these

proceedings, Wärtsilä hereby submits the attached Supplemental Written Testimony of

Brian T. Fladger, Market Development Analyst for the Americas, Market Development of

Wärtsilä.

WHEREFORE, Wärtsilä respectfully requests the Bureau receive and accept the

attached Supplemental Written Testimony.

RESPECTFULLY SUBMITTED,

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Counsel for Wärtsilä North America, Inc.

# CERTIFICATE OF SERVICE

I hereby certify that on December 11, 2019, I have sent the Motion Submitting Supplemental Written Testimony of Brian T. Fladger via email to the Energy Bureau, PREPA, and the intervenors:

- Energy Bureau (secretaria@energia.pr.gov; wcordero@energia.pr.gov; legal@energia.pr.gov; sugarte@energia.pr.gov; viacaron@energia.pr.gov; csanchez@energia.pr.gov; ireyes@energia.pr.gov; asanz@energia.pr.gov; bmulero@energia.pr.gov; nnunez@energia.pr.gov; gmaldonado@energia.pr.gov);
- PREPA (mvazquez@diazvaz.law; kbolanos@diazvaz.law; astrid.rodriguez@prepa.com; jorge.ruiz@prepa.com; n-vazquez@aeepr.com; c-aquino@prepa.com);
- Environmental Defense Fund (acarbo@edf.org);
- Sunrun, Inc. (javier.ruajovet@sunrun.com);
- Local Environmental Organizations (pedrosaade5@gmail.com; rmurthy@earthjustice.org);
- EcoEléctrica, L.P. (carlos.reyes@ecoelectrica.com; ccf@tcmrslaw.com);
- Grupo WindMar (victorluisgonzalez@yahoo.com; mgrpcorp@gmail.com);
- Oficina Independiente de Protección al Consumidor (hrivera@oipc.pr.gov; jrivera@cnslpr.com);
- Empire Gas Company, Inc. (manuelgabrielfernandez@gmail.com);
- National Public Finance Guarantee Corp. (acasellas@amgprlaw.com; corey.brady@weil.com);
- Progression Energy (maortiz@lvprlaw.com; rnegron@dnlawpr.com);
- Shell NA LNG LLC (paul.demoudt@shell.com);
- Non Profit Intervenors (agraitfe@agraitlawpr.com);
- Solar and Energy Storage Association of Puerto Rico & Caribe GE International Energy Services, Corp. (cfl@mcvpr.com);
- League of Cooperatives of Puerto Rico and AMANESER 2025, Inc. (info@liga.coop; amaneser2020@gmail.com)
- Arctas Capital Group, LP (sierra@arctas.com, tonytorres2366@gmail.com)

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| **IN RE**: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCE PLAN | **CASE NO.**: CEPR-AP-2018-0001<br><br>**SUBJECT:** SUPPLEMENTAL WRITTEN TESTIMONY OF BRIAN T. FLADGER ON BEHALF OF WÄRTSILÄ NORTH AMERICA, INC. |

**SUPPLEMENTAL WRITTEN TESTIMONY OF**
**BRIAN T. FLADGER**
**ON BEHALF OF WÄRTSILÄ NORTH AMERICA, INC.**
**DECEMBER 11, 2019**

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**Supplemental Written Testimony of Brian T. Fladger**

1    **I.**     **INTRODUCTION**

2         **A.**     **Witness Identification**

3   **Q.**    **Please state your name, title, employer, and business address.**

4   A.    My name is Brian T. Fladger. I am Market Development Analyst for the

5        Americas, Market Development of Wärtsilä North America, Inc. ("Wärtsilä").

6        My business address is 62 Rookwood Court, The Woodlands, Texas 77382.

7   **Q.**    **On whose behalf are you testifying before the Puerto Rico Energy Bureau**

8        **(the "Energy Bureau") in this proceeding?**

9   A.    I am testifying on behalf of Wärtsilä, an intervenor in this proceeding.

10   **Q.**    **Did you previously provide testimony in this proceeding?**

11   A.    Yes. On October 23, 2019, I submitted Initial Pre-Filed Testimony ("Initial

12        Testimony") on behalf of Wärtsilä in this proceeding. My credentials are

13        provided in that Initial Testimony.

