NEPR

Received:

Oct 15, 2019

3:04 PM

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

IN RE:

REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCES PLAN

CASE Number: CEPR-AP-2018-0001

Matter: Empire Gas written testimony.

INTERVENTOR'S TESTIMONY

To the Honorable Puerto Rico Energy Bureau: ("Bureau")

NOW COMES, EMPIRE GAS COMPANY, INC. ("Empire") through its undersigned legal representation and respectfully STATES its written testimony as follows:

I. IDENTIFICATION OF WITNESS:

RAMON GONZALEZ SIMOUNET, Esq. Vice-President, Empire Gas Company, Inc.

II. WITNESS CREDENTIALS:

Provided at the beginning of the testimony questions 1 and 2.

III. ISSUES OR SUJECTS:

Use of Liquified Petroleum Gas and or Synthetic Natural Gas as fuels by PREPA Generating Units, including the *Peak Shaving Units* described in Section Section 10.1.5 *Install New Resources*, *Mobile Gas Turbine Peaking Units (MGTPU's).*

Changing the proposed liquified natural gas import terminals proposed for Mayagüez and Yabucoa to liquified petroleum gas. Section 10.1.7.

IV. DIRECT EXAMINATION

1. Please state your full name?

a. Ramón González Simounet.

2. Please state your academic background?

a. I hold B.B.A. degree from Loyola University, New Orleans, LA; a Juris Doctor (JD) degree from the Inter American University School of Law and a Master of Laws (LLM) degree in Banking and Financial Law from Boston University.

3. Please state your professional experience?

a. Since 1987 I have been acting as Vice President and Legal Counsel for Empire Gas Company, Inc. ("Empire") a Puerto Rico Liquefied Petroleum Gas (LPG) importer and distributor. My duties include logistics, purchasing, client development, marketing as well as financial and administrative duties.

4. What is Empire and how was it formed and organized?

a. Empire, is a local corporation; currently the largest importer and distributor of Liquefied Petroleum Gas ("LPG" or "propane") in Puerto Rico. It was founded by Mr. Ramón González Sr. in 1967. Mr. González Sr. had previously worked for many years in the local LPG industry as a sales manager for the leading U.S. LPG company in

Puerto Rico, Tropigas. Empire became in 1967 the first Puerto Rican LPG wholesaler and distributor and encouraged the formation of independent LPG retail distributors.

Since then, Empire has been supplying LPG for domestic, commercial and industrial uses within the Commonwealth of Puerto Rico. Empire operates more than 50 LPG filling plants in Puerto Rico; employing some 400 persons. Its staff and outside resources include engineers, specialized and highly trained personnel, accountants and legal counsel. On April 12, 2019, Mr. Ramón González, Sr., Empire's founder and President, was inducted to the LP Gas Hall of Fame. http://lpgashalloffame.com/ramon-gonzalez-sr/

5. Please describe Empire's Importation and Distribution infrastructure?

a. Empire's main import terminal and storage facility in Peñuelas, Puerto Rico is a fully refrigerated facility, with a storage capacity of some 23,000 MT or 12.2 MM ("million gallons") of LPG. This storage capacity provides an import potential for millions of additional gallons of LPG per year.

Empire has a large and modern fleet of tank trailer transports with an average capacity of 10,000 gallons ready to access any point within the Commonwealth of Puerto Rico and operates its own repair/maintenance hub in Guaynabo, Puerto Rico.

6. Can you describe Empire's operations?

a. Empire supplies LPG through it's filling plants to hundreds of independent local LPG distributors serving both the residential and the commercial LPG sector. LPG is used domestically for cooking, cloth drying and water heating applications; commercially, by restaurants, dry cleaners, coffee roasters and other applications.

Empire is also the leading supplier of LPG for industrial operations; providing LPG not only for conventional boiler heat and steam requirements; but also for Combined Heat and Power ("CHP") and electrical co-generation and electric generation applications. CHP's are able to provide, on a combined basis, energy, steam and cooling for industrial applications. By using excess heat (similarly to a *combined cycle* unit) CHP units are capable of achieving 80% efficiency rates, versus 34% for most electric generating utilities.

We also provide turn-key power and CHP solutions to local and multi-national manufacturing operations; including the design, purchase of generating machinery, assembly, testing and operations of such solutions. Empire services and supplies LPG to several CHP operations, among them:

a. *Olein Recovery*, Yabucoa, Puerto Rico, operates a 1 MW CHP unit.

b. *Hospital la Concepción*, San Germán, Puerto Rico, operates a 1 MW CHP unit, The unit operated continiously durning and after Hurricane Maria, saving lives and providing full medical services to the region.

c. *Edwards Lifesciences* in Añasco operates a 1 MW CHP unit with a GE reciprocating engine.

d. *ProCaribe* in Peñuelas, uses a 1 MW CHP unit. Operated by Empire.

e. *Pfizer* will begin operations in December 2019 of a 4 MW CHP unit running on Siemens reciprocating engines. This system has been designed, built and will be operated by Empire. Other CHP units will be established in Guayama (2021) and Barceloneta (2022).

f. *Cervecera de Puerto Rico* operates a 1 MW CHP unit running on a Siemens reciprocating engine.

g. *Pall Pharmaceutical* in Fajardo will operate a 1 MW CHP unit.

7. What are the main characteristics of LPG?

a. LPG stands for *"Liquefied Petroleum Gas*". LPG is a heavier than air mixture of hydrocarbon gases; the two most common being butane and propane and it is considered an alternative fuel under the *Energy Policy Act of 1992*. (www.nrel.gov/docs/fy01osti/30147.pdfAT) Almost all of the LPG imported and used in Puerto Rico is of the *HD5* standard, having at least 90% propane content. LPG is not toxic and not classified a *greenhouse gas;* contrary to natural gas, which is. See answer to Question 15, infra.

At room temperature, LPG is a colorless and odorless gas. LPG is liquefied generally by pressurization; compared to natural gas ('NG") which is *cryogenically* turned to liquefied natural gas ("LNG"). For safety reasons, LPG is mixed with an odorant, *mercaptan,* to allow for detection by its consumers. Under pressure or in cooler conditions; it transforms into a liquid state. This process leads to the reduction of the volume to 1/260 of the gaseous aggregate state. LPG has a caloric value (BTU/cuft) at 60 F, of 2,506 while LNG has a value of 1,012.

https://altenergy.com/media/1106/propdatapdf.pdf

According to the *Enciclopedia Britanica*:

"Liquefied petroleum gas (LPG), also Called LP gas, any of several liquid mixtures of the volatile hydrocarbons propene, propane, butene, and butane. It was used as early as 1860 for a portable fuel source, and its production and consumption for both domestic and industrial use have expanded ever since.

A typical commercial mixture may also contain ethane and ethylene, as well as a volatile *mercaptan*, an odorant added as a safety precaution. Liquefied petroleum gas (LPG) is recovered from "wet" natural gas (gas with condensable heavy petroleum compounds) by absorption.

The recovered product has a low boiling point and must be distilled to remove the lighter fractions and then be treated to remove hydrogen sulfide, carbon dioxide, and water. The finished product is transported by pipeline and by specially built seagoing tankers. Transportation by tuck, rail, and barge has also developed, particularly in the United States.

LPG reaches the domestic consumer in cylinders under relatively low pressures. The largest part of the LPG produced is used in central heating systems, and the next largest as raw material for chemical plants. LPG commonly is used as fuel for gas barbecue grills and gas cooktops and ovens, for gas fireplaces, and in portable heaters. In Europe, LPG water heaters are common. It is also used as an engine fuel and for backup generators. Unlike diesel, LPG can be stored nearly indefinitely without degradation." https://www.britannica.com/science/butane

Currently, on a worldwide basis, LPG is produced with two methods; with approximately 60% derived from raw natural gas during natural gas processing and approximately 40% coming from crude oil refining. https://www.wlpga.org/about-lpg/production-distribution/ However, in the U.S.A. the percentage derived from natural gas ("NG") is much higher, 83%. In 2017, hydrocarbon gas liquids (including LPG) produced from NG amounted to 3.78 million barrels per day, while refinery derived liquids only 0.63 million barrels per day.

https://www.eia.gov/energyexplained/hydrocarbon-gas-liquids/.

