Response to Consultation Document:

COMMENTS ON INTEGRATED RESOURCE PLAN PROPOSAL CONSULTATION

REGULATORY AUTHORITY OF BERMUDA

17 August 2018

Submitted by a consortium comprised of the following members:

Bermuda Environment Energy Solutions Group
Louis Berger Power
Corcon Ltd.

NON-CONFIDENTIAL VERSION

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17 August 2018

Regulatory Authority of Bermuda
Attn: Monique Lister, Senior Legal Advisor
Craig Appin House, 1st Floor
8 Wesley Street
Hamilton HM11
Bermuda

Subject: Response to Consultation Questions from the Regulatory Authority of Bermuda Regarding Bermuda Electric Light Company Ltd. (BELCO)'s Integrated Resource Planning Proposal

Dear Madam,

This submittal supersedes and replaces in its entirety our response on 2 July 2018.

Our locally owned company, Bermuda Environment Energy Solutions Group (BEESG), has formed a diverse, dynamic, and experienced consortium of leading local and overseas companies to develop a robust solution herein presented in response to the need for an affordable, reliable, and environmentally sustainable energy supply option for the island of Bermuda.

We assembled this consortium to respond expressly to the Bermuda Land Development Company (BLDC)'s recently released Request for Qualifications (RFQ) for the development of a power plant at Marginal Wharf. We believe our international experience in project development, engineering, procurement, and construction, in combination with local knowledge and expertise, uniquely positions us to deliver a quality product that aligns with the needs and aspirations of the people of Bermuda. Our extensive network of financing options completes the suite of capabilities built into this consortium, which are critical to the successful delivery of any bankable infrastructure project.

The members of our consortium are as follows:

1) **BEESG, http://www.beesg.com,** is an environmental and project development company headquartered in Bermuda and operated by Bermudians. Mr. Oliver Binns, entrepreneur and promoter of responsible energy solutions, heads this group. Mr. Binns has worked in the areas of sports management, information technology, and all aspects of the hospitality industry. Mr. Damon Wade, a former BELCO engineer and general manager of Bermuda Gas & Utility, is a widely recognized local energy expert and locally registered professional engineer who supports this effort.

2) **Louis Berger Power (LBP), https://power.louisberger.com,** a wholly owned subsidiary of Louis Berger, is a USA-based global EPC power projects company delivering customized, turnkey solutions supporting the full project lifecycle. LBP focuses on emerging and frontier markets, remote locales and island power solutions integrating the newest OEM technology and fuels infrastructure, resulting in the most cost effective, lowest emissions-solution. Recent/current island project locales include American Samoa and Puerto Rico/USVI.

3) **Corcon Ltd, www.correiaconstruction.bm**, a locally owned Bermuda general contractor providing electrical engineering and construction services for a wide range of projects and clients to include residential, commercial, industrial, and marine. Project scope includes, but not limited to, feasibility, arc-fault and coordination studies; technical review, design/build construction, and plant testing and commissioning.

Regarding project financing, we are engaged in discussions with a number of credible investment management firms specializing in government, social and economic infrastructure, healthcare and energy-related assets. Our intent is to work with a firm whose focus is not only providing our consortium with the most competitive financial position, but also with a stake expressly in Bermuda infrastructure, ultimately benefiting the community.

Collectively, we offer this submission to the IRP public consultation process. As per the requirements for submission, we believe that our proposal demonstrates (i) how its inclusion in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and ministerial directions and (ii) how it uses technology that is in commercial operation in another jurisdiction. Should you have any questions, or require additional information, please contact me at OEBinns@beesg.com or (BDA) +1 (441)-705-2337 or (US) +1 (424)-571-0771.

Sincerely,

Oliver E. Binns
Chief Executive Officer, Bermuda Environmental Energy Solutions Group

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QUESTION 1

Are there any provisions in the IRP proposal that should be modified? Please include any reasoning and evidence in your answers.

Given the huge task of evaluating BELCO's IRP submission for the first time, we believe it would be wise for the RA to solicit an independent engineering assessment of the IRP proposal's compliance with the Authority's IRP guidelines. We believe Section 5 of the report submitted by Oxera accurately captures the weaknesses of BELCO's IRP. However, there are three areas of concern listed in Section 5.2 of Oxera's submission that we wish to elaborate on in our response.

1) **Methodological Concern.** We believe BELCO's IRP falls short on its obligation to enable the Regulatory Authority to deliver on Section 3.4 of IRP Guidelines:

   "3.4 The IRP must therefore be credible, comprehensive in its treatment of available resources (whether currently available or anticipated to be available in future), auditable, and robust to identifiable sources of uncertainty in order to enable the Authority to:
   - *approve the least-cost, or otherwise most appropriate, electricity capacity expansion plan that meets demand at lowest overall cost and with acceptable levels of system reliability and implementation risk to consumers;*
   - *assess the economic, environmental, and social implications of adopting alternative capacity expansion plans so as to be able to determine the optimal trade-offs contained in Ministerial directions; and*
   - *evaluate the merits of applications by prospective IPPs or other licensees as well as other proposals that entail deviations from the IRP, in particular by calculating their benefits, costs, and risks to the electricity system."*

   We have provided presentations to BELCO in the past, and we are confident that they are fully aware of proposals from other IPPs. However, their submission makes no mention of other IPPs other than Tynes Bay and the impending solar project designated at "The Finger." Failure to disclose these options, while possibly an oversight, disempowers the RA in their attempt to satisfy Section 3.4 of the IRP guidelines.