1      **B.     <u>Summary of Supplemental Written Testimony</u>**

2   **Q.     What are the purposes and subjects of your Supplemental Written**

3          **Testimony?**

4   A.     My Supplemental Written Testimony addresses the differences between modeling

5          by the Puerto Rico Electric Power Authority ("PREPA") that was based on

6          inaccurate and insufficient inputs resulting in the Energy System Modernization

7          ("ESM") plan in the 2018 Integrated Resource Plan update ("IRP") and modeling

8          that I performed based on information provided in PREPA's responses to

9          Wärtsilä's Second Set of Requirements of Information ("Second ROI").

10        Specifically, I discuss the results that are produced when proper modeling is done

11        using relevant and accurate inputs.

12   **Q.     What are your conclusions and recommendations related to your**

13         **Supplemental Written Testimony?**

14   A.     In the Initial Testimony, I identified five issues with the modeling by PREPA in

15        the IRP: (i) the software used; (ii) the inaccurate cost inputs; (iii) the failure to

16        include start-up costs; (iv) the failure to accurately model minimum downtime for

17        reciprocating internal combustion engine ("RICE") technology; and (v) the

18        inaccurate modeling of the variable operation and maintenance ("VOM") costs for

19        the combined cycle gas turbine ("CCGT"). In this testimony, I rely on the

20        information provided by PREPA in response to the Second ROI to model. First, I

21        used that information to model using the more appropriate software, Plexos.

22        Second, I included the following relevant inputs in the model: (i) start-up costs;

1    (ii) accurate minimum downtimes, which were both overstated for RICE and

2    understated for CCGT and the open cycle gas turbine ("OCGT") (I only modeled

3    the accurate minimum downtime for RICE and did not adjust the understated

4    minimum downtime for CCGT or OCGT); and (iii) accurate VOM, which results

5    in significantly higher renewables and fewer CCGTs than results from the

6    modeling by PREPA and shown in the ESM.

7    **Q.**    **Are there any exhibits attached to your Supplemental Written Testimony?**

8    A.    Yes. My Supplemental Written Testimony includes the following exhibits:

9          • Wärtsilä Ex. 2.01: compares two graphs: (i) PREPA's ESM; and (ii)

10          modeling that I have labelled "Siemens Inputs Optimized;" and

11          • Wärtsilä Ex. 2.02: compares two graphs: (i) PREPA's ESM; and (ii)

12          modeling that I have labelled "Puerto Rico Optimized."

13    **II.**    **DISCUSSION**

14    A.    **Corrections to the Modeling Approach Used by PREPA in the IRP**

15    **Q.**    **Did PREPA's responses to the Second ROI provide the information required**

16    **to enable you to run a model?**

17    A.    Yes. Using PREPA's responses to the Second ROI, specifically hourly historical

18    profiles for wind and solar, hourly demand data, and reserve assumption details in

19    response to Wärtsilä-PREPA-02-07 and information regarding start costs in

20    response to Wärtsilä-PREPA-02-09, together with the inputs set forth in the IRP, I

21    was able to run a model.

1 Q. **What software did you use for the modeling?**

2 A. I used Plexos software for the reasons set forth in the Initial Testimony at page 4,

3 line 20 to page 5, line 8. In particular, I used Plexos because it is a more robust

4 modeling tool that allows for greater variables and constraints and, thus, provides

5 better results than Aurora.

6 Q. **Is Plexos proprietary software only available to Wärtsilä?**

7 A. No. Plexos is a globally-recognized software that is generally available by

8 purchase.

9 Q. **When you ran the model with the Plexos software, were there any differences**

10 **in the modeling approach?**

11 A. Yes. I used the inputs from the IRP and the responses to the Second ROI,

12 meaning the same inputs that Siemens used on behalf of PREPA, but I ran the

13 model at hourly granularity (as compared to the ESM which was run every other

14 hour) to generate the graph on the right side of Exhibit 2.01 labelled "Siemens

15 Inputs Optimized." As you can see from a comparison of the two graphs, using

16 Plexos and the hourly chronology generates noticeably different results.

17 Q. **What are the results comparing the ESM graph to the Siemens Inputs**

18 **Optimized graph?**

19 A. Specifically, the ESM graph reflects gas turbines built in 2021 and 2022 without

20 any RICE technology versus the Siemens Inputs Optimized graph that reflects

1    416 MW of RICE technology built in 2022, and renewables, including battery

2    storage.