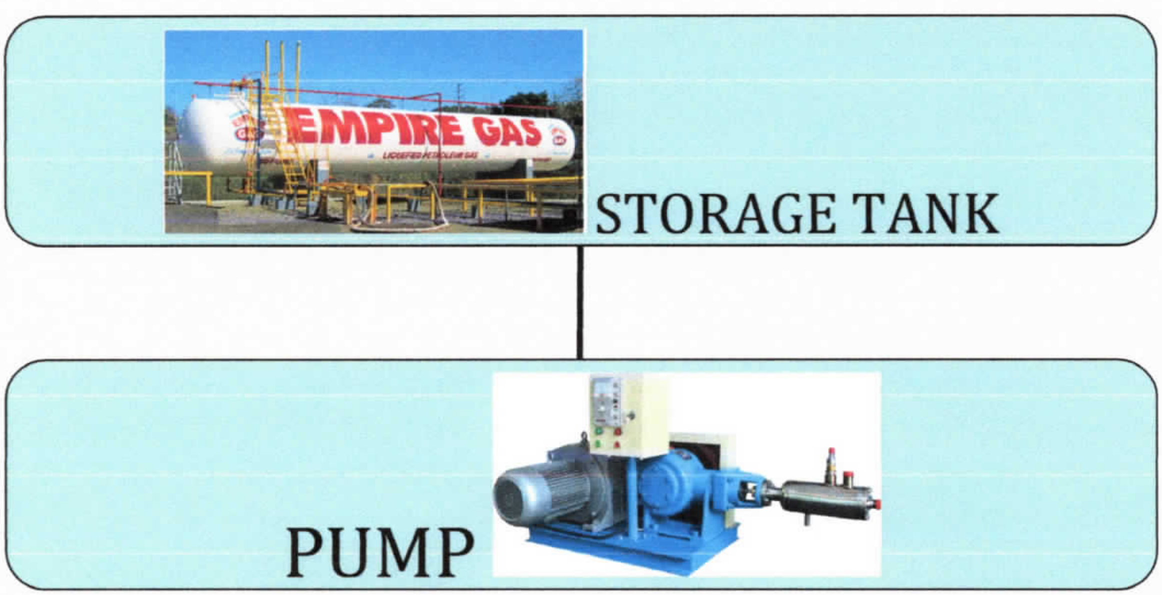
It should be kept in mind that raw natural gas itself is made of methane, propane, butane, isobutane, ethane, ethene, isobutene, butadiene, pentane and pentanes plus; as raw unrefined natural gas. Refined natural gas is made of almost entirely methane.

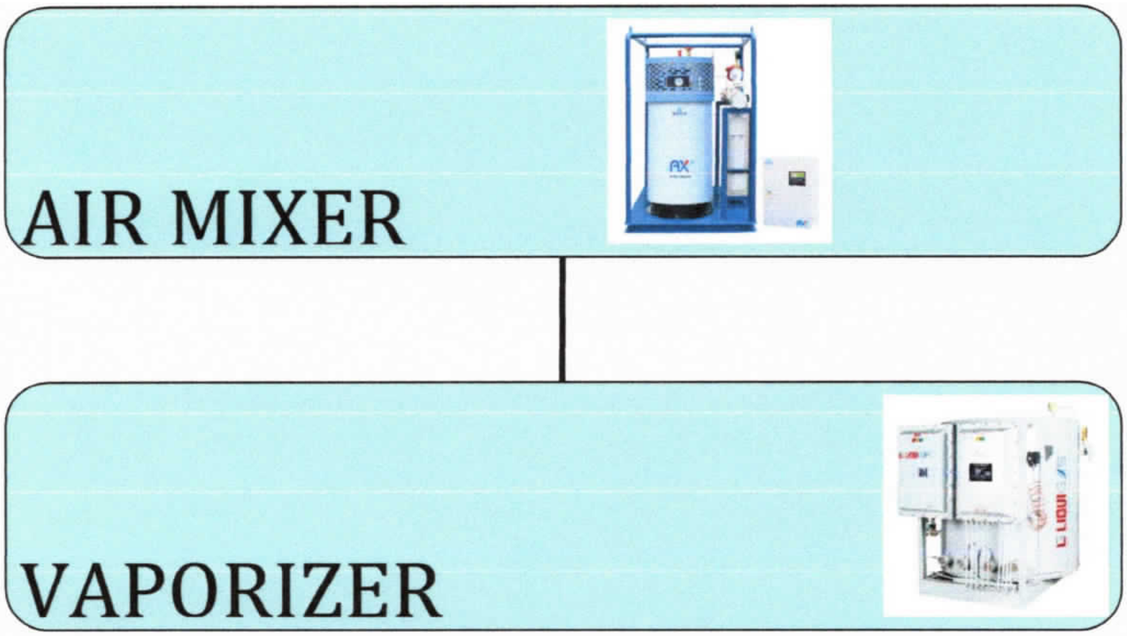
8. What is *Synthetic Natural Gas* ("SNG")?

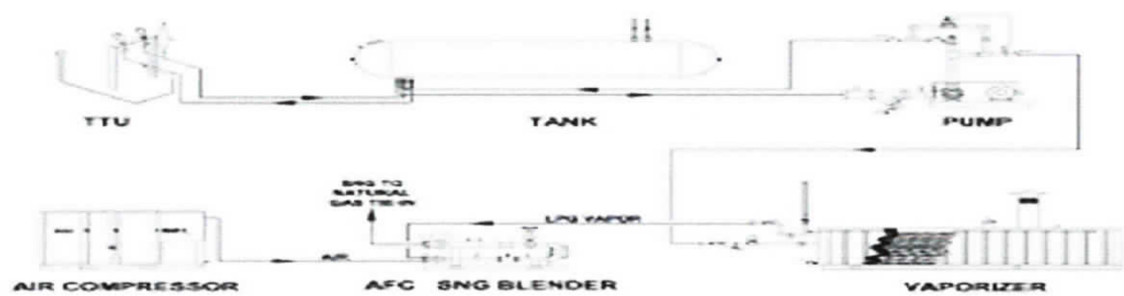
a. *Synthetic Natural Gas* ("SNG") is propane mixed with air; in exact proportions as to replicate the characteristics of natural gas. To ensure the greatest certainty and clarity when discussing the issue of interchangeability between LPG ("propane') and liquefied natural gas ("LNG"), the technically correct and globally accepted definition must be incorporated.

The most common specific method to mediate the exchange of combustible gases is the so-called "*Wobbe Index*". It is an indicator of the interchangeability of fuels such as LPG, liquefied natural gas ("LNG"), natural gas ("NG") and Synthetic Natural Gas ("SNG") or propane air. See https://sciencing.com/calculate-wobbe-index-5147506.html. LPG can easily be converted into SNG by a simple air dosing process, in which approximately 45% of atmospheric air is mixed with 55% LPG vapor. It is also known as "*propane air*" ("*aire-propanado*") in Spain and Latin America.

The following images illustrates a typical SNG installation:







It must be remembered and reiterated that, natural gas is *cryogenically* **(cryogenics is the production and behaviour of materials at very low temperatures)** turned to liquefied natural gas ("LNG") and to be used, LNG transported and shipped as LNG and must be *re-gasified* and converted back into natural gas through a process that transforms it back into a gaseous state.

Therefore, if SNG requires some auxiliary dosing equipment to achieve the desired air blend; **LNG needs a much more complex and costlier re-gasification equipment; plus the required and extremely costly natural gas**

storage equipment; capable of storing the LNG as a refrigerated liquid before its re-gasification.

In Puerto Rico, SNG has been produced and delivered for decades to residential and commercial users in San Juan, via the underground distribution grid of a local company, *San Juan Gas.*

9. Is Synthetic Natural Gas interchangeable with natural gas?

a. Yes. As indicated by the *"U.S. Department of Homeland Security*" in a study prepared for the *"Infrastructure Assurance Center Decision and Information Sciences Division, Argonne National Laboratory"* on February 2012:

"Propane-air, also called liquefied propane gas (LPG)-air, is essentially a synthetic natural gas that is formed by mixing vaporized propane or LPG with air. **The resulting homogeneous mixture can be used as a direct replacement for natural gas in combustion applications**." (Emphasis added) http://www.ipd.anl.gov/anlpubs/2012/07/73792.pdf

As explained in WLPGA's paper *SNG, LPG (Air, Propane Air) the LPG Opportunity* in Section 3.1.2:

"The principle of an SNG system starts with the conversion of liquid LPG into vapour, which is then mixed with air at a preset ratio (usually 53-57% LPG 43-47% air) LPG can have a vapour BTU content of approx 22,500 Kcal's per cubic meter, compared to NG of approx. 9,000 Kcal. **Since LPG's BTU content is much higher than NG it has to be "diluted".** The vaporized LPG is run through a LPG/air mixer that mixes at the required ratio of vapour LPG and air, to create a mixture compatible with NG....