2) **Replacement Generation.** We vehemently agree with the views expressed by Oxera in Section 5 of their submission, in that to render the 56MW upgrade unavailable to IPPs is in direct opposition to Section 5.4 of the Bermuda National Electricity Policy:

   "5.4 Independent Power Producers
   It is the Government's policy to create an enabling environment for IPPs to introduce competition in bulk generation, help reduce the cost of power in Bermuda, develop new energy sources, and contribute to achieving the other objectives of this Policy. For example, the Government recognises that IPPs may bring unique expertise that can yield high-quality generation using technologies not currently in the electricity matrix, thus promoting energy security and realising more opportunities to reduce local and global emissions.

   IPPs are entities that provide energy, capacity, and ancillary services (for example storage) for commercial purposes, exclusively to the Electric Utility under long-term contracts that have been secured through the IRP process (see Section 6)."

   Figure 1.5 of the IRP illustrates the existing local generation capacity, the approved capacity for the upgrade to the North Power Station (NPS), and the anticipated demand for the island. When taken into consideration in conjunction with the lifecycle of the new build and the RA's obligation to ensure a reasonable return on that investment, it becomes increasingly clear that allowing BELCO to build this project precludes any further significant entry or opportunities for IPP "Bulk-Generation" on the island until 2031. This will essentially limit the breakthrough of new technologies and/or renewables into the local energy mix for the next decade.

3) **Qualitative Assessment.** We support the assessment criteria of Table 1-3 of BELCO's submission, but we believe the subjective nature of a qualitative assessment renders it meaningless in this process unless it is completed by the Regulatory Authority – not a self-assessment.

QUESTION 2

Do you consider the procurement strategy outlined in the IRP proposal to be appropriate?

Considering the forecasted generation capacity requirements for Bermuda over the next 10 years, BELCO has incorporated into its IRP submission the 56MW plant that it has recently been approved to build for their NPS project. We consider this a highly inappropriate procurement strategy. Our rationale is as follows:

a. There is no indication that this is a "Least Cost" solution. Even if BELCO did release this for competitive bidding, it is our understanding that the quotes are now several years old and that there are new players and technologies present in the market that can offer an overall better value (see our response to Question 6 as follows).
b. The decision to approve the 56MW plant was heavily influenced by the risks associated with the security of supply. The most salient factor was the time requirement to replace our most at-risk generation plant in comparison to the potential savings inherent and anticipated in this IRP public consultation process. BELCO has not started their process (presumably due to their need to wait on the results of their rate increase submission, to be determined after the public consultation of this IRP). Furthermore; they have increased the depreciation terms of their generation assets in their latest annual report. Both facts suggest the risks originally assumed regarding the reliability of supply on the island are no longer as critical as originally proclaimed; hence, we believe the approval for the 56MW plant should be denied by the Regulatory Authority under the provisions of the Regulatory Authority Act (RAA) and subsequently re-released for open competition through this IRP process.
c. If our recommendation to deny the approval of the 56MW plant above is rejected, any competitive generation for the grid is precluded until 2026 at the earliest (according to Table 1-1 of the IRP).
d. Furthermore, in spite of BELCO's preferred Scenario 3, **Figure 1**, their actual approval is consistent with Scenario 2, **Figure 2**. BELCO's approval has no provisions for the importation, regasification or storage of LNG (liquefied natural gas). Given the Bermuda National Energy policy targets, **Figure 3,** and the approval of the 56MW, BELCO plan is far off the mark as it relates to the government's LNG and Solar/PV aspirations, **Figure 4**.

