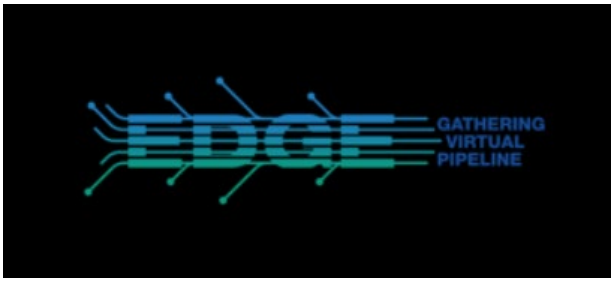

Edge Gathering Virtual Pipeline LLC

Response to Consultation Document for the Regulatory Authority of Bermuda Regarding Bermuda's 2018 IRP

2 July 2018

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Glossary of Terms

AEO	Annual Energy Outlook
BELCO	Bermuda Electric Light Company
DSM	Demand-Side Management
EA	Electricity Act
EE	Energy Efficiency
EV	Electric Vehicles
EIA	United States Energy Information Agency
FSRU	Floating Storage and Regasification Unit
GDP	Gross Domestic Product
HH	Henry Hub
IRP	Integrated Resource Plan
LED	Light Emitting Diode
LFO	Light Fuel Oil
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
NYMEX	New York Mercantile Exchange
PPA	Power Purchase Agreement
The Authority	Regulatory Authority of Bermuda
RFI	Request for Information
RFP	Request for Proposal
TD&R Licensee	Transmission, Distribution, and Retail Licensee

1 Introduction

Section 40(1) of the Electricity Act 2016 (EA) requires the Regulatory Authority of Bermuda (the "Authority") to request that the Transmission, Distribution and Retail Licensee (the "TD&R Licensee") prepare an Integrated Resource Plan Proposal (the "IRP Proposal") with two years of the commencement of the EA. Pursuant to the Authority's Notice of Request dated 17 November 2017, the TD&R Licensee submitted its IRP Proposal to the Authority on 15 February 2018. Subsequently, as required by Section 42 of the EA, the Authority has issued a Consultation Document for consultation on the IRP Proposal submitted by the TD&R Licensee.

Edge Gathering Virtual Pipeline LLC ("Edge") is at the forefront of delivering energy solutions to governments and power providers. Edge is submitting this document to provide some recommendations on sections in the IRP Proposal that could be updated and revised to help Bermuda make the most informed decision possible about its energy future. To introduce this document, we describe the following:

- The purpose of this document (Section 1.1)
- The four planning scenarios in the IRP Proposal (Section 1.2)
- Who is Edge Gathering Virtual Pipeline (Section 1.3)
- The solution Edge Gathering Virtual Pipeline can provide to lower the cost of power generation in Bermuda (Section 1.4)

1.1 Purpose of Document

This document responds to the Authority's IRP Proposal Consultation. It answers questions asked by Authority that relate to the IRP Proposal. Answering these questions will help inform the Authority, the TD&R Licensee, and the relevant government ministries as to which candidate fuel will best meet Bermuda's needs. These needs include security of supply, affordability, efficiency, and lower CO2 emissions.

Specifically, this document answers the questions:

- *Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?* (Section 2)
- *Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?* (Section 3)

Answering these questions makes it clear that assumptions underlying the costs of the candidate fuels need to be updated and revised, thus changing the comparative advantages of respective scenarios.

1.2 The Four Planning Scenarios in the IRP Proposal

The IRP process selected four feasible planning scenarios for detailed quantitative and qualitative evaluation. These four scenarios are based on candidate fuels combined with energy efficiency (EE), electric vehicles (EV), and renewable energy (RE). The four planning scenarios are:

- Scenario 1—A reference scenario that continues to use fuel oil as the primary fuel for power generation with no additional RE, EE, or EV

- Scenario 2—A revised version of scenario 1 with the addition of RE, EE, and EV
- Scenario 3—Conversion to natural gas (NG) for all thermal generation with RE, EE, and EV
- Scenario 4—Expansion of thermal resources operating on liquefied petroleum gas (LPG) with RE, EE, and EV

1.3 Introduction to Edge Gathering Virtual Pipeline LLC

Edge was formed in 2018 as a joint venture company between Galileo Technologies ("GT) and Nextera Energy Marketing ("NEM). GT owns 74 percent of the equity of the company and NEM owns 26 percent. NEM also has exclusive marketing rights to all LNG/CNG production.

The company was formed to take advantage of the large number of abandoned and distressed gas well assets in the Marcellus/Utica Shale Region. The Edge business model is premised on the Galileo Technologies Gas 3.0 technology. The cheapest natural gas available in the market is available at orphaned gas wells located in many of the shale formations in the US. In addition to capturing the lowest natural gas prices in the US, the units themselves are powered by natural gas.