3    **Q.**    **Did you run any other models?**

4    A.    Yes. In addition to that model, I also used the responses to the Second ROI and

5    the Plexos software to run the Puerto Rico Optimized model, in which I changed

6    the incorrect or omitted inputs that I previously identified and included one other

7    variable. Specifically, I used: (i) the current pricing for the 18V50DF engines of

8    $981 as I described in the Initial Testimony at page 6, line 19 to page 7, line 2; (ii)

9    correct start-up costs, including accurate VOM; and (iii) correct minimum

10    downtime for RICE technology (I did not adjust the understated minimum

11    downtime for CCGT or OCGT). In addition, based on the responses to the

12    Second ROI, the ESM excludes the use of batteries to provide spinning reserves.

13    *See* PREPA response to Wärtsilä-PREPA-02-07(h) (listing unit types that can

14    contribute to the spin requirement). Allowing the use of batteries to provide

15    spinning reserves decreases fuel consumption and the related costs. In the Puerto

16    Rico Optimized model, I included the use of batteries to provide spinning

17    reserves.

18    **Q.**    **How did you determine the start-up costs?**

19    A.    In the Initial Testimony, I provided an approximate cost range for 300 MW of

20    engines with 300 starts per year. While that is a reasonable range, with the

21    additional information from the responses to the Second ROI, I determined that it

1       would be even more accurate to define start-up costs by the two key components,

2       VOM and start-up fuel consumption.

3  Q.    **What information did PREPA provide in the responses to the Second ROI**

4       **that is relevant to this modeling?**

5  A.    For the CCGT, Siemens, on behalf of PREPA, used a fairly high capacity factor

6       with only daily starts. *See* IRP, PREPA Ex. 1.0, Rev. 2.1, at Section 6.3.2,

7       Exhibits 6.4 and 6.5 (revised June 19, 2019); PREPA response to Wärtsilä-

8       PREPA-02-09. Relying on such infrequent starts, the IRP and responses to the

9       Second ROI reflect VOM of only $1.75/MWh. Based on my experience and

10      expertise, I knew that VOM of only $1.75/MWh could not reflect start-up costs. I

11      used a more specific input generated by a tool called State of the Art Power Plant

12      ("SOAPP"), which is available for purchase from the Electric Power Research

13      Institute. SOAPP is widely used in the electric industry because it allows the user

14      to put in operating assumptions for specific units and it will state the maintenance

15      costs. Based on SOAPP, the increased starts and stops that would realistically be

16      required would mean the VOM would be approximately $4-5. So, the Initial

17      Testimony, which was based on my general knowledge and experience, is

18      supported by the results determined by SOAPP.

19  Q.    **Why do you include the cost of start-up fuel?**

20  A.    Upon the start of an engine, some fuel is used when the engine is turned on. Also,

21      it is standard practice in the industry to account for fuel in this way. In order to

22      get accurate cost inputs, you must account for all costs, and fuel is one of them.

1    Q.    **How did you determine the fuel costs?**

2    A.    We have an internal tool that draws upon many resources to determine the fuel

3        based on operating conditions. It is a basic fact that if a unit takes 1-2 hours to

4        start, it does not start at its maximum efficiency. This means that there is some

5        amount of fuel that is greater than general operating conditions.

6    Q.    **Was it difficult to determine and derive the start-up costs?**

7    A.    No. There are several ways that Siemens could have obtained accurate start-up

8        cost information. Wärtsilä, like Siemens, Mitsubishi, and other manufacturers,

9        has a sales group and a services group. The services group generally knows the

10       importance of maintenance and start-up costs. In addition, Siemens could have

11       asked one of the vendors, such as Wärtsilä.

12    Q.    **How did you address the issue of incorrect minimum downtime that you**

13       **previously identified?**

14    A.    With Plexos, I am able to input precise figures for the minimum downtime so I

15       used the actual downtime for RICE technology of 5 minutes as compared to the 2

16       hour downtime used by PREPA for both CCGT and RICE technology.

17       B.    **Using the Correct Modeling Approach Results in More Renewables**
18           **and Less Thermal Development than the ESM in the IRP**

19    Q.    **What were the results of the model when you used Plexos and the correct**

20       **inputs?**

21    A.    On Exhibit 2.02, the graph on the far right labeled "Puerto Rico Optimized"

22       reflects the results of the model using the Plexos software and correct inputs.