Figure 1 – BELCO Integrated Resource Planning Proposal – Scenario 3

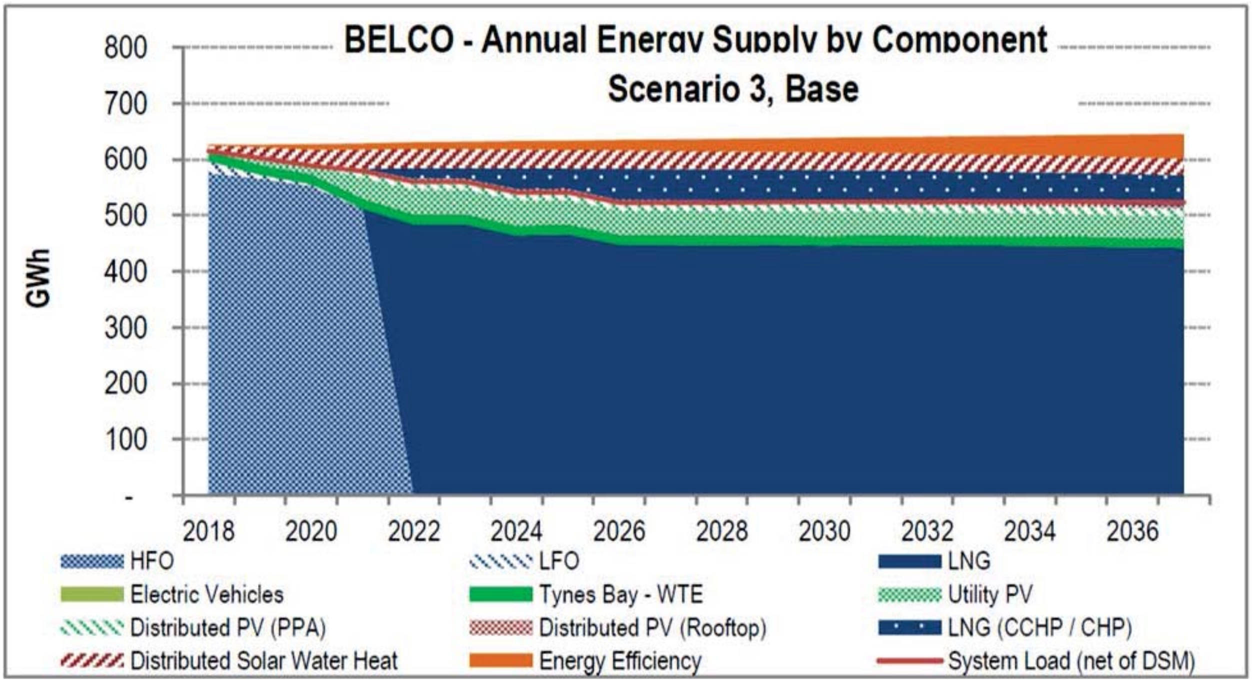


Figure 2 – BELCO Integrated Resource Planning Proposal – Scenario 2

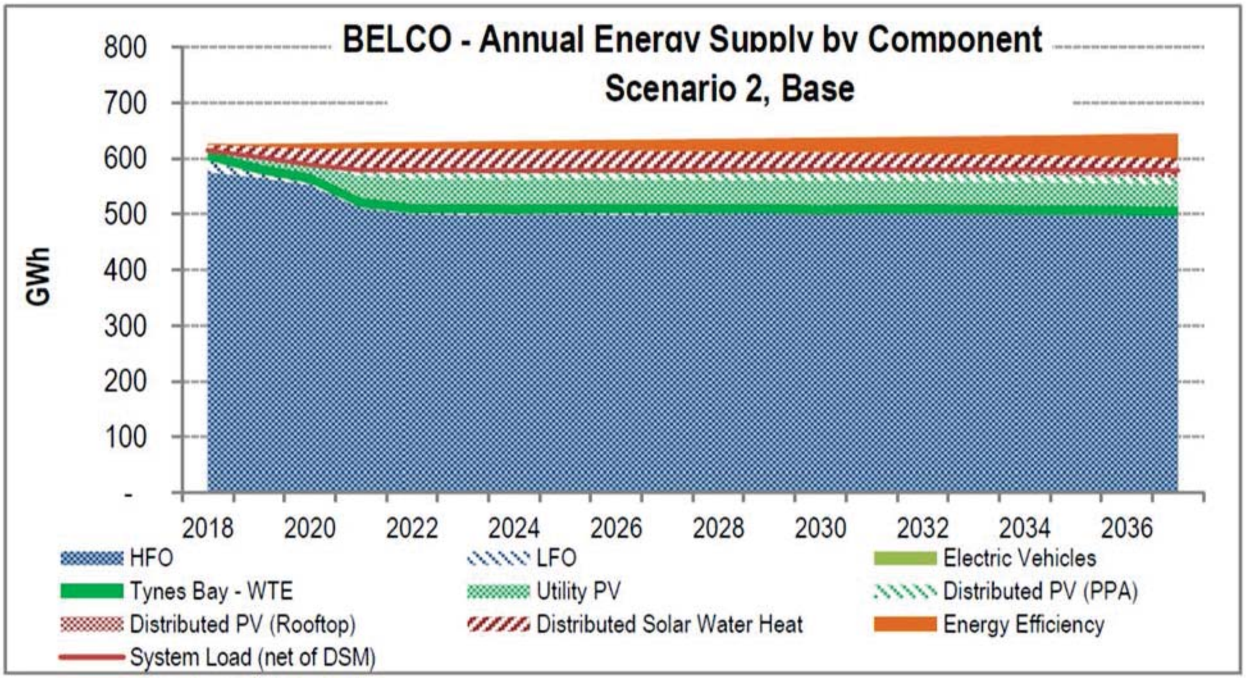


Figure 3 - Bermuda National Energy Policy - Targets

4.1 Targets

Indicative targets shown in Table 4.1 allow benchmarking the sector in terms of share of renewable generation, diversity of supply, emissions of GHGs, and energy efficiency.

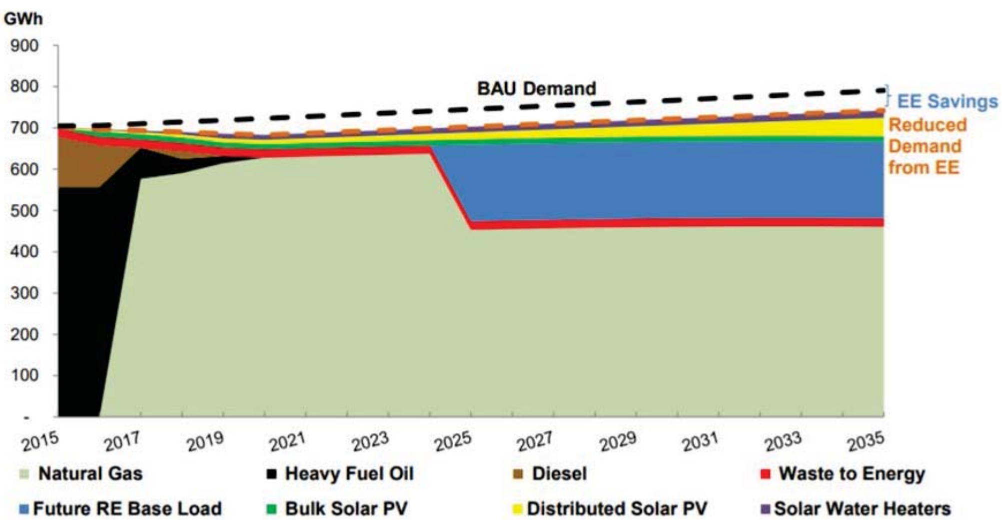
Table 4.1: Targets for Electricity Performance