Effectively, Edge is able to offer the lowest priced LNG available within a 350-mile radius of Pennsylvania. These mobile and modular gas liquefaction units (Cryotrucks) will be provided by Galileo Technologies through an exclusive agreement. The Cryotrucks will be placed at the well locations and connected to the well pipe. LNG will be shipped via ISO-tank trucks to local destinations in the Northeast.

1.4 The Solution Edge Gathering Virtual Pipeline LLC Can Provide to Lower the Cost of Power Generation in Bermuda

By virtue of the Galileo Technologies Gas 3.0 capability, Edge will be able to deploy multiple Cryotrucks in a very short amount of time. To satisfy the proposed LNG volume requirement specified in the IRP Proposal we estimate that approximately 16 Cryotrucks would be required. Based on current production schedules we estimate that this deployment could be underway in under six months. In addition, Edge plans to build a 2 million-gallon LNG tank at a waterborne terminal in the port of Philadelphia. Edge will charter a 3,500 cubic meter to 7,000 cubic meter LNG ship for transport of the LNG to Bermuda. The total estimated time to deploy the liquefaction units and construct a 2 million-gallon LNG tank is 1.5 years. This is significantly shorter than the estimated time to deploy LNG to Bermuda in the IRP Proposal of 3.5 years. Estimated LNG delivered price to Bermuda will be at a cost below the values indicated in the IRP Proposal.

2 Views on Assumptions, Assessment Methodology, and Conclusions Set Out in the IRP Proposal

The Consultation Document asks in Question 5,

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

The following aspects of the assumptions, assessment methodology, and conclusions set out in the IRP Proposal should be addressed:

- The methodology for calculating the costs of fuels needs to be evaluated and reconsidered (Section 2.1)
- The assumptions on the cost of LNG storage and regasification infrastructure should be provided and updated (Section 2.2)
- The assumptions on the load forecast need to be reviewed and revised (Section 2.3)
- The qualitative evaluation matrix should be revised (Section 2.4)

Updating and revising these assumptions to make them more up-to-date and more reflective of the available technologies and risks impacts the competitiveness of the candidate fuel scenarios.

2.1 The Assumptions for Calculating the Costs of Fuels Need to Be Updated and Revised

The methodology used to calculate the costs for fuels, shown in Appendix II.C of the IRP Proposal, uses values that should be updated, and the methodology itself should be evaluated and reconsidered. In this section we examine the methodology used to calculate fuel prices for:

- Natural gas (Section 2.1.1)
- Distillate fuel oil (Section 2.1.2)

Projected costs of fuels, shown in Appendix II.C of the IRP Proposal, use prices from the New York Mercantile Exchange (NYMEX) and projections from the U.S. Energy Information Agency's (EIA) 2017 Annual Energy Outlook (AEO). The EIA published an updated version of the AEO (the 2018 AEO) on 6 February 2018.[1] So that the IRP Proposal should reflect the most up-to-date information the projections should use data from this most recent edition. NYMEX futures for Henry Hub (HH) have also changed since the IRP Proposal was released, and the most recent natural gas prices from NYMEX should be used as well.

Using the most recent data reveals that there are changes to the relative prices of fuels. Natural gas is projected to be cheaper in the 2018 AEO than in the 2017 AEO, while fuel oil and LPG are both projected to be more expensive. This change in prices widens the spread between

[1] U.S. Energy Information Administration, Annual Energy Outlook 2018 "Energy Prices by Sector and Source." Accessed July 2018 at: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2018&cases=ref2018&sourcekey=0

natural gas and the other fuels—thereby, making natural gas more competitive from a cost basis.

In this section we examine the assumptions underlying the cost of each fuel, and how those assumptions can be made more accurate.

2.1.1 Methodology for Calculating the Cost of Fuel for Natural Gas

The methodology used to project natural gas prices in Appendix II.C of the IRP Proposal shown in Figure 2.1 below. This methodology it calculates the commodity price for LNG by taking the following steps:

- Using the "Commodity (HH)" price as the natural gas price input for the total cost of gas to power using LNG
- Setting the "Commodity (HH)" price equal to the NYMEX value for natural gas for years 2017 through 2020. It is not clear exactly what value is used for this variable (for example, is it the annual average for each year?). Being explicit about the exact value used is important for comparing it with other values and also for being able to update it
- Beginning in 2021, the "Commodity (HH)" price equals the "Commodity (HH)" price of the previous year times the percentage change for natural gas prices as forecasted in the EIA's 2017 AEO. This percentage change is calculated as the year-on-year change for natural gas prices in nominal US$. In other words, the "Henry Hub Natural Gas (NG) NYMEX Near Term Strip" in the figure below is the base from which all values after 2021 are calculated

This methodology is shown in Figure 2.1 below, which comes from Appendix II.C of the IRP Proposal.