This LPG/air mixture is directly compatible with NG; it can replace directly NG and can therefore be used by any equipment that uses NG such as burners, heaters, stoves, etc. without any modifications to the equipment." https://www.wlpga.org/wp-content/uploads/2018/02/SNG-The-LPG-Opportunity-2017.pdf

According to the World LP Gas Association:

""The vaporized LPG is run through a LPG/air mixer that mixes at the required ratio of vapour LPG and air, to create a mixture compatible with NG. **This LPG/air mixture is directly compatible with NG, it can replace directly NG and can therefore be used by any equipment that use NG such as burners, heaters, stoves, furnaces, water heaters, etc.,without any modification to the equipment. Such systems can also be connected directly to NG pipelines"** ....

Emulating NG with SNG is a conventional proposal, which can be used in base load, backup, and peak shaving systems. The use of SNG is not a new idea as mentioned above; it started over 50 years ago. **Because its properties can imitate NG so well, SNG can be used interchangeably in systems designed for NG**, grids, appliances, equipment. This offers significant benefits to companies or institutions that! decide to implement SNG systems. They can avoid costly infrastructure or appliance conversions, unlike switching to a diesel oil or LPG system." (Emphasis added)

https://www.wlpga.org/wp.../SNG-The-LPG-Opportunity-2017.

Thus, **SNG and natural gas are fully interchangeable according to the aforementioned index.** SNG REPLACES natural gas; FOR ALL TYPES OF USE FROM RESIDENTIAL TO INDUSTRIAL. See, Eaton, D. Gary, "*PEAK SHAWNG WITH SNG*" LP Gas Global Technology Conference, 2006; Propane Education and Research Council ("PERC") World LP Gas Association ("WLPGA"). Schedule "A". The author indicates that:

"If the natural gas and the SNG have an identical or nearly identical Wobbe Index, they produce an equivalent amount of energy and require the same amount of combustion air. **Burners operating on SNG will not require pressure adjustments and the measured and observed combustion characteristics show essentially complete acceptance**."
http://www.premiergas.com.pk/LPG%20Global%20Technology%20Conference2006%20Presentation.pdf

10. What are the principle uses of SNG?

a. According to Gary Eaton, the principle uses of LNG are:

"1. Peak Shaving Systems: Allows both NG local distribution companies (LDCs) and industrial gas consumers to supplement their NG during peak demand periods.

2. Base-Load Systems: Provide a "natural gas equivalent" bridge fuel in regions where NG will be implemented but is not yet available. Later the SNG system will later revert to a peak shaving function.

3. Backup Systems: Allows industrial natural gas customers to use SNG during curtailment periods, and, allows taking advantage of arbitrage opportunities."

http://www.premiergas.com.pk/LPG%20Global%20Technology%20Conference2006%20Presentation.pdf

11. Can LPG/SNG be used for energy and electrical generation at utility generation scale?

a. Yes. Several countries operate LPG/SNG fired power plants; including the U.S.A. (as *Peak Shaving* plants with SNG) the USVI, Pakistan, Ghana, El Salvador, China and Honduras. The largest, the *Bridge Power Plant*, in Ghana, will ultimately have an electricity generating capacity of 400 MWe, using LPG to fire gas turbine generator sets with steam turbines in Combined Cycle Gas Turbine ("CCGT") configuration. Once completed, it will represent over 15% of the country's power generation capacity.

General Electric signed in July 2018, a memorandum of understanding with the Beximco Group to create Bangladesh's first LPG-based power plant to generate 150 MW of electricity. General Electric, *Aereo Fuel Flexibility Whitepaper.*

www.ge.com/content/dam/gepowerw/global/en_US/documents/GasPower/gasturbines/GEA34108_Aero_Fuel_Flexibility_Whitepaper_Final.pdf

Gas turbine manufacturer *Hitachi* reports that a total 121 LPG burning gas turbines, (from 17 to 110 MW, most under 50 MW) have been installed in the world since 1964. All units are dual or triple fuel compatible. Among those; 47 have been installed in the U.S.A., 11 in Japan, 10 in Australia, 6 in Saudi Arabia and 4 in Argentina.

https://lpg-apps.org/uploads/Modules/Library/power-generation-lpg-gas-turbines-kuba_hitachi_mitsubishi_japan.pdf

Recently, In Honduras, a LPG fired 28 MW project using four Wärtsilä 34SG-LPG reciprocating engines, has been built for the 60,000 habitants island of Roatan.

The U.S. Virgin Islands Water and Power Authority (WAPA) will operate seven GE turbines at the 198-MW plant on St. Thomas and operates a 118-MW plant on St. Croix using LPG.

In the U.S.A. as of 2012, at least 56 *Peak Shaving* facilities are in operation using Propane-Air (SNG as discussed above). See *Preliminary Assessment of a Propane-Air Backup System for the Anchorage, Alaska, Area* Prepared for U.S. Department of Homeland Security, February 2012.

https://publications.anl.gov/anlpubs/2012/07/73792.pdf

It should be noted that most manufacturers of turbine and reciprocating units manufacturers; such as GE, Hitachi, Siemens and Wartsila, offer LPG or dual LPG/NG fueling capabiliies.

12. Why is LPG/SNG ideal fuels for countries lacking a comprehensive Natural Gas infrastructure?

a. As a matter of economics, LPG/SNG based generation may be an ideal alternative for island enclosed systems with no natural gas access. As explained by a leading author on the subject:

"**For island grids dependent on imported fuel oil, propane power is especially attractive**. Though it's not as clean as solar or wind, it's far cleaner than diesel while still being dispatchable…

The U.S. Virgin Islands Water and Power Authority (WAPA) is in the middle of a $150 million transition from fuel oil to propane. **The project is expected to cut WAPA's fuel costs by 30%,** amounting to annual savings of around $90 million. The seven GE turbines at the 198-MW plant on St. Thomas and the 118-MW plant on St. Croix that previously ran on No. 2 fuel oil are being converted to dual-fuel operation by Dutch firm Vitol." Thomas, supra. (Emphasis provided)

The author further indicates the basic reason for such alternative:

"**Compared to LNG, the infrastructure required to make the switch to propane power is far less challenging. Though generation with propane results in slightly lower output and efficiency compared to natural gas, propane is much easier and less expensive to compress, ship, and store than LNG** (propane liquefies at –42C compared to –260C for natural gas) or compressed natural gas (which must be stored at far higher pressures: about 3,000 psi versus 100 psi to 150 psi for propane).

Propane-powered turbines can be used for the same simple cycle, combined cycle, or co-generation applications as natural gas–fired turbines." Overtone, Thomas, *"Propane Power Is Grabbing Growing Share of Gas-Fired Market"* *www.powermag.com/propane-power-is-grabbing-growing-share-of-gas-fired-market.*

According to the World LPG Association, in its *"Global LPG Power Generation Market Development & Recommendations for Future Growth"* study:

"There is growing evidence to suggest that LPG will have an important role to play within the global Power Generation sector in the next 10 to 20+ years……

...However, many countries do not have an established network of natural gas pipelines. In countries where these do exist, infrastructure is often reserved for areas of high population density and/or centers of industrial activity, leaving more remote areas with little or no access to natural gas. In such cases, there is a clear opportunity for LPG to provide a solution for power generation – especially when new power plants are necessary to meet increasing electricity demand." See https://www.wlpga.org/wp-content/uploads/2017/06/Global-LPG-Power-Generation-Market-Development-and-Recommendations-for-Future-Growth.pdf. (Empahsis added)

As indicated by the *World LPG Association*:

"Over time, we expect natural gas grid infrastructure to expand in many regions throughout the world. However, in some countries, power shortages are becoming critical issues today and governments cannot afford to wait for five to ten years before natural gas pipelines are in place to fuel new-build power plants.