Target	Unit	2020	2025	2035
Share of renewable generation	%	8%	35%	38%
Share of generation by source	Natural gas %	92%	65%	62%
	Waste to Energy %	3%	3%	3%
	Bulk Scale Solar PV %	2%	2%	2%
	Distributed Solar PV %	1%	2%	6%
	Solar water heaters %	2%	2%	2%
	Future Renewable Energy Base Load %	0%	26%	25%
Share of peak demand by source †	Natural gas %	91%	117%	122%
	Waste to Energy %	6%	6%	6%
	Bulk Scale Solar PV %	8%	7%	7%
	Distributed Solar PV %	6%	9%	24%
	Solar water heaters %	7%	8%	10%
	Future Renewable Energy Base Load %	0%	21%	20%
Annual emissions	Tons CO_2e	401,488 (-33% vs BAU)	289,980 (-52% vs BAU)	294,663 (-55% vs BAU)
Energy efficiency / conservation	Average annual consumption per end user, in MWh (includes self-generation)	16.50 (5.2% below BAU)	16.97 (5.2% below BAU)	17.93 (5.2% below BAU)

Note: † Share of peak demand by source adds up to more than 100% due to reserve margin (installed capacity > peak demand). BAU = business as usual. CO_2e = carbon dioxide equivalent.

Figure 4 - Bermuda National Energy – Aspirational Electricity Matrix

Figure 4.1: Aspirational Electricity Matrix, 2015–2035



QUESTION 3

Which generation resources should the TD&R Licensee procure using competitive bidding, if any?

Given our response to Question 2 (above), it should be clear that we believe the 56MW plant recently approved by the Regulatory Authority should be denied under section 63.1(b) of the Regulatory Authority Act:

> *"63 (1) The Authority may issue orders that do any or all of the following—*
> *a. grant or deny any application or request received from a sectoral participant;*
> *b. approve, modify or disapprove any submission received from a sectoral participant;*
> *c. clarify the application of any statutory provision, regulations or administrative determination to a specific factual situation; and*
> *d. take any other action within the scope of its authority, other than an action that may only be taken by the adoption of a general determination or an adjudicative decision and order."*

We believe the RA can "disapprove" the existing submission if they receive a better alternative solution through the IRP consultation process. Oxera agrees with our view, as illustrated in section 5.7 of their submission:

> *"5.7 The second concern is that the IRP Proposal proceeds under the assumption that the replacement generation Assets are not to be subject to the IRP process. By effectively treating replacement generation as outside of the IRP process, the extent to which the policy objectives of the Government and the Authority, as well as the extent to which the replacement generation facilitates the least-cost provision of electricity, is not considered. By taking the replacement generation as an input rather than an output of the IRP process, it is not possible to observe the cost-efficiency of the replacement generation relative to the other options for new generation capacity that are available."*

QUESTION 4

Are there alternative scenarios not included in the IRP proposal which may provide for an electricity generation mix that is more consistent with the purposes of the EA (e.g. least-cost provision of reliable electricity?

Our proposal is a primary fuel LNG solution (see response to Question 6, below) which brings additional benefits to the people of Bermuda more closely aligned to the Electricity Act 2016. These include:

- Competitive power generation supply
- Decentralized power grid
- Lower electric costs throughout Bermuda
- Improved environmental performance
- Modern, efficient, reliable and proven dual-fuel technology
- Creation of new jobs and an injection of capital to stimulate business in Bermuda
- Promote BLDC's success and the revitalization of business in St. David's

QUESTION 5

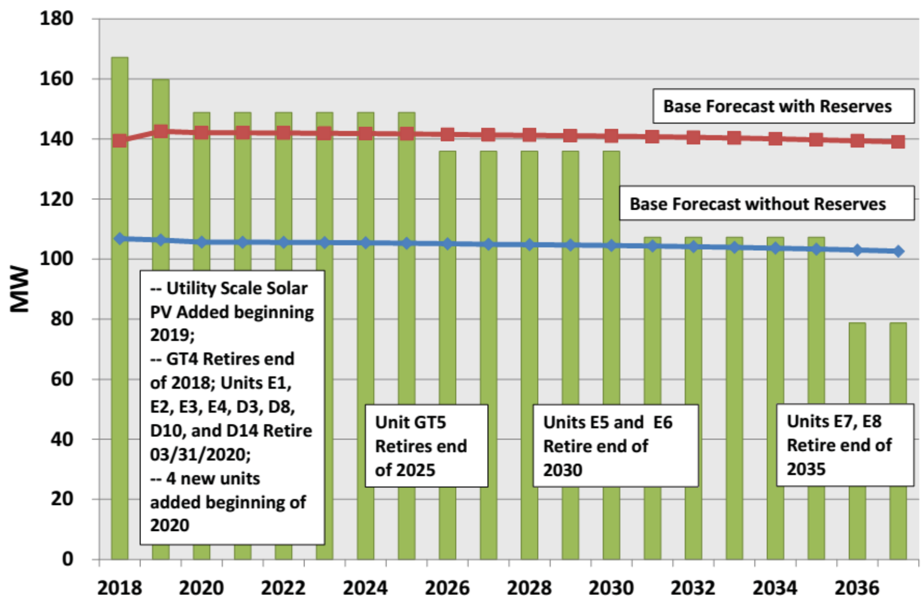
Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?