Figure 2.1: IRP Proposal Methodology for Calculating Natural Gas Prices

Delivered Fuel Price Projections	Units	2017	2018	2019	2020	2021	2022	2023	2024
Base Case: LNG - Bulk (NYMEX Henry Hub Near Term 2017-2020)									
Commodity									
EIA AEO Price Forecast (Real 2016$)	$/mmBtu	2.99	3.41	3.92	4.48	4.43	4.37	4.40	4.48
Inflation Factor	2.00%	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17
EIA AEO Price Forecast (Nominal $)	$/mmBtu	3.05	3.54	4.16	4.85	4.89	4.92	5.05	5.25
EIA Annual Percent Change	%	22.3%	16.2%	17.3%	16.6%	0.8%	0.8%	2.6%	4.0%
Henry Hub Natural Gas (NG) NYMEX Near Term Strip	$/mmBtu	3.16	3.03	2.86	2.83				
NYMEX Annual Percent Change	%	28.4%	-4.0%	-5.7%	-1.1%				
Commodity (HH)	$/mmBtu	3.16	3.03	2.86	2.83	2.85	2.87	2.95	3.07

Source: Bermuda Electric Light Company Limited (BELCO), "2018 Integrated Resource Plan Proposal." Appendix II.C

Updating the inputs in this methodology results in a lower commodity price for LNG. Specifically, current NYMEX futures for HH are lower than those used in the IRP Proposal, and the variance in natural gas prices projected in the 2018 AEO is lower than the variance projected in the 2017 AEO. For example, the "Commodity (HH)" price used in Appendix II.C for the year 2020 is US$2.83 per MMBtu. As of 28 June 2018, NYMEX futures for HH in 2020 were US$2.56, which is approximately 10 percent lower.

Combining a lower cost of natural gas from NYMEX with a lower variance in the AEO 2018 forecasts results in a lower commodity price for LNG over the course of the Study Period.

Error! Reference source not found. below shows how recent NYMEX futures for HH are lower than those used in the IRP Proposal.

Table 2.1: June 2018 NYMEX Henry Hub Futures Compared to NG Prices Calculated in IRP Proposal

		2019	2020	2021
2Commodity (HH) Price in Appendix II.C	US$ per MMBTU	2.86	2.83	2.85
NYMEX NG Futures as of Market Open June 28, 2018	US$ per MMBTU	2.68	2.56	2.52
Price Difference from IRP Forecast	US$ per MMBTU	**-0.18**	**-0.27**	**-0.33**
Price Difference from IRP Forecast	%	**-6.3%**	**-9.4%**	**-11.7%**

Source: ino.com, NYMEX:NG, accessed June 28, 2018 at: https://quotes.ino.com/exchanges/contracts.html?r=NYMEX_NG

Note: Recent NYMEX prices used are month of June averages for each year

Finally, since the IRP Proposal was published, natural gas futures for the next seven years have declined, on average, over 10 percent for each year.

Edge can provide natural gas at a lower price than HH and AEO projections

Edge Gathering Virtual Pipeline LLC purchases natural gas at significant discounts to HH. Oil Shale production hubs in Marcellus and Utica (for example, Leidy and Dominion South) trade at discounts to HH according to pipeline transportation tariffs and takeaway capacity. The Edge Gathering Virtual Pipeline gas supply contracts with producers are typically discounts to those hubs of between US$50 cents to US$1.00/MMbtu.

2.1.2 Methodology for Calculating the Cost of Fuel for Fuel Oil #2

As is the case with the other candidate fuels, the IRP Proposal uses a methodology to forecast fuel oil prices that should be reevaluated. This methodology is shown in Figure 2.1 below, and it calculates the commodity price for fuel oil by taking the following steps:

- Using the "Commodity Price for IRP" as the distillate fuel oil price input for the total cost of power generation using distillate fuel oil
- Converting the NYMEX value for Gulf Coast USLD Platts, which is in US$ per gallon, to the BELCO fuel spec (HHV) in US$ per MMBtu
- Setting the "Commodity Price for IRP" equal to the converted NYMEX value for Gulf Coast USLD Platts for years 2017 and 2018. The IRP Proposal does not indicate exactly what is the value that is being used (for example, is it an annual average of monthly prices. Being clear about the exact value is important for adequate comparison and updating of the value
- Beginning in 2019, the "Commodity Price for IRP" equals the "Commodity Price for IRP" of the previous year times the percentage change for distillate fuel oil prices forecasted in the EIA's 2017 AEO. This percentage change is calculated as the year-on-year change for distillate fuel oil prices in nominal US$

This methodology is shown in Figure 2.1 below, which comes from Appendix II.C of the IRP Proposal.