Therefore, in a bid to provide security of electricity supplies, governments are increasingly considering the potential for using LPG as a 'bridging' fuel. In these cases, power plants fueled by LPG are built – often with short one to two-year lead times - but with a longer-term plan to convert to natural gas once the pipeline infrastructure is in place." *World LPG Association*, supra. (Emphasis added)

In Honduras Roatan Island, the local utility reasoned considered the following elements in its selection process:

"For this project, Roatan Electric Company evaluated LPG and LNG, both of which are cleaner fuels than distillate (LFO) and residual oil (HFO). Whereas LNG would require significant investment and a lengthy construction period for the cryogenic storage on site, LPG can be stored in industry standard pressurized bullet tanks. Furthermore, the worldwide fleet of small pressurized LPG tankers is large, and existing vessels could be used for the Roatan trade while at the same time supplying LPG to existing other consumers in the region. For LNG, small LNG tankers would have to be sourced and tailored for the specific trade. **On the basis of these considerations, LPG was found to be the most attractive choice of fuel for the new environmentally friendly power plant."** See World LPG Association, *AN EXEPTIONAL ENERGY CASE STUDY, the role of LPG in a modern hybrid power system with renewable energy generation". (Emphasis added)* https://www.wlpga.org/wp-content/uploads/2019/02/WLPGA-RECO-Roatan-Case-Study-Draft-FINAL.pdf

The environmental aspects of the selection are highlighted as follows:

"The Roatan LPG power plant delivers significant environmental advantages. In addition to a ≈20% reduction of CO2 emissions (greenhouse gas) the new LPG power plant has significantly lowered nitrogen oxide (NOx), CO2, Sulphur and particulate emissions compared to the former LFO-fired diesel power plant." *AN EXEPTIONAL ENERGY CASE STUDY (supra)*

Furthermore, the plant's modern design and control equipment facilitates renewable energy source integration:

"The integration of renewable energy into the Roatan power system was high on the agenda, and the inherent intermittency of wind and solar energy was a factor that needed to be overcome. Wartsila's latest generation advanced control systems provide accurate control that facilitates large scale renewable energy generation." *AN EXEPTIONAL ENERGY CASE STUDY (supra)*

As for the USVI, their plants operated entirely on diesel fuel, and their capacity was similar to some currently in use by PREPA. The jurisdiction switched to LPG as its primary fuel. **As a matter of fact, LPG was chosen for a new generation of central station power plants; as it was deemed the cheaper alternative to liquefied natural gas (LNG).** See Congressional Research Service, "*Potential Options for Electric Power Resiliency in the U.S. Virgin Islands",* February 2018. https://fas.org/sgp/crs/row/R45105.pdf

13. What are the estimated fuel savings of switching from Diesel to LPG in small and mid-size electric generation plant?

a. We have estimated at least a 35% fuel savings for PREPA by switching from Number 2 Oil and diesel to LPG. Here are some of the sources we have used in our analysis.

First, according Wärtsilä Energy Solutions presentation at the 2019 "*Congreso Internacional de GLP, Bogota Colombia, LPG FOR POWER GENERATION,* as of June

2019, the cost in $/MMBTU for propane was about $7.90 cheaper than diesel or light fuel oil (LFO, Houston 380 cSt bunker)

http://www.gasnova.co/wp-content/uploads/2019/08/LPG-for-Power-Generation-Wartsila-20190730.pdf

According to General Electric, switching from a diesel engine and electric generator (diesel genset) to one of it's a TM2500, (a mobile 36 MW mobile gas turbine power plant) burning LPG can save $7 million per year in operating costs. https://www.ge.com/content/dam/gepower-pgdp/global/en_US/documents/product/gas-power-systems-product-catalog-2019.pdf (page 42)

According to gas turbine manufacturer *Hitachi* in a 25 MW gas turbine, LPG's fuel cost can be substantially less than diesel. *Hitachi* assumes an LPG cost of $0.86 USD/Gallon and a Diesel cost of $4.50 USD/gallon; it concludes that the cost of LPG in terms of one million BTU's generated ($MM/BTU) is $10.20; versus Diesel's ($MM/BTU $35.00. Maintenance intervals are increased also by 20-30%. htttps://lpg-apps.org/uploads/Modules/Library/power-generation-lpg-gas-turbines-kuba_hitachi_mitsubishi_japan.pdf

Using a BTU equivalence calculator provided by *Midstream Energy Group* (www. midstreamenergygroup.com) based on the same formula, and assuming a more realistic current diesel fuel cost per gallon of $2.25, (EIA US No 2 Diesel at $1.98 p/g as of October 2019, plus shipping and handling) it's $MM/BTU would be $16.07. As for LPG; assuming a current market Puerto Rico LPG wholesale price of approximately

$0.95, its cost $MM/BTU would be $10.37; a 36 % difference in cost. This calculation tends to validate the USVI estimate of 30% reduction in fuel costs by switching to LPG.

According to the IRP, Exhibit 4-1, *Summary of Existing Plant Characteristics and Performance,* the $MM/BTU of existing plants running on Number 2 Oil and diesel range between $11.73 to $22.73. Key units in the system like Mayaguez 1-4 with a 220 MW installed capacity and Cambalache with a 248 MW installed capacity; show $MM/BTU'S rates of $17.20 and $16.40. This rates represent a 40% and 36% difference compared to LPG's estimated $MM/BTU.

Overall, we believe that a 35% spread in cost is a reasonable estimate.

14. What are the estimated fuel savings of switching from Number 6 Oil to LPG in larger size electric generation plant?

a. In terms of energy costs, the advantages of LPG are lower, but still noticeable. Units like Aguirre Steam 1 and 2 ($MM/BTU of $12.52) and San Juan 7-10 ($MM/BTU of $11.41) would benefit from a LPG conversion. The environmental advantage remains, however.

15. What are the environmental advantages of LPG?

a. As previously stated and recognized in Section 7.1.2.13, LPG is a clean and environmentally friendly fuel. In terms of CO2 emissions, its impact is slightly more than LNG but substantially lower than fuel oils. LPG emits 0,23 KgCO2/KWr versus 0,20 for natural gas. Diesel emissions are much higher, at 0,28 KgCO2/KWr. https://www.volker-quaschning.de/datserv/CO2-spez/index_e.php

Nevertheless, there is an extremely important environmental factor that has been overlooked in the IRP. **The fact that natural gas or LNG is a greenhouse gas and LPG is not**. This means that in the event of a spillage to the atmosphere, no damage would be caused by an LPG emission; **but a substantial environmental damage may be made by a natural gas emission, since it is almost composed entirely of methane, a *greenhouse* gas.**

According to the Environmental Protection Agency, (EPA): "Natural gas is mainly **methane—a strong greenhouse gas".**

https://www.epa.gov/ghgemissions/overview-greenhouse-gases

see also

https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php

According to the Cornell's University Methane Project research:

"Emissions of even small amounts of unburned methane **give natural gas a huge greenhouse gas footprint, since methane is more than 100 times more powerful as a greenhouse gas than carbon dioxide**. Natural gas and coal are both climate disasters, with coal worse for carbon dioxide emissions but natural gas far worse from the standpoint of methane."

http://www.eeb.cornell.edu/Howarth/summaries_CH4.php

On the other hand, LPG is not a greenhouse gas and presents absolutely no danger to the environment in case of an accidental leakage. According to Propane 101, an industry sponsored educational website:

"Natural gas, when discharged into the environment is a greenhouse gas whereas propane is not classified as such. Propane is not toxic or damaging and will not harm the environment if it is released into the atmosphere, which is why it is not labeled as a greenhouse gas. Therefore, while propane will not contribute to pollution in its unused state if released, natural gas will. Propane is a green fuel before combustion and remains environmentally friendly even after it is used, as described below."

https://www.propane101.com/propanevsnaturalgas.htm

16. How could LPG/LNG be used for electric generation in Puerto Rico?

a. It should be used as the main alternate fuel to fuel oils; instead of natural gas. Note that the same scenario as previously described for the USVI, Honduras and other countries exists in Puerto Rico today. Except for the Ecoeléctrica operation, we do not produce or import natural gas in large quantities. It should be noted, that PREPA has pursued many natural-gas conversion projects; at a costs of millions of dollars, since the turn of the last century. PREPA has tried North and South pipeline projects, gas ports, gas barges based storage and other ideas; all to no avail. The problem remains: **as much as natural gas is a very desirable fuel; the cost of building new import and storage facilities is astronomically high and we still have no access to U.S. natural gas transported in large vessels due to existing *Jone's Act* limitations**.

As a matter of fact, Ecoeléctrica is currently connected via pipeline to Empire's LPG import terminal and main storage facility. It is currently capable of running on LPG; and it did, during the first months after its construction and does for short periods of time while the natural gas storage facilities undergo maintenance or repair operations.

LPG/SNG provides an excellent immediate available alternative to LNG as a *bridge fuel,* while other renewable energy sources become available and on a permanent basis, since a fuel based generation capacity will be necessary in the future.

17. What are the advantages of LPG and SNG as alternate fuel sources?

a. There are many advantages of LPG over other fuel types and should also be considered in the IRP. This include, lower emission profiles, (as stated in the IRP) lower full life-cycle costs (versus natural gas for example), and quicker lead-times.