1    Q.    **What differences are shown when you compare the ESM and the Puerto Rico**

2        **Optimized graphs?**

3    A.    There are several important differences. Overall, the model reflects a very

4        different power system for Puerto Rico. Specifically, there would be much more

5        renewables, including battery storage. In addition, there would not be any

6        additional inefficient and inflexible CCGT and OCGT, but there would be RICE.

7    Q.    **Are you able to summarize the differences between the ESM and Puerto Rico**

8        **Optimized graphs?**

9    A.    Yes. Exhibit 2.02 shows that there is 314 MW more solar (2,894 MW minus

10        2,580 MW), 595 MW more battery storage (2,235 MW minus 1,640 MW), 530

11        MW more RICE (530 MW minus 0 MW), and 604 MW and 464 MW less CCGT

12        and OCGT, respectively.

13    Q.    **How would you summarize the result from your modeling resulting in the**

14        **Puerto Rico Optimized graph?**

15    A.    The issues that I have raised question the validity of the modeling approach used

16        by Siemens on PREPA's behalf. The Puerto Rico Optimized graph shows that the

17        issues that Wärtsilä has raised regarding the inputs and modeling approach used

18        by PREPA have significant consequences for capacity buildout, or unit

19        commitment, for the next twenty years. For example, PREPA's discovery to

20        Wärtsilä suggested that it was skeptical of Wärtsilä's claim that including start-up

21        costs would change the outcome of the ESM. *See* PREPA-WNA-03. This

1      Supplemental Written Testimony shows the significance of PREPA's omission of

2      key inputs such as start-up costs.

3   **III.**   <u>**CONCLUSION**</u>

4   **Q.**   **Does this conclude your Supplemental Written Testimony?**

5   A.   Yes, it does.

# WARTSILA
## Exhibit 2.01

### ESM Build Out



■ New Build CCGT   ■ New Build OCGT   ■ Battery   ■ New Build Solar

### Siemens Inputs Optimized



■ New Build CCGT   ■ New Build RICE   ■ Battery   ■ New Build Solar

# WARTSILA
## Exhibit 2.02



Puerto Rico Optimized

New Build RICE ■ Battery ■ New Build Solar

ESM Build Out

New Build CCGT ■ New Build OCGT ■ Battery ■ New Build Solar

# The State of Texas

## Secretary of State

I, Ruth R. Hughs, Secretary of State of the State of Texas, DO HEREBY

CERTIFY that according to the records of this office,

## LUZ MARINA LIPSCOMB

was commissioned as a Notary Public for the State of Texas on February 13,

2019, for a term ending on February 13, 2023.

Issued: December 9, 2019
Certificate Number 11850781
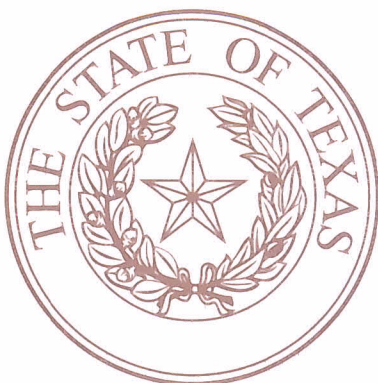
Ruth R. Hughs
Secretary of State
GF/rm

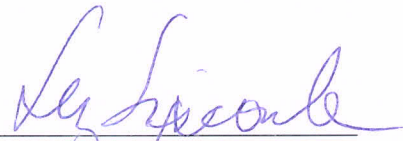| | |
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## ATTESTATION

Affiant, Brian T. Fladger, being first duly sworn, on oath states the following: the prepared Supplemental Written Testimony and the information, documents, and workpapers attached thereto constitute the pre-filed testimony of the Affiant in the above-styled proceeding. Affiant states that he would give the answers set forth in the Supplemental Written Testimony if asked the questions propounded therein at the time of the filing. Affiant further states that, to the best of his knowledge, his statements made are true and correct.

_____
Brian T. Fladger

Subscribed and sworn to before me, a Notary Public in and for _Texas_ ,

this __6__ day of December, 2019.

_____
Notary Public

My Commission expires:

LUZ MARINA LIPSCOMB
Notary Public, State of Texas
Comm. Expires 02-13-2023
Notary ID 130116612