Figure 2.2: IRP Proposal Methodology for Calculating Fuel Oil #2 Prices

Delivered Fuel Price Projections	Units	2017	2018	2019	2020	2021	2022	2023	2024
Base Case: Fuel Oil #2 (LFO - NYMEX Near Term)									
Commodity									
EIA AEO Price Forecast (Real 2016$)	$/mmBtu	14.16	16.19	17.42	18.07	18.58	19.03	19.37	19.68
Inflation Factor	2.00%	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17
EIA AEO Price Forecast (Nominal $)	$/mmBtu	14.45	16.84	18.49	19.56	20.52	21.43	22.25	23.05
EIA Annual Percent Change	%	22.2%	16.6%	9.8%	5.8%	4.9%	4.5%	3.8%	3.6%
Gulf Coast USLD Platts NYMEX Near Term Strip	$/gal	1.57	1.56						
NYMEX Annual Percent Change	%	19.0%	-0.2%						
Volume Conversion	gal/bbl	42.00	42.00	42.00	42.00	42.00	42.00	42.00	42.00
Gulf Coast USLD Platts NYMEX Near Term Strip	$/bbl	65.76	65.64	0.00	0.00	0.00	0.00	0.00	0.00
Commodity Price for IRP	$/bbl	65.76	65.64	72.07	76.24	79.97	83.53	86.73	89.85
BELCO fuel spec (HHV)	mmBtu/bbl	5.93	5.93	5.93	5.93	5.93	5.93	5.93	5.93
Commodity Price for IRP	$/mmBtu	11.10	11.08	12.16	12.86	13.49	14.09	14.63	15.16

Source: Bermuda Electric Light Company Limited (BELCO), "2018 Integrated Resource Plan Proposal." Appendix II.C

Using the most recent distillate fuel oil prices from NYMEX and projections from the 2018 AEO results in a higher fuel oil commodity price than that calculated in the IRP Proposal. As of 2 July 2018, NYMEX futures for Gulf Coast USLD Platts were significantly higher than the prices referenced in the IRP Proposal. July 2018 futures for Gulf Coast USLD Platts were US$2.17 per gallon[2]—which is about 40 percent higher than the US$1.56 per gallon used in the IRP Proposal.

Fuel oil prices are projected to be consistently higher in the 2018 AEO when compared to the 2017 AEO. Over the 15-year period shown in Table 2.2 below, prices are on average 3.6 percent higher. These higher prices reduce the cost advantage of the reference scenario.

Table 2.2: Comparison of Projected Fuel Oil #2 Prices Between 2017 and 2018 AEO

		2020	2025	2030	2035
2017 EIA AEO Price Forecast (Real 2016$)	$/mmBtu	18.07	20.19	21.46	22.73
Inflation Factor	2.00%	1.08	1.2	1.32	1.46
2017 EIA AEO Price Forecast (Nominal $)	$/mmBtu	19.56	24.13	28.32	33.11
EAI Annual Percent Change	%	5.8%	4.7%	4.0%	2.7%
Gulf Coast USLD Platts NYMEX Near Term Strip	$/gal				
NYMEX Annual Percent Change	%				
Volume Conversion	gal/bbl	42	42	42	42
Gulf Coast USLD Platts NYMEX Near Term Strip	$/bbl	0	0	0	0
Commodity Price for IRP	$/bbl	76.24	94.05	110.37	129.06
BELCO fuel spec (HHV)	mmBtu/bbl	5.93	5.93	5.93	5.93
Commodity Price for IRP	$/mmBtu	12.86	15.87	18.62	21.77
2018 EIA AEO Price Forecast (Nominal $)	$/mmBtu	19.91	25.33	29.32	34.46
Price Difference from 2017 EIA AEO Price Forecast (Nominal $)	$/mmBtu	**0.35**	**1.20**	**1.00**	**1.35**

[2] https://www.cmegroup.com/trading/energy/refined-products/gulf-coast-ultra-low-sulfur-diesel-usld-platts-calendar-swap.html

Price Difference from 2017 EIA AEO Price Forecast (Nominal $)	%	**+1.8%**	**+5.0%**	**+3.5%**	**+4.1%**

Sources: Bermuda Electric Light Company Limited (BELCO), "2018 Integrated Resource Plan Proposal." Appendix II.C

U.S. Energy Information Administration, Annual Energy Outlook 2018 "Energy Prices by Sector and Source." Accessed July 2018 at: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2018&cases=ref2018&sourcekey=0

2.2 The Assumptions on the Cost of LNG Storage and Regasification Infrastructure Should Be Provided and Updated

In the IRP Proposal, the cost of LNG storage and regasification infrastructure does not evaluate different available technologies and modes of LNG delivery. The IRP estimates the capital cost of this LNG storage and regasification infrastructure to be approximately US$117 million, as indicated by the line named "All-In Capital Cost" on page 3 of 16 of Appendix II.C. The IRP Proposal does not provide the detail used to calculate this cost estimate. The IRP Proposal needs to provide the detailed assumptions used to estimate this cost so that the estimate can be adequately assessed and updated as may be required to include changes in costs or the availability of new technology.