LPG/SNG is an ideal fuel. It is readily available, (some import facilities exist and are ready) and capital cost of establishing an onsite LPG or SNG storage facility is minimal compared to natural gas; which might be several times higher. For instance, as a replacement for natural gas, a generating unit established near a LPG import facility may be immediately converted, using the existing LPG import terminal and storage capacity. It should be noted that according to Exhibit 6-6 of the IRP, the GE LM2500+G4 SAC, a medium CCGT, **was modeled with the capability of burning LPG** and natural gas when offered as an option for the North. Most modern generating units have this capability, and it should be incorporated as a requirement for any possible future acquisitions.

Even in the absence of existing LPG storage facilities; a storage facility could be easily and readibly built much more rapidly and at a fraction of the cost of a natural gas storage facility. The lower fuel storage costs might enable the propane supplier to deliver the same amount of BTU's at a similar or perhaps a lower cost. This would be the case of Mayaguez and Yabucoa, were existing port facilities could be use to fuel existing and proposed *Peak* units.

Furthermore, we also believe that LPG/SNG should be considered as a viable alternate fuel for larger generating units since: a) it is readily available; b) import facilities exist and c) capital cost of establishing an onsite LPG/SNG storage facility is minimal compared to LNG, which might be several times higher and d) it is a clean fuel source, able to comply with environmental parameters.

LPG/SNG is currently in existence, readily available; and its storage facilities can be built in a very short time (days or weeks) as compared to years for any viable LNG import and storage facilities. **LPG cost of building a storage facility is measured in thousands of dollars or low millions for larger storages; while LNG storage facilities construction costs are measured in terms and hundreds of million dollars**.

Constructing an adequate natural gas import and storage facility make take years and cost several million dollars. On the other hand a 120,000 gallon Propane storage facility consisting of four 30,000 gallon tanks and may be established in a matter of days.

It has been estimated that the cost of building regasification facilities and terminals in the Caribbean requires total investment ranging from US$52 million for Belize to US$261 million for the Dominican Republic. An estimate of $900 per cubic meter of storage capacity was assumed. See Inter American Development Bank, Rigoberto Ariel Yépez-García and Fernando Anaya Amenábar, "*Unveiling the natural gas opportunity in the Caribbean*".

On the other hand, ASME cylindrical or spherical LPG storage tanks could cost a fraction of such cost, being in the low million dollar range. Construction time would also be a fraction of that required for an LNG storage facility.

18. Have any feasibility studies considered the possible use of LPG/SNG for electrical utilities generation in specific scenarios were natural gas is not readily available?

a. Yes. **First**, a study commissioned by the Propane Education and Research Council (PERC) *World LP Gas Association* (WLPGA) recommends SNG for *Peaking Stations*. **Note that SNG and not LPG is recommended, in the U.S.A. scenario; namely because it is assumed that LNG will be available in the future and/or that the equipment is designed to use LNG only burners; whereby in Puerto Rico the *Peak Shavers* could either: a) for existing units, be converted to LPG or dual LPG/LNG burners or b) for new ones, ordered with LPG and/or LPG/LNG dual fuel capability; and thus run on LPG only.**

Even though LNG might be cheaper as of today, as a fuel, the cost of LPG/SNG could be lower or come very close to LNG, however; if you factor in the opportunity cost related to the time from an order to proceed to operations. See, Eaton, D. Gary, "*PEAK SHAWNG WITH SNG*" LP Gas Global Technology Conference, 2006; Propane Education and Research Council (PERC) World LP Gas Association (WLPGA). The introduction to this report illustrates the significance of SNG as a complementary alternative fuel when LNG is not readily available:

"Clearly, LNG is a critical strategic tool. It allows transportation of inter-regional gas to help meet large scale demands where they exist. **But LNG is not perfect for all applications – it is slow to implement and hugely expensive.**

For smaller, local supply and deliverability issues, LPG can be a key. Blended with air, LPG can be used to supplement natural gas via peak shaving, base-load and back-up fuel applications." (Emphasis added)

Its further states as for SNG uses:

"**A significant number of utility SNG systems have been installed around the world. All of these have been constructed to either supplement natural gas via "*peak shaving*" or to both precede the arrival of natural gas in a region (e.g. natural gas pipeline is not yet constructed but the desire is to have distributed natural gas equivalent available), and then to augment as needed after natural gas is present via peak shaving**."

http://www.premiergas.com.pk/LPG%20Global%20Technology%20Conference2006%20Presentation.pdf

Second, according to a 2017 World LP Gas Association ("WLPGA") market study related to LPG as an alternative fuel for electrical power generation **in non-natural gas jurisdictions,** there are several instances in which a country or jurisdiction may be in an ideal position to consider the use of LPG/ SNG as a primary source fuel for electricity generation. As stated in the publication's introduction:

"This study has been commissioned by the World LPG Association (WLPGA) in order to **highlight the key market characteristic** which are necessary for a country to be considered an '**ideal' market for using LPG as a fuel for power generation**." World LP Gas Association, "*The Ideal Market for LPG Power Generation, an exploration of the key characteristics which can make a country an ideal market for LPG Power Generation*". https://www.wlpga.org/wp-content/uploads/2017/09/The-Ideal-Market-for-LPG-Power-Generation.pdf. (emphasis added)

The following summarizes such market characteristics:

"ONE: Seeking to fill power gaps of up to 250 Mew.

Countries which have power shortages and are looking to make investments to fill short term power gaps will likely offer opportunities for LPG, especially in more remote regions with no natural gas infrastructure.

TWO: Existing power generation relying heavily on diesel / HFO

Countries which rely heavily on using liquid fuels (e.g. diesel and heavy fuel oil) to meet their power generation needs are often exposed to high prices and/or have plans to move away from this fuel for environmental reasons. This creates an opportunity for LPG to be considered as an alternative fuel.

THREE: High wholesale electricity prices.

Markets with high wholesale electricity prices are likely to offer more attractive pay-back periods for LPG power generation investments.

FOUR: Already using LPG (with high propane content)

Countries which are already consuming large volumes of LPG are likely to have the necessary infrastructure in place to facilitate the use of LPG within the power generation sector. In most countries with high LPG consumption, the fuel is primarily used for residential applications (e.g. cooking). When used for power generation, it is also important that LPG has high propane content.

FIVE: Limited (or non-existent) natural gas grid.

The best opportunities for LPG are likely to be in markets with a limited – or non-existent – natural gas grid. Countries with an extensive natural gas grid will present few opportunities for LPG.

SIX: Domestic production of LPG.

Countries which are producing significant quantities of LPG domestically will likely have an access to a more cost-effective source of the fuel versus countries which have to import, often at high prices.

SEVEN: Policies which encourage a focus on emission reduction.

Countries which are seeking to lower their carbon emissions may well be looking to LPG as an alternative fuel, especially as a 'bridging' solution until natural gas grids have been developed.

EIGHT: Well-functioning regulatory policies & enforcement.

LPG power generation investments will be most successful in markets which are well governed and where the regulatory framework is conducive to doing business." The Ideal Market. (supra)

19. How do these characteristics/factors in this study compare to Puerto Rico?

a. Seven of the Eight factors are fully applicable to Puerto Rico and fully complied with. Number Six, is not applicable. We consider factor number ONE: Seeking to fill power gaps of up to 250 Mwe.

It should be noted that the proposed IRP calls for the conversion of existing "*Peaking Units*" from diesel fuel to natural gas, as well as building other such units up to a total of 18 units. Section 10.1.5 Install New Resources, *Mobile Gas Turbine Peaking Units (MGTPU's).* According to the IRP, this will be of 23 MW capacities each, distributed at five different plant locations around the island**. It indicates that these new units will be capable of burning <u>containerized natural gas</u> delivered by truck with on site tankage.**

The IRP therefore is seeking to fill a power gap with the new *MGTPU's*. LPG and SNG should provide a better fueling solution than LNG. If the *MGTPU's* units are required to run on LPG or dual fuel LPG/LNG; the installation of the LPG storage tanks should be immediately available. If they are designed for LNG only; then SNG will be the solution; just by adding the pump, vaporizer and air-mixer at site. Also as discussed below in question 20, for purely logistical reasons, SNG delivered via tank truck to the *MGTPU's* is not a viable alternative and should be discarted.

TWO: Existing power generation relying heavily on diesel / HFO

Regarding this factor, according to the IRP in Section 1.1, "address the impacts of an aging generation fleet that burns costly liquid fuels (mostly heavy fuel oil), that does not meet environmental regulations (e.g. Mercury and Air Toxics Standards "MATS"), has poor reliability, and is inflexible, which limits the incorporation of renewable resources". Furthermore, it states in Section 1.2, that: "These changes are essential to mitigate, manage and enable timely recovery from future major storms, while shifting the existing generation fleet from largely heavy fuel oil and distillate fuels to renewables and cleaner natural gas."