5.1 Replacement alternatives

The fundamental objective of power system operations is to continuously match supply of energy from power generation to customers' load. This involves proper planning to ensure the power supply has sufficient energy, capacity and balancing capability to cover the monthly, daily and hourly variations in load and generation. Currently, in Bermuda the system has sufficient capability to cover hourly peaks (capacity) and short-term variations in load (balancing); however, this will not be the case when existing capacity is retired.

The electric utility industry employs a simple strategy for maintaining reliability: always have more power supply available than demand requires. In the IRP, BELCO defines a Reserve Margin (RM) of approximately 35%, resulting in a 35 MW margin, which is the difference between the blue/base and red/reserve lines depicted on **Figure 5** below.

Figure 5 – BELCO Integrated Resource Planning Proposal – Capacity vs Load



BELCO plans to retire approximately 11 MW at the beginning of 2019 and 68.5 MW by end of March 2020. The retirement of the 11 MW will not affect the RM as the existing network has surplus capacity.

According to the IRP, the 68.5 MW will be replaced by four (4) new units, with a gross rating of 57.6 MW. These units are dual-fuel engines that will primarily burn HFO with an average heat rate of 8,400 BTU/kWh, until LNG is available on-island. **Figure 5** above already reflects this replacement, without considering alternatives. **Figure 5** does show additional RM may be required in 2026, and in 2031 and 2036.

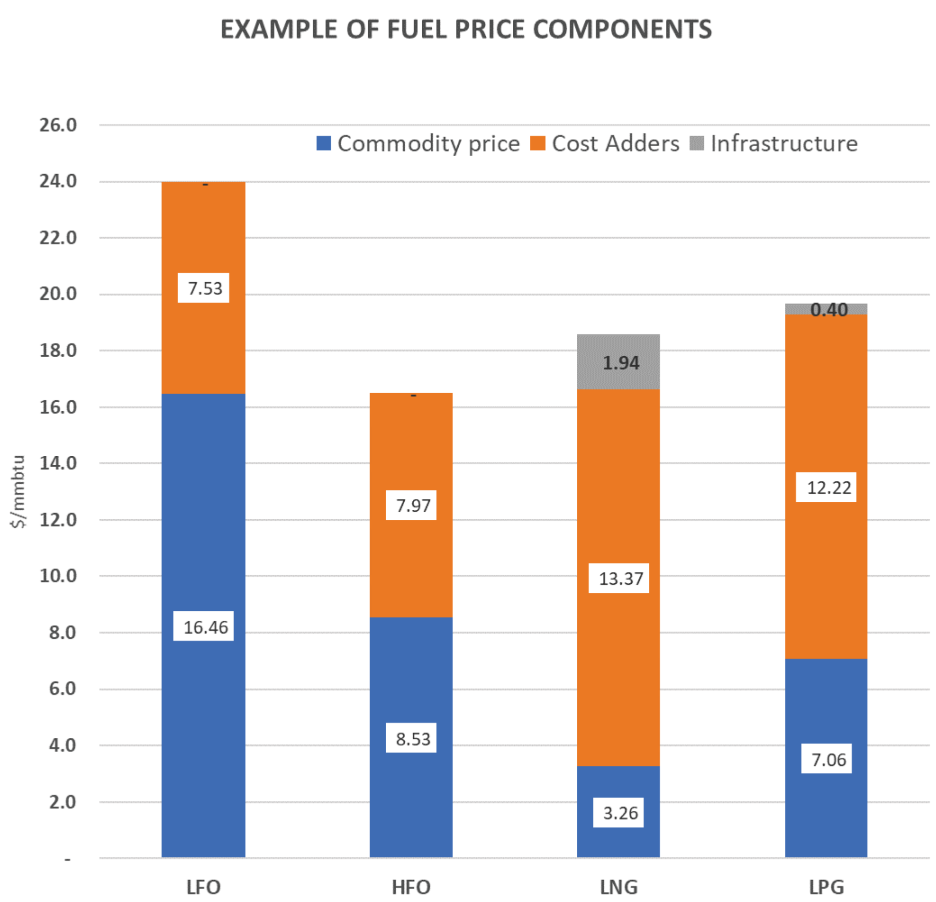
With the present generation technology, we believe that better power generation alternatives in the market can provide a more cost effective and efficient solution for the replacement strategy. One of the main purposes of the Electricity Act is to promote and preserve competition, which can be accomplished by including other potential "Bulk" generators to participate in the retirement and replacement plan.

5.2 Price projection

The fuels currently used for generation by BELCO are LFO (diesel fuel—ULSD/DS2) and HFO (heavy fuel oil), both are supplied by a local on-island company.