In the last few years, the technology for delivering LNG through ISO-containers has improved and it has been used for delivering LNG to Jamaica and Barbados. With these changes in the technology and the lower cost, the IRP Proposal should consider the possibility of delivering LNG ISO-containers to Bermuda. The economics of shipping LNG ISO-containers to Bermuda utilizing a Roll-on Roll-off barge and then trucking to the power plant may in fact require a significantly lower capital cost and a lower delivered price for LNG.

2.3 The Assumptions on the Load Forecast Need to Be Reviewed and Revised

The load forecast methodology, explained in Appendix I.D.4 of the IRP Proposal, makes assumptions that may need to be revised given existing trends and projections. The assumptions in the IRP Proposal result in a load forecast that is flat in some scenarios (LPG) or declining in others (LNG). If the load forecast increases, which is a possibility more fuel will be needed to support future power generation and the price differential between candidate fuels will become even more important.

Two current assumptions that support a flat or declining load forecast are:

- Real GDP growth is estimated to be zero percent per year during the study period, as indicated in Appendix I.D.4 of the IRP Proposal
- DSM and EE gains reduce energy demand, including from an LED street-lighting program

Both assumptions appear to contradict existing trends and projections, which we examine below.

Current GDP growth forecasts for Bermuda are positive

The 2017 National Economic Report of Bermuda, published by the Ministry of Finance projects that the country's economy will grow by 1.5 to 2.0 percent in 2018.[3] Furthermore, Appendix I.D.2 cites an IHS Global Insight study projecting Bermudian GDP growth rates of 1.7 to 2.0 percent per year from 2018 through 2022.

Despite internal and external projections of positive economic growth, Appendix I.D.2 of the IRP Proposal assumes real GDP growth to be zero during the study period (the study period is from 2017 to 2037). The Appendix I.D.2 cites a limited number of responses from local stakeholders as the reason for this assumption.[4] This conclusion should be reviewed and updated based on credible projections.

DSM, EE, and distributed PV gains should be comparable between scenarios

Tables 2-6 through 2-9 in Section 2 of the IRP Proposal show annual expansion plan summaries for each candidate fuel. Reductions in energy demand due to demand side management (DSM), energy efficiency (EE) measures, and distributed solar vary between each scenario. To compare the candidate fuel scenarios accurately, these demand side resources should be the same for all scenarios. Table 2.3 compares each scenario's demand side resources, in MW, in the annual expansion plans for the alternative scenarios.

Table 2.3: Demand Side Resources of Candidate Fuel Scenarios Compared by Year, MW

Candidate Fuel Scenario	Demand Side Resources, MW, by Year			
	2020	2025	2030	2037
Reference (1)	1.6	2.8	4.3	7.3
Fuel Oil (2)	3.8	6.1	7.5	10.4
Natural Gas (3)	3.8	11.0	14.9	17.8
LPG (4)	3.8	6.1	7.5	17.1

Source: Bermuda Electric Light Company Limited, 2018 Integrated Resource Plan Proposal, February 15 2018

Note: 2037 is the last year of annual expansion plan summaries

The scenario with natural gas has the greatest reduction in demand due to these gains; 17.8MW. The reference scenario and fuel oil scenario, on the other hand, only have reductions in demand of 7.3MW and 10.4MW respectively. To understand the price advantages of specific

[3] Government of Bermuda, Ministry of Finance, "National Economic Report of Bermuda 2017." Februrary 2018. https://www.gov.bm/sites/default/files/2017-National-Ecomonic-Report_web.pdf

[4] The TD&R licensee requested opinions on the GDP outlook for Bermuda from a variety of local stakeholders. Responses were limited, the IRP Proposal writes on page 7 in Appendix I.D.2, "in the absence of an economic forecast by the Ministry of Finance, supported by specified national policies to promote economic growth, we have assumed an average annual real GDP growth rate of zero percent for the Study Period."

fuels, on a dollar per MMBTU basis, demand side resources should be as close as possible across all four scenarios.

DSM and EE gains are likely overstated in the short-term

Demand side resources through EE measures may be overstated in the short-term for some scenarios. Since 2010, Bermuda's peak demand has fallen from 122.8MW in 2010 to 110MW in 2017,[5] and a further reduction in demand of 3.8MW by 2020 would be subject to many factors.

According to the Load Forecast Methodology in Appendix I.D.4 of the IRP, the plan for increasing EE is the implementation of the Government's light emitting diode (LED) street-lighting program. Page 18 of Ascendant's 2017 Annual Report[6] (BELCO's parent company) states that Bermuda's maximum demand in 2017 was 110.7MW. A reduction in demand of 3.8MW would be a 3.4 percent reduction from this value. Whether this is a realistic reduction due to EE and DSM measures implemented over the next year and a half should be reviewed.