The largest operating PREPA units operate on fuel-oil as illustrated in Exhibit 4-1. *Summary of Existing Plant Characteristics and performance, of the IRP.* And the existing *Peak Units* operate on diesel fuel. Thus, this factor is fully met.

THREE: High wholesale electricity prices. This is obvious for Puerto Rico, and necessarily related to factor number 2. It is sufficient to quote from the Statement of Motives of Law 17-2919:

"Electric power services in Puerto Rico are inefficient, unreliable, and provided at an unreasonable cost to residential, commercial, and industrial customers despite the existence of a vertically integrated monopolistic structure."

According to the EIA, residential energy costs in Puerto Rico is approximately 20.37 cents per kw/h while the median US price is 13.34 cents. https://www.eia.gov/state/data.php?sid=RQ#Consumption

FOUR: Already using LPG (with high propane content)

The Puerto Rico LPG market has been developed since the 1950's and includes various import facilities, hundreds of filling stations and approximately 600 independent distributors.

Puerto Rico's LPG market consumes approximately 4 thousand barrels/day or 61,320,000 gallons per year, according to the Energy Information Administration as of 2016. www.eia.gov/state/data. Puerto Rico has a considerable storage capacity of LPG with approximately 23,400 MT for Empire's ProCaribe; Corco, with 1,820 MT, Puma Energy, 2,300 MT, Tropigas, 960 MT; Phillips (Closed) 3,650 MT; Puerto Rico Fuels, 1,340 MT. Four (4) terminals are located on the southern part of Puerto Rico (Procaribe, Corco, Phillips and PR Fuels) and two (2) in the north. (Puma and Tropigas)

Almost all of the LPG imported to Puerto Rico is HD5 with a minimum of 90% pure propane. The factor is fully complied with.

FIVE: Limited (or non-existent) natural gas grid

Another obvious factor. Currently Puerto Rico has only 1 LNG import facility at Ecoeléctrica. Furthermore, the IRP in Section 1.1, considers various scenarios relating to the possible growth of this infrastructure as follows:

Scenario 1 - No new natural gas (gas) delivery infrastructure added combined with expected (base case) cost and availability of renewable generation.

Scenario 2 - Gas delivery is made available only in the north combined with expected (base case) cost and availability of renewable generation (this Scenario was dropped after the first screening).

Scenario 3 - Gas is made available at multiple, new LNG terminals (north, east and west locations) combined with further reduction in the cost of renewable and higher renewable availability.

Scenario 4 - Gas is made available at multiple, new LNG terminals (north, east and west locations) combined with expected (base case) cost of renewable and availability.

Scenario 5 - Similar to Scenario 4, but with the Aguirre Offshore Gas Port as an option, larger combined cycle units and centralized Strategy 1, as described below.

We believe that taking into account PREPA'S past traumatic experiences with natural gas import facilities, including 2 failed gaseoducts and 1 gasport; as well as the existing *Jones Act* limitations; only Scenarios 1 and 2 (assuming *San Juan's 5 and 6* conversion succeeds) should be realistically be considered.

Thus, LPG/SNG are poised as real, immediately available and financially sound alternative fuels to natural gas; and should be considered and integrated fully in the IRP as a rational substitute and/or complementary fuel *vis a vis* natural gas.

SIX: Domestic production of LPG.

Puerto Rico currently does not produce LPG; it used to in the 1960's to 90's while the refineries and petrochemical complexes operated. Nevertheless, it has had more than 5 decades of experience using LPG as previously described.

SEVEN: Policies which encourage a focus on emission reduction

This is another obvious factor. As a matter of fact, the proposed IRP already recognizes that LPG is a clean fuel, capable of meeting Federal MATT Standards as applicable to PREPA:

7.1.2.13 Alternative Fuels

PREPA received an unsolicited proposal from Puma Energy Caribe (Puma) and Aggreko in August 2017, which was approved for further consideration in October 2017...

<u>The proposed solution would also have a relatively low heat rate (8,900 Btu/kWh) to provide efficient power generation, burn relatively clean LPG fuel to help meet MATS standards (and which is typically cheaper than diesel or residual fuel oil)</u>, have a fast start time of two minutes to 100% capacity, and be strategically located near existing Puma facilities where no additional LPG storage would be needed beyond the existing 100,000 barrels of LPG storage."

EIGHT: Well-functioning regulatory policies & enforcement.

Needless to say, the existence of the Bureau together with the policy and operational considerations of Laws 57-2014, 4-2016, 120-2018 and 17-2019; attest to the existence of such policies and procedures.

20. Why is SNG via tank truck not a desirable alternative for the *MGTPU's?*

a. This arrangement is inherently flawed and limited.

First, the operation of containerized natural gas as described in the IRP assumes the supply of LNG delivered by truck; may be described as follows. Rather than having a large LNG tank at the site of the *MGTPU's* (capable of delivering fuel for at least several weeks or months) together with the complex re-gasification equipment needed, the truck itself acts as self-contained LNG storage and de re-gasification equipment. They are capable of maintaining the LNG refrigerated until the time comes for re-gasification, performed at the same truck. **Note that the trucks are filled at LNG stations on the U.S. mainland and then shipped to Puerto Rico;** thus, its delivery depending on a complex delivery process; not controlled by PREPA; and not even completely controlled by the LNG provider himself.

Needless to say, the proposal contained in the IRP for fueling the *MGTPU's* with natural gas **and on site storage facilities**, depends entirely upon Scenarios 3, 4 or 5 of Section 1.1 of the IRP coming to life; assuming that LNG is made available at multiple, new LNG terminals. This are, as of today, **highly speculative scenarios**, bearing in mind that PREPA has been attempting a natural gas conversion for almost 3 decades; and has consistently failed.

Assuming no additional LNG import facilities are developed in Puerto Rico; then each tank truck will contain a limited amount of LNG; and its continuity of service depends on a replacement truck taking its place before the existing's truck's LNG is depleted. Thus any major natural disaster such as an earthquake or hurricane will disrupt the site's supply of LNG; causing an immediate, indefinite shut-down. If the existing *Peak Units* would have been running on LNG trucks during Hurricane Maria; the units would have to be maintained out of service for weeks or months; due to the limited availability at the ports to receive the LNG trucks.

But, even assuming, *arguendo*, that multiple LNG import facilities become available; the onsite LNG storage considered due to its enormous complexity and cost (including on site storage and *re-gasification*), as well as the time of completion of such installations, would make it an inefficient arrangement.

To solve this problem, the proposed *MGTPU's* in the IRP should be immediately converted to LPG/SNG, achieving immediately a 30% plus reduction in fuel costs, as the USVI experience shows.

21. Has PREPA analyzed the container tank truck LNG option?

a. YES. In a 2017 a *Siemens* report prepared for PREPA called "*Fuel Delivery Option Assessment*" analyzed the possibility of supplying the San Juan, Palo Seco and Aguirre units via International Organization for Standardization ("ISO") LNG tank truck containers. The report discarded this possibility because of the huge amount of daily containers required; (as high as 600) but it also analyzed the logistical risks inherent to this option (assuming no additional LNG terminals are available). The report stated in Section 7.1:

"The complex supply chain involves many moving parts, requires tight coordination, and good working relationships with supply and delivery partners...

As mentioned above, successful operation of this complex supply chain will require the well-coordinated efforts of several third parties including the fuel supplier loading LNG into containers, the port authority loading containers, the shipper delivering the cargo, the Puerto Rico port unloading and delivering containers to San Juan, the San Juan staff manipulating the fuel storage container both full and empty, and a trucking service to deliver containers to other locations.

The health of any one partner could place the delivery at risk, so mitigating plans must be prepared to be executed upon."

22. Is the world's LPG market able and ready to handle PREPA'S requirements?

a. Yes. The world market for LPG is a surplus market, more than ready to absorve any increase in demand. As a matter of fact, as of 2019, the U.S. supply presents a gap between capacity and actual exports that started to open up in 2016 and is projected to close between 2019 and 2021. https://www.fgenergy.com/ngls/lpg-forecast-2019.aspx. It should be noted that the U.S. became a net exporter of LPG in 2012, and since then has been increasing its exports due to the so called "*shale revolution*", since American *shale* oil is rich in gas natural liquids; and LPG is being derived more and more from such liquids.