In the IRP, HFO, LFO, LPG (liquefied petroleum gas) Bulk, and LNG Bulk commodity pricing are based on BELCO's information and other external sources with no independent verification. Similar comment applies for the fuel "Cost Adders" used for the Projections and Detailed Fuel Model Development. Therefore, we highly recommend the RA seeks commodity pricing data from independent fuel suppliers and other market sources. In particular, we believe that the fuel Cost Adders for LNG and LPG as shown in the Appendix to the IRP, **Figure 6**, below are extremely high. Please note for the purposes of our response and comparison, we use BELCO's Projections and Detailed Fuel Model Development for the various calculations and/or evaluations (versus independent pricing data).

Figure 6 – Detailed Fuel Model



LNG and LPG infrastructure capital costs are included in the all-in costs and amortized for the lifetime of the project. Details can be found in the IRP's Appendices.

QUESTION 6

Do you have any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

Yes, we propose an alternative that is cost effective, efficient, in compliance with environmental standards, and achieves the intent of the Electricity Act.

We hereby propose the following solution:

- A 56.2 MW Power Plant in a LNG/HFO dual fuel configuration, comprised of six (6) high efficiency [redacted] generators, to be located at the BLDC energy site at Ships Wharf, St. David's.

As stated in our response to Question 4, this option will lead to the development of a decentralized and resilient power grid for Bermuda, bringing innovation to the traditional centralized power distribution system. In addition, this will also promote the development of St David's and new LNG infrastructure in Bermuda.

6.1 Technology Selection

We propose the use of LNG and HFO as fuels for power generation in a dual-fuel engine configuration. LNG will be the primary fuel and HFO as secondary.

We have also evaluated the use of LPG fuel for power generation. Although the landed LPG prices in Bermuda, as presented in the IRP are somewhat higher than LNG, the infrastructure cost of the facilities required for receiving and handling LPG are much lower than the infrastructure cost for an LNG terminal. Using internal combustion engines (ICE) in a dual-fuel configuration, LPG can be used as primary fuel, but only LFO as secondary fuel. However, the price of LFO brings this configuration to a disadvantage as LFO is much more expensive when compared to HFO as a backup fuel.

The LPG option will be further evaluated covering (1) an in-depth revision of the LPG cost adders, and (2) an increase of the storage capacity at the supplier location to avoid the use of LFO as backup fuel. We have also considered another alternative by using LPG in straight gas engine burning LPG/NG. However, this option is considered not relevant since no liquid fuel is used as backup.

6.2 Plant Proposal

The power plant proposed is a tested and well proven simple cycle power plant configuration, comprised of six (6) high efficiency [redacted] lean-burn reciprocating dual-fuel engines. We select these units as prime movers based on their reliability, high efficiency and cost effectiveness, providing 56.2 MW gross power under ISO conditions.

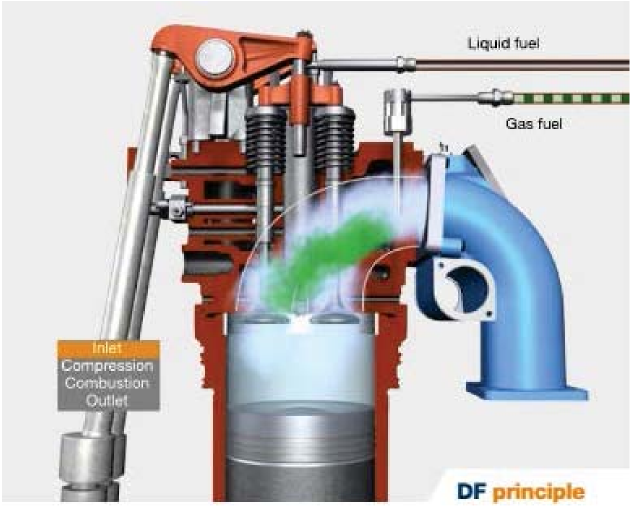
Wärtsilä's multi-fuel power plants have a reliable, high-performance history, effectively implemented in many locations with energy output and fuel efficiency consistent across the entire load range. [redacted]

The unique operational flexibility of the Internal Combustion Engine (ICE) technology with ultra-fast starts and stops and quick loading ensures seamless control overload fluctuations. As energy demand grows, their modular design makes it easy to expand the power plant to meet any future needs. Plants can be upgraded at any time without risking operational reliability.

6.3 Dual-Fuel Engines (DF) Technology

When operating on gas, the dual-fuel engine depicted in **Figure 7** (right) utilizes a lean-burn combustion process. The gas is mixed with air before the intake valves during the air intake period. After the compression phase, the gas-air mixture is ignited by a small amount of liquid pilot fuel. After the working phase the exhaust gas valves open and the cylinder is emptied of exhaust gases. The inlet air valves open when the exhaust gas valves close, and the process starts again. The dual-fuel engine is also equipped with a back-up fuel system. This is a normal diesel process with camshaft operated liquid fuel pumps, running parallel to the process and working as a stand-by. The engine can switch between diesel and gas mode, even during operation.