EV assumptions are likely overstated during the study period

Section 1.8, Demand-Side Resource Options, of the IRP Proposal states that EV adoption is forecasted to increase an average of 34.9 percent per year over the Study Period. A 2017 Bloomberg New Energy Finance report about global EV sales is cited as the source of this assumption. Whether Bermuda's EV adoption rate matches global trends should be reviewed as an assumption.

2.4 The Qualitative Evaluation Matrix Should Be Revised

The qualitative evaluation matrix, shown in Appendix II.E1 of the IRP Proposal, uses five qualitative factors to evaluate the candidate resource types; supply quality, environmental sustainability, security and cost resilience, logistics, and economic development The assumptions underlying two of these qualitative factors, security and cost resilience and logistics, do not reflect the complexity surrounding each resource type. Specifically:

- Security and cost resilience does not account for the impact of severe weather and natural disasters (Section 2.4.1)
- Logistics does not account for multiple methods of fuel delivery and/or reception (Section 2.4.2)

2.4.1 Assumptions on Security and Cost Resilience

The security and cost resilience factor in the IRP Proposal does not account for the potential impact on Bermuda of severe weather, such as hurricanes. According to the Bermuda Weather Service[7], damaging tropical cyclones impact Bermuda, on average, once every six to seven years. Hurricanes can significantly damage infrastructure used to supply electricity. For example, hurricanes can lead to the following adverse impacts:

[5] Figure 1.2 in Section 1.3 of the IRP Proposal

[6] Ascendant, "2017 Annual Report." Accessed July 2018 at: https://www.ascendant.bm/wp-content/uploads/2018/05/ASCENDANT_AR2017_PRESSFILE_FullReport_20Apr2018_F.pdf

[7] Mark Guishard; James Dodgson; Michael Johnston (April 2016). "Hurricanes – General Information for Bermuda". Bermuda Weather Service. Retrieved October 26, 2016.

- The need for unexpected capital investments to rehabilitate and/or replace all or parts of any fixed assets that are damaged
- Damages to existing fixed assets
- Loss in revenue from business interruption during the time the asset is not operational.

In the qualitative evaluation matrix, distributed solar PV and utility solar PV score well in security and cost resilience factor. However, solar generation assets can be particularly vulnerable to hurricane damage. Therefore, it is important to account for the risks associated with the potential damage caused by hurricanes in the assumptions underlying security and cost resilience.

2.4.2 Assumptions on Logistics

Natural gas scores a 10 out of 20 on logistics because,

> *Significant gas fuel handling and transportation infrastructure is required, creating permitting and siting challenges.*

The assumed fuel handling and transportation infrastructure required should be made explicit. If, for example, it assumes the need for a pipeline, there are other logistical options that exist.

As mentioned in Section 2.2, Edge believes that an LNG ISO-tank solution may be a more attractive solution due to lower capital costs and a shortened implementation timeline.

3 Clarifications Required on the Procurement Plan

The Consultation Document asks in Question 2,

Do you consider the procurement strategy outlined in the IRP Proposal appropriate?

The procurement plan, in Section 2.7 of the IRP, is very broad and should be clearer in the use of terms, assumptions underlying time estimates, and explanation of how fuel suppliers will be selected. Greater clarity in the procurement strategy may reveal that it is not appropriate for meeting the goals of the IRP, the Authority, and Government of Bermuda.

Specifically, the aspects of the procurement plan to be reviewed are:

- Clarification of how suppliers are to be selected (Section 3.1)
- Clarification of the term 'bulk LNG' (Section 3.2)
- Clarification of the time estimate for procuring LNG (Section 3.3)
- The TD&R Licensee should use competitive bidding to procure any generation resources (Section 3.4)

3.1 Clarification of How Suppliers Are to Be Selected

The procurement plan outlines activities specific to each resource. Activities for some resources provide detail as to how procurement will be executed, while activities for others are vague. The procurement plan for utility solar PV, for example, outlines plans for a request for information (RFI), a power purchase agreement (PPA), and a request for proposal (RFP). The procurement plan for natural gas, on the other hand, does not offer any explanation as to how suppliers will be selected. It is vital that the procurement plan establish a process for selecting fuel suppliers. This will ensure Bermuda receives fuel from the most cost-effective supplier in the most cost-effective means of delivery possible.