The ever increasing U.S. production of LPG has helped create the surplus market. Still, the US is expanding its LPG export capacity. As stated by Butane-Propane News in 2008:

"As noted at the February Argus Americas LPG Summit in Key Largo, Fla., the U.S. is not only the largest LPG exporter, but also the leading producer in the world, and one of the results of this exponential rise in production has been increased exports. **LPG exports have surged to more than 16 million tones a year from a starting point of about 5 million tones less than 10 years ago, meanwhile transforming the global market.** Additional projects to build new export facilities are planned, which could push U.S. export capacity to 40 million tons by 2018." (Emphasis added)

https://bpnews.com/index.php/publications/magazine/current-issue/830-u-s-is-world-s-largest-lpg-exporter-but-when-will-market-balance

According to *IHS MARKIT* in a presentation by Dr. Walt Hart, total LPG world production was 250 million metric tons (mm) in 2010; increased to around 325 mmt in 2019 and is expected to reach approximately 360 mmt in 2025.

https://www.lpgc.or.jp/corporate/information/images/Ph.D.,P.E.Hart.pdf

According to an OPIS Staff Report in January 2019:

"Significant continued growth is expected in U.S. propane production, associated with continued increases projected in Permian production. IHS Markit research points to a 300,000-b/d increase in U.S. propane production by end-2019, pushing the total to near 2 million b/d by the start of 2020, a new record." ....

Growth in production and flat demand would contribute to a build in U.S. propane inventories through 2019. IHS Markit projections call for U.S. propane stockpiles of 78 million bbl in December 2019, compared with around 68.5 million bbl at the end of 2018."

http://blog.opisnet.com/2019-lpg-price-preview

Puerto Rico would be not only a plausible customer for the world LPG supply industry; it would be a highly desirable one. Having established the worldwide availability of LPG/SNG; the Puerto Rico LPG industry has the necessary infrastructure, import facilities and transportation resources to serve PREPA'S requirements for LPG/SNG on an almost immediate timetable.

23. Siemens states in Section 7.1.2.14 of the IRP that while increases in propane production associated with U.S. *shale* gas production have led to recent market imbalances that have depressed the prices of this product, however LPG prices have begun to rise. *How does this compares to actual LPG Mont Belvieu Spot prices?*

a. **LPG prices have not increased at all; they have declined substantially**. According to the Energy Information (EIA) as of January 2018, the Spot Price per gallon at Mont Belview TX (reference market for Puerto Rico) for January 2018 was $.90, dropped to $.88 in June and further dropped to $0.67 in December. The price kept dropping in 2019; at $0.66 in January, decreased to $0.449 in June and reached a historic low in August of $0.40. Today it is $0.46.

https://www.eia.gov/dnav/pet/IHSt/LeafHandler.ashx?n=pet&s=eer_epllpa_pf4_y44mb_dpg&f=m

As indicated by *IHS MARKIT* in June 2019:

"**US propane prices have been on a free-fall since January of this year with further downside price pressure expected**. Weekly US propane prices have fallen from 63 cents per gallon (cpg) in early January to 41 cpg in mid-June based on various and sundry market factors. The market factors affecting the US propane price include but are not limited to crude oil prices, US natural gas production from both oil-directed drilling and natural gas-directed drilling, and weekly and monthly propane supply, demand, trade and inventory levels.." (Emphasis added)

https://ihsmarkit.com/research-analysis/how-low-can-the-mont-belvieu-propane-price-go.html

The increased offer of LPG on a worldwide basis, due to the enournous *Shale Gas* revolution factor; has expanded to global markets, making LPG increasingly atractive for alternate applications, including power generation. Furtermore, as highligted by Dr. Walt Hart:

"With US Shale Gas being a key disruptor of the decade, increased supply of LPG has been made available to the global markets, increasing product competitiveness. This is encouraging newer applications of the product, both on the wholesale and retail chain - from petrochemicals to usage as a marine bunker fuel." Wart Hart, *"LPG Demand Drivers for the Next Decade"* IHS MARKIT, 2019.

www.wlpga.org/wp-content/uploads/2018/12/Round-Table-Discussion-Global-Trends-Demand-Drivers-for-the-next-decadeWalt-Hart.pdf

According to Dr. Walt Hart, in an analisis taking into account the surplus market conditions of the LPG market driven by the U.S. *shale* revolution, LPG pricing at Mt. Belview TX will remain stable until approximately 2026, increasing then slightly due to---

production leveling and world demand flatening.

See *IHS MARKIT* presentation by Dr. Walt Hart, Supra.

Section 7.2.5 estimates future LPG prices based on a historical regression analysis of petroleum products. We believe that a more realistic approach should factor in the surplus market condition of LPG supply; created by the *shale* revolution as well as the forecasted increases in U.S. production. The IRP's LPG cost projection starts from a \$1.12 delivered price per gallon in 2018 and \$1.10 for 2019 benchmarks, and we believe that a current price (assuming no excise tax applies) should be close to \$0.95.

In our opinion, the forecasted increase in U.S. LPG production and the relative stability of U.S. demand; will keep the price on a lower track and further closing the small existing gap in price in terms of $MM/BTU between LPG and LNG.

The IRP's Fuel Cost estimate for 2018 is based on a *Base Forecast* of $0.87 (Nom. $/gal). See PREPA, CEPR Fuel Cost ROI 1_7_01. This appears to be based on the 2018 yearly price as indicated by the EIA of $0.878. But as of August 2019, the yearly average for LPG Spot Mt. Belview was approximately $0.56 (January to August) a $0.31 difference. Today it stands at $0.46.

https://www.eia.gov/dnav/pet/hist/EER_EPLLPA_PF4_Y44MB_DPGD.htmimately

The IRP's Section 7.1.2.14 forecast on climbing and increasing LPG prices seens to be not based on actual and real market conditions and should be revised and corrected immediately.

24. Siemens states in Section 7.1.2.14 of the IRP that in the long-term, propane prices will maintain higher levels relative to diesel and that propane is not expected to be long-term cost-effective solution. How do this compare to actual market conditions and data?

a. This conclusion does not constitute a correct analysis according existing and forecasted market condiotions.

First, the statement contradicts what is stated in the IRP in section 7.1.2.13, that: "***Siemens believes that LPG fuel will remain cost-competitive compared to diesel** and residual fuel oil.*" Also, it should be noted that comparing LPG to Diesel, Exhibit 7-

12. *Delivered Fuels Price Forecast to San Juan / Palo Seco / Mayagüez / Yabucoa* (Nominal$/MMBtu) the IRP maintains in general terms the price difference between LPG and Diesel; with a consecutive advantage for LPG.

Second, market analists forecast indicates that LPG should remain as a lower cost option over diesel fuel oils. As stated in recently by the WLPGA:

"The US shale gas boom has increased the production of LPG considerably, and propane is also now competitively priced compared to LFO and HFO. **The US Energy Information Administration forecasts that propane will be significantly cheaper than both LFO and HFO in the region in the future.**" https://www.wlpga.org/wp-content/uploads/2019/02/Roatan-28-MW-LPG-Power-Plant-2019.pdf

Furthermore, according to General Electric:

"There are alternative fuels that offer both environmental and economic benefits. For example, propane (LPG) is both a lower cost fuel and offers improved emissions (fewer particulates, less SOx) than some liquid fuels, including high sulfur diesel fuels and HFO. Figure 17 shows that **propane spot prices have been historically lower than diesel, with propane being ~50% of current diesel prices as of November 2018**." General Electric, *Aereo Fuel Flexibility Whitepaper,* (supra).

Please note that as previously stated in our answer to question 23, LPG has been forecast to maintain price levels per gallon of close or lower than $0.50 until 2026, and then increasing slightly and Siemen's Fuel forecast calls for Diesel prices ascending up to $2.35 per gallon on 2026 and constantly climbing tp $3.34 in 2040. See PREPA, CEPR Fuel Cost ROI 1_7_01.

25. Siemens states in Section 7.1.2.14 of the IRP that over the past two years, propane has been about 2.5 times as costly as natural gas. Is this a correct conclusion?

a. No. According to Exhibit 7-13 of the IRP, Costa Sur natural gas in 2018 had a cost per MM/BTU of $9.02 and $8.08 in the best scenario. As previously stated in our answer to question 13, LPG would have an approximate cost per MM/BTU of $10.37 (at $.95 per gallon).

As simple mathematics reveals, 2.5 times $9.02 equals to $22.50. For LPG to reach this price level, each gallon of LPG would need to have a delivered price of approximately $2.00. The annual average LPG per gallon Mt. Belview price was $0.48 in 2016, $0.76 in 2017 and $0.87 in 2018.