Figure 7 – Dual-Fuel Engine



The key benefits of this technology are:

- Flexibility to operate on natural gas and liquid fuels (LFO and HFO)
- High efficiency
- Low emissions, due to clean fuel and lean burn combustion
- Low gas pressure
- Pilot fuel for ignition of gas
- Advanced control.
- Gas mode operation, 0-100%

The proposed [redacted] multi-fuel power plant consists of:

- Generating sets (6x[redacted])
- Mechanical auxiliary systems including the fuel system, lubrication, air intake, cooling, exhaust processing and sound-proofing
- Electrical systems
- Automation
- Civil works and structures.
- Optional heat recovery system for additional power generation

The multi-unit configuration creates a part-load profile that enables the plant's entire output range to be optimized (high turndown capability). For any given total plant load, this multi-fuel power plant withstands extreme conditions, with minimal de-rating of the heat rate and output in hot temperatures. The engine cooling arrangement using closed-loop radiator cooling reduces the plant process water consumption to a mere 0.2 l/MWh, minimizing the effect on local water resources.

Generators are installed on a common base frame with the engines and the common base frame is isolated from the foundation by flexible mounting with steel springs. Most of the auxiliaries are factory built in large new type modules which enable easy relocation of the equipment.

The control system is a distributed bus-based system where monitoring and control function is placed close to the measuring and control point. This leads to less wiring and improved performance. The engines are designed for continuous operation in gas mode in island mode at any load between 40 -100% of nominal power.

The multiple generating set concept ensures high reliability and availability. All maintenance can be performed on-site, one engine at a time, leaving the remaining units fully available for duty. The use of several identical engines also reduces the cost of on-site spare parts stock. [redacted]

The environmental impact of this multi-fuel power station is low. Lean combustion reduces peak temperatures and therefore NO_X emissions. In gas mode, the engine is already compliant with IMO Tier III regulations without any secondary exhaust gas purification systems. Dual-fuel technology offers reduced SO_X and CO_2 emissions as well as smokeless operation in gas operation mode. In liquid fuel oil mode, the dual-fuel engines are fully compliant with the IMO Tier II exhaust emissions regulation. To further reduce the environmental impact and to comply with even the stringent regulations, effective oxidation catalysts, NO_X catalysts, and other advanced equipment can be installed.

The engine hall design and low building profile will aid the plant blend in blending in with its surroundings. Effective soundproofing allows the plant operations in even densely populated areas.

6.4 Performance

These [redacted] units have guaranteed performance with heat rates below 8,000 BTU/kWh – reporting efficiencies (LHV) of 43.1% when burning HFO and 45.2% when burning NG. [redacted]

Introducing a combined cycle solution via steam boiler module and steam turbine, powered by engine waste heat can improve plant efficiency and increase power production by approx. 10%. The steam cycle option can either be included in the initial design or added at a later stage.

The power plant has a footprint of approximately 20,000 m². [redacted]

6.5 Fuel Consumption

- LNG

The estimated LNG consumption is approximately 15,700 m³/month at 100% load. LNG can be provided to the plant via pipeline from a new receiving terminal. In this case, the LNG would be received at the plant conditioned, at low pressure.

Another alternative but not financially evaluated, is to develop a small-scale receiving terminal adjacent to the power plant in at Ships Wharf. This option may also reduce the cost of fuel, and therefore the cost of electricity. In this case, the LNG can be stored in cylindrical metal tanks at pressures of up to 10 bar (150 psi). The benefit of employing pressurized tanks is the boil-off gas can remain in the tank and act as a pressure source for gas feed. When the excess pressure is controlled by releasing gas through a control valve, the evaporation inside the container lowers the temperature and keeps the container in equilibrium. As a result, the tank arrangement is extremely simple, having no compressors or rotating equipment of any kind. It simply consists of the tank, an emergency pressure relief valve, regasification heat exchangers, and an outgoing gas pressure stabilization valve. Pressurized small-scale LNG tanks come in different sizes, limited by transport constraints and weight. We will further develop this option if given RA direction to move forward in the public consultation process.

- HFO

The estimated HFO consumption is approx. 8,790 m³/month at 100% load. HFO will be stored in atmospheric steel tanks per API 650 – Welded Tanks for Oil Storage

We provide the LNG and HFO fuel consumption calculations in the table on **Figure 8,** below. **Figure 9,** below, shows a small-scale LNG terminal with pressurized tanks.

Figure 8 – Fuel Consumption Calculations

FUEL CONSUMPTION CALCULATIONS

		Fuel	LNG	HFO
		Case	100% design	100% design
1	yearly	hr/y	8,760	8,760
2	conversion	Btu/kwh	3,412	3,412
3	density	MT/m3	0.4500	0.9800
4	hhv	Btu/gal	84,820	150,000
5	lhv	Btu/gal	74,720	140,000
6	plant power	kwe	56,220	56,220
7	**energy**	**kwh/y**	**492,487,200**	**492,487,200**
8	heat rate	Btu/kwh	7,548	7,924
9	efficiency		45.2%	43.1%
10	Fuel power	kw	124,369	130,565
11		Btu/h	424,348,560	445,487,280
12	fuel cons	Btu/y	3,717,293,385,600	3,902,468,572,800
13	Volume	gal/y	49,749,644	27,874,776
14		gal/m	4,145,804	2,322,898
15		gal/d	136,300	76,369
16		m3/y	188,303	105,506
17		**m3/m**	**15,692**	**8,792**
18		m3/d	516	289

Figure 9 – LNG Terminal with Pressurized Tanks

6.6 Location

The site is located at the Ships Wharf, St. David's and is part of the Bermuda Land Development Corporation (BLDC) Base Lands. For visual representations, refer to the following page for **Figures 10** and **11**. The site has a land area of 26,550 m² and is located at 32° 22' 13.61"N 64° 41' 07.35" W.