3.2 Clarification of the Term 'Bulk LNG'

The procurement plan specifies the import of 'bulk LNG.' The term bulk, as it relates to energy, means capable of supporting a large interconnected electrical system. This differentiates it from distributed generation or mini-grid systems. If the procurement plan specifies the import of bulk LNG, it should clarify which modes of delivery that would include. Modes of LNG delivery capable of supporting a bulk power system include:

- LNG carriers that deliver the LNG to storage facilities and have a capacity exceeding 30,000 cubic meters
- Floating storage regasification units (FSRUs) are carriers that also provide storage and regasification capabilities offshore
- ISO containers which can have a capacity of 40 cubic meters and be trucked directly to the generation facility

Because ISO containers deliver LNG on a smaller scale, they might be overlooked in a procurement plan that focuses on 'bulk LNG.' The procurement plan should consider ISO containers because ISO containers are fully capable of delivering LNG at the price and quantity required to meet Bermuda's energy needs. In fact, there are many logistical and cost advantages to using ISO containers.

3.3 Clarification of the Time Estimate for Procuring LNG

The current procurement plan for LNG estimates 3.5 years to develop LNG offloading, storage, and regasification facilities. It appears that this time estimate comes from the 'Viability of LNG in Bermuda' report completed by Castalia Strategic Advisors in September of 2015 (published in March of 2016). In Section 6.5 of the study, the timeline for introducing natural gas requires "30 months to build an LNG carrier and other infrastructure necessary to receive LNG."[8] Since that report was written, there have been changes to the available technology and economics of delivering LNG to Bermuda.

This time estimate only applies to one delivery option, while several exist. Delivering LNG to Bermuda via ISO tanks, for example, would shorten this preparation time considerably.

For example, Edge can supply LNG to Bermuda via LNG ISO-tanks and construct a revaporization unit at the power plant within one year of a binding contract.

3.4 The TD&R Licensee Should Use Competitive Bidding to Procure Any Generation Resources

The Consultation Document asks in Question 3,

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

The TD&R Licensee should procure any generation resources using competitive bidding. This will lead to the lowest cost fuel supply for Bermuda and maximize the benefits of the selected fuel scenario.

[8] Castalia, "Viability of LNG to Bermuda." September 2015. Accessed June 2018 at: https://www.gov.bm/sites/default/files/Viability-of-Liquefied-Natural-Gas-in-Bermuda.pdf

Regulatory Authority of Bermuda

Response to Consultation Document 2018 05 02

(Integrated Resource Plan Proposal Consultation)

August 17th, 2018

Dear Sirs,

Introduction

We are pleased to submit the following commentary on the proposed IRP issued by BELCO. We are of the opinion that the IRP Proposal and Appendices is geared more to the best interests of BELCO rather than the best interests of Bermuda as required in the purposes of the Electricity Act (EA). If Bermuda were to follow this IRP, we fear Bermuda would end up having one of the lowest levels of adoption of renewable energy and the highest outputs of carbon dioxide per capita in the western world by 2037. Based on the advancement of renewable and storage technologies, we also fear Bermuda would continue to have one of the highest costs for electricity in the world for decades if we were to adopt this IRP as written. We are also alarmed at the erroneous LCOE values provided by Leidos for certain renewable technologies, which grossly distort the IRP to make fossil fueled generation look relatively more attractive than renewables and thus falsely justify the low use of renewables through 2037. Our following commentary is geared mostly to the renewable energy and energy efficiency content of the proposed IRP and appendices.

National Electricity Sector Policy Aspirational Matrix for Renewables, Energy Conservation and Efficiency vs. BELCO's IRP.

We note in the IRP Appendices that Liedos points out that Bermuda has no mandatory targets for the use of renewables, energy efficiency and conservation. They then go on to virtually ignore many of the aspirational targets for these set in the National Electricity Sector Policy of Bermuda (NESP) from 2015. In our opinion, Liedos, BELCO and Ascendant have designed an IRP that is heavily orientated to the continued use of fossil fuel powered generation with just a small percentage of renewables. They designed an IRP that from 2022 is aimed only at those utility scale renewables where BELCO's Transmission, Distribution and Retail Licensee (TDRL) can buy electrical energy from at low cost and resell at a comfortable mark up. The IRP virtually excludes the addition of any electricity self-supply technologies such as rooftop solar PV, after 2022. The only small scale renewable that Liedos/BELCO seem to be promoting in this IRP is solar thermal for generating hot water, but adoption of this technology in recent years has almost completely ceased because of its high cost in typical Bermuda residences and relatively poor return on investment compared to solar PV and heat pump water heaters. Although this

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IRP is only supposed to cover a five year period, Liedos/BELCO have included for projections out to 2037, to justify the cost of converting to LNG based generation.