25. What are Empire's specific recommendations related to the IRP?

a. **First,** the IRP should be reviewed and Section 7.1.2.14 *No New Natural Gas Infrastructure,* should be amended to conclude that **LPG/SNG is a viable and practical primary fuel for PREPA'S need for a clean, affordable fuel in order to fulfill the IRP's policy objective,** for the following reasons: a) The LPG market operates on a supply side, with a low cost forecast for the next 10-15 years; it is available and ready to immediately serve Puerto Rico's immediate needs for a safe, economic and environmental friendly fuel as a replacement for fuel oils. b) LPG is a safe and clean fuel, and it is NOT classified as a greenhouse gas, c) LPG/SNG storage cost and development time are a fraction of those required by LNG. d) LPG infrastructure and market have been developed in Puerto Rico for decades, and the local LPG industry is ready to serve PREPA'S needs; and at the same time, helping our local economies' growth.

Second, the IRP should be amended to provide for the use of LPG/SNG instead of LNG for the conversion of existing "*Peaking Units*" and future *MGTPU's* from diesel fuel to a new fuel; as well as for the proposed building of additional units up to a total of 18 units. The IRP indicates that these new units will be capable of burning **containerized natural gas** delivered by truck with on-site tankage. See **Section 10.1.5 Install New Resources, Mobile *Gas Turbine Peaking Units (MGTPU's)*.** <u>**We propose that such units should be fueled instead with LPG or SNG entirely.**</u>

It is Empire's proposal that such *Peaking Units* and new *MGTPU's* should be fired entirely using LPG/SNG instead of LNG, at a lower cost than diesel; taking into effect the following factors: a) LPG/SNG is readily available for immediate consumption, whereas a containerized natural gas is not and its availability in significant numbers depends on the yet to be built LNG importation and re-gasification facilities; b) capital cost of establishing an *on-site* LPG/SNG storage facilities is minimal compared to containerized natural gas, which might be several times higher; c) containerized natural gas depends on the continuous availability of relatively small capacity self-contained storage trucks and does not provide a high security of supply assurance d) LPG/SNG can be stored nearly indefinitely without degradation e) as demonstrated in the weeks following Hurricane *Maria*, diesel supplies were rapidly exhausted; but LPG was available in quantity due to the industries' proven storage capacity.

As previously discussed in question number 20, natural gas delivered by truck with onsite tankage is not a viable alternative for the *MGTPU's*. If the IRP is not immediately amended, switching from LNG to LPG/SNG, the integration to the grid of the *MGTPU's* and the existing *Peking Units* with an alternative, cheaper and cleaner fuel would be unreasonably delayed; constituting an unreasonable burden on the IRP's implementation schedule. It would condemn energy consumers to higher energy costs for many years, just because the IRP insists on relying on natural gas being available in large quantities and places, when the present conditions do not facilitate such scenario.

Third, as to the proposed new LNG marine terminals in Mayagüez and Yabucoa, Sections 1.2.3 (10), 1.2.3 (11) and 10.1.7 of the IRP; for which the IRP, based on the uncertainty of the availability of an abundant natural gas supply on the island, recommends that PREPA proceed with the preliminary permitting and planning activities for LNG conversion together with their associated ship-based LNG delivery infrastructure; (Section 1.2. page 1-8) **we recommend instead that such terminals should be for LPG instead of LNG importation and work to begin immediately.**

This is due to the fact that contrary to the case of natural gas, LPG presents absolutely no uncertainties at all. Quite to the contrary, storage could be easily done with standard LPG tanks and supply of LPG would be immediately available.

The Mayagüez 4 x 50 MW *aeroderivative* gas turbines could be quickly converted to LPG or dual LPG/LNG service. As stated by GE:

"Today, GE's aeroderivative gas turbines are capable of operating on a wide range of LPG fuels, from 100% propane to 100% butane. This has been enabled primarily by upgrades to the controls and fuel accessory systems to deal with the large difference in vaporization temperature between propane and butane." General Electric, Aereo Fuel Flexibility Whitepaper" (supra).

Even before the burner conversion is finished, a receiving LPG storage terminal facility could be designed and built at a fraction of the cost and time required for a LNG terminal.

In relation to the proposed CCGT 302 MW unit planned for Yabucoa, there could be many options for the establishment of a LPG import facility near the new plant. Again, this could be done at a fraction of the time and cost.

Fourth, as to existing mayor mayor oil or diesel fueled generating units that are close to a port facility; such as Aguirre Steam I and 2, CCGT 1 and 2; Costa Sur Steam 3, 4, 5 and 6; Costa Sur GT and Palo Seco 1, 2, 3 and 4; the IRP should consider switching from natural gas to LPG/SNG as their main fuel source; because of the immediate availability of such fuel sources, immediate favorable environmental impact and the short construction time for storage facilities.

26. What would be your conclusion and closing remarks?

a. As time is of the essence, the IRP should mandate the LPG/SNG fuel option as the most readily available and cost-efficient option for the implementation of the IRP's goals in relation to environmental compliance and facilitating the incremental use of renewable energy sources. Plus, the use of the local LPG industry as a primary fuel source for PREPA or its successors would help the island's economic development process by generating new jobs and economic opportunities locally.

The Puerto Rico LPG industry is here, available and ready to immediately serve Puerto Rico's immediate needs for a safe, economic and environmental friendly fuel as a replacement for fuel oils. Contrary as indicated in the IRP, LPG prices are not increasing; they have been reduced scientifically. The IRP should incorporate this unique opportunity. Otherwise we will be held hostages of the *natural gas continuum*, endlessly waiting for two or more decades for a multiplicity of natural gas import and storage facilities as Section's 1.1 Scenarios' 2-5 hope for; that have never materialized.

CERTIFICATION

I Ramón González Simounet, of legal age, single and a resident of San Juan, P.R. CERTIFY that the contents of my testimony of facts personally known to me is the truth according to my best good faith and reasonable knowledge. As for all technical and operational aspects included in my testimony; they are based on public information which I have gathered in good faith; but I cannot and do not guaranty the truthfulness and veracity of such information gathered from third parties.

____
RAMON GONZALEZ SIMOUNET

Affidavit 9421

Sworn and subscribed before me by Ramón González Simounet, of legal age, single, lawyer and a resident of San Juan, PR who I do give faith of knowing personally in San Juan PR this 14 of October 2019.

____
NOTARY PUBLIC

ALBERTO COUVERTIE-BARRERA ABOGADO-NOTARIO

Respectfully submitted, In San Juan, Puerto Rico, this day 15 of October, 2019.

Electronically Filed https://radicacion.energia.pr.gov

CERTIFY: that I have sent a copy of this motion via e mail to all parties in the case as follows:

RECIBO

4U18-04433541

Sello

CNPR/VBO

9397
07/23/2019
$5.00

Sello de Asistencia Legal
80069-2019-0723-71744209

RTO COUVERTIE-BARRERA
-NOTARIO

I CERTIFY: that I have sent a copy of this motion via e mail to all parties in the case as follows:

wcordero@energia.pr.gov	astrid.rodriguez@prepa.com	jorge.ruiz@prepa.com
n-vazquez@aeepr.com	c-aquino@prepa.com	acarbo@edf.org
javier.ruajovet@sunrun.com	pedrosaade5@gmail.com	rstgo2@gmail.com
rmurthy@earthjustice.org	larroyo@earthjustice.org	jluebkemann@earthjustice.org
carlos.reyes@ecoelectrica.com	ccf@tcmrslaw.com	rtorbert@rmi.org
victorluisgonzalez@yahoo.com	mgrpcorp@gmail.com	hrivera@oipc.pr.gov
jrivera@cnslpr.com	axel.colon@aes.com	acasellas@amgprlaw.com
corey.brady@weil.com	maortiz@lvprlaw.com	rnegron@dnlawpr.com
paul.demoudt@shell.com	escott@ferraiuoli.com	aconer.pr@gmail.com
agraitfe@agraitlawpr.com	presidente@ciapr.org	castrodieppalaw@gmail.com
voxpopulix@gmail.com	cfl@mcvpr.com	sierra@arctas.com
tonytorres2366@gmail.com	info@liga.coop	amaneser2020@gmail.com
csanchez@energia.pr.gov	sugarte@energia.pr.gov	ireyes@energia.pr.gov
asanz@energia.pr.gov	bmulero@energia.pr.gov	viacaron@energia.pr.gov
nnunez@energia.pr.gov	gmaldonado@energia.pr.gov	kbolanos@diazvaz.law
corey.brady@weil.comc	secretaria@energia.pr.gov	legal@energia.pr.gov

s/MANUEL FERNANDEZ MEJIAS
RUA: 8170
PO BOX 725
Guaynabo PR 00970-0725
TEL: 787-462-3502
manuelgabrielfernandez@gmail.com