BLDC has successfully established a diverse range of competitive commercial projects, of which the Ships Wharf project is the latest opportunity to be brought to market.

Figure 10 – Satellite View of BLDC Development Area at St. David's

Figure 11 – Ships Wharf Energy Plant Land Area

Another important consideration for choosing this location is fuel supply. The power plant is approx. 1.5 km away from the existing fuel receiving terminal, and much closer than BELCO's Power Plant location in Hamilton, which is approx. 9 km away. For a visual representation, refer to **Figure 12** below. This will result in lower delivered fuel cost, which will favorably affect rates. Also as mentioned previously, there is the potential to develop a small scale LNG receiving terminal adjacent to the power plant in front of Ships Wharf. This option will reduce the cost of fuel, further reducing electricity cost. Small-size LNG ships of approx. 10,000 m^3 capacity or less could offload at the new facility.

Figure 12 – Distance from Fuel Receiving Terminal to Ships Wharf Site

6.7 Budgetary Proposal
The total price of the proposed system is approximately US$85,680,000.

This quoted price is an indicative price and it assumes the following:
- Full EPC- Engineering, Procurement of all Gensets and associated plant auxiliaries, Installation of engines and all plant auxiliaries and Project/Construction management.
- No LNG storage or receiving infrastructure included (to align with the IRP cost comparison)
- Flat land, no pilings required, no unique site prep
- No electrical interconnection to BELCO system
- Construction time of 12 months
- Warranty period of 12 months
- 25% import tax

This is purely a high-level estimate at this stage. If required a detailed cost estimate can be prepared.

6.8 Economics
Depending on the fuel mix employed, we estimate the total cost savings to range from US$43 to $59 million over the project lifecycle. Our proposal offers two salient savings elements:
1. CAPEX savings – by comparing the cost to design/build, install and commission the facility
2. Fuel cost savings - due to better engine efficiencies (better heat rate than the BELCO proposed plant)

For comparative purposes, we use fuel prices as stated in the IRP. **Figure 13,** below shows savings in US$.

Figure 13 – Summary of Savings

SUMMARY OF SAVINGS

Fuel burned ->

Concept	**HFO**	**LNG**
Capex Saving	24,584,000	24,584,000
Heat rate savings (NPV)	34,239,879	19,004,801
Total Savings	**58,823,879**	**43,588,801**

Additional cost savings are possible related to:
1. Proximity of the existing fuel receiving terminal to the Ships Wharf location, versus what is presented in the IRP
2. Alternative receiving terminal location developed at Ship Wharf

Figure 14 on the following page provides our detailed savings calculations.

Figure 14 – Detailed Savings Calculations

SAVINGS CALCULATIONS

I. CAPEX SAVINGS

	Descripction	Power (kW)	CAPEX USD	USD/kW
1	Belco - MAN 51/60 DF (x4)	57,600	110,264,000	1,914
2	Proposed system DF (x6)	56,220	85,680,000	1,524
3	**CAPEX Savings**		**24,584,000**	

II. YEARLY SAVINGS IN FUEL COSTS

#REF!			
ENG 1 - MAN 51/60 DF (x4)	Btu/kWh	8,400	*
ENG 2 - Proposed system DF	Btu/kWh	7,925	
Difference Heat rate	Btu/kWh	475.00	
Hours per year	h	8,760	
Capacity factor		0.95	
Gross Power	KW	56,200	
Auxiliries consumption		2%	
Auxiliries consumption	KW	1,124	
Net Power	**KW**	**55,076**	

*BELCO IRP

#REF!			
ENG 1 - MAN 51/60 DF (x4)	Btu/kWh	7,700	**
ENG 2 - Proposed system DF	Btu/kWh	7,500	
Difference Heat rate	Btu/kWh	200.00	
Hours per year	hours	8,760	
Capacity factor		0.95	
Gross Power	KW	56,200	
Auxiliries consumption		2%	
Auxiliries consumption	KW	1,124	
Net Power	**KW**	**55,076**	

**assumed

YEARLY SAVINGSIN FUEL COSTS (USD)

2020	3,178,605
2021	3,200,376
2022	3,206,908
2023	3,304,878
2024	3,391,963
2025	3,496,466
2026	3,594,436
2027	3,670,636
2028	3,731,595
2029	3,820,857
2030	3,934,068
2031	4,053,810
2032	4,180,083
2033	4,236,689
2034	4,347,722
2035	4,439,161
2036	4,589,383
2037	4,659,051

Lifetime savings not discounted	$ 69,036,689
Discount rate	8%
Savings NPV	**$ 34,239,879**

YEARLY SAVINGSIN FUEL COSTS (USD)

2020	3,178,605
2021	3,200,376
2022	1,609,699
2023	1,629,866
2024	1,655,533
2025	1,676,617
2026	1,702,284
2027	1,725,201
2028	1,754,535
2029	1,782,952
2030	1,808,619
2031	1,843,453
2032	1,867,287
2033	1,887,454
2034	1,905,788
2035	1,934,205
2036	1,961,706
2037	1,987,373

Lifetime savings not discounted	$ 35,111,554
Discount rate	8%
Savings NPV	**$ 19,004,801**

APPENDICES