Table 1

IRP SCENARIO 3 SYSTEM GENERATION FOR YEARS 2020, 2025 & 2035

Data compiled from BELCO's IRP Appendix II.D4 - Scenario 3 Results

	2020		2025		2035	
BELCO	**GWH**	**%**	**GWH**	**%**	**GWH**	**%**
GENERATION MIX						
HFO	552	88.0%		0.0%		0.00%
LFO	4	0.6%		0.0%		0.00%
LNG		0.0%	468	73.9%	456	70.92%
LNG (CCHP / CHP)		0.0%	37	5.8%	55	8.55%
Tynes Bay - WTE	18	2.9%	18	2.8%	18	2.80%
Utility PV	15	2.4%	43	6.8%	40	6.22%
Distributed PV (PPA)		0.0%	14	2.2%	13	2.02%
Distributed Solar Water Heat	26	4.1%	33	5.2%	30	4.67%
Energy Efficiency	10	1.6%	16	2.5%	38	5.91%
Electric Vehicles	0	0.0%	(1)	-0.2%	(11)	-1.71%
Distributed PV (Rooftop)	3	0.5%	5	0.8%	5	0.78%
Totals	627	100.0%	633	100.0%	643	100.00%

Table 2

IRP Renewables Maximum Annual GWH and Year of Maximum

	IRP Scenarios 2, 3 & 4	
Renewable Energy Type	**Max GWH**	**Year of Max**
Tynes Bay - WTE	18	2018
Utility PV	45	2024
Distributed PV (PPA)	15	2022
Distributed Solar Water Heat	34	2021
Distributed PV (Rooftop)	5	2022
Total Renewables GWH in 2025	114	
Total Island GWH in 2025	**632**	
Renewables % of total	18.04%	
Renewables % of total Excluding Solar Water Heat	12.66%	

To compare the IRP to the NESP Aspirational Matrix for future generation, we have compiled **Table 1** from the Liedos Appendix II.D4 which is for the LNG Scenario 3, listing the GWH of forecast energy per year for each technology and the percentage of the total for each. We have done this for years 2020, 2025 and 2035 to match the target years set in the NESP aspirational

matrix. We have ignored using the peak power/demand figures because they are not a measure of emissions and fuel costs, or the lack thereof in the case of renewables.

Table 2 uses data from the same IRP appendix table to show the maximum projected annual GWH from each renewable energy technology listed in the IRP table, for all three scenarios, excluding scenario 1, the reference scenario. Please note that for each renewable, the maximum size of the renewable technology according to the IRP occurs between 2021 and 2024. No growth of renewables is forecast after 2024 in the IRP to help justify the continued high usage of fossil fueled generation. So basically what the IRP is modelling is the complete cessation of new renewable energy installations from 2024 onwards. We put it to the RAB that this modelling is contrary to the purposes of the Regulatory Authority Act (RAA) and the Electricity Act (EA) because it essentially kills all employment in the renewables installation industry, eliminates future competition, limits future innovation, inhibits sustainability, inhibits the use of future cleaner (renewable) energy sources and advocates higher future electricity prices. Besides being contrary to these two acts, the scenarios are also at complete odds to most other jurisdictions where employment and investment in the renewable industry sector now exceeds those in conventional utility generation, with continued further expansion of renewables further into the future.

Table 3 compares the renewable generation targets set in the NESP to those in the IRP for Scenario 3, for the target years of 2020, 2025 and 2025. Looking at the share of total renewables as a percentage of total generation, the IRP forecasts a slightly higher renewable percentage in 2020, but by 2025, the percentage drops to just over half of the NESP target. By 2035, the IRP renewables target is less than half of the NESP target. A big part of the reason for the IRP's big drop compared to the NESP for 2025 is that the IRP does not include anything for the Future Renewable Base Load carried in the NESP for 2025. Of course, BELCO could possibly use the excuse that this Future Renewable Base Load technology alluded to in the NESP does not have a proven history of commercial operation as required under Section 42 (2) b of the EA. However, Liedos/BELCO do not appear to have looked at any other substitutes for this big shortfall in renewable generation. We suggest that it is now time tor the Ministry to consult on other bulk scale renewables which can be used instead, in order to establish a more robust energy policy.

We would like to point out to the RAB the grey area in the IRP labelled Distributed Solar PV (PPA), that Liedos/BECO have listed in the IRP that is not listed in the NESP. However, in looking at the candidate resource definitions on Liedos' page 1-15, we have grouped this under Bulk Solar as opposed to Rooftop Solar (Commercial & Residential). With this grouping, the Bulk Scale Solar PV percentages in the IRP are considerably ahead of the NESP targets for all three target years. However, the Distributed Rooftop Solar PV percentages in the IRP fall far short of those in the NESP. Indeed, according to the IRP modelling, by 2035 rooftop solar PV will be at only 13% of the target level set in the NESP. This is the basis of our claim that the IRP is leaning heavily to Bulk Solar where BELCO's TDRL can buy the energy at low cost and sell it on at a profit, while falling far short on distributed rooftop solar, where the building's owner is

engaged in self supply. Not only does the latter stray far from the NESP targets, it also goes against what is happening in most other jurisdictions with more advanced energy policies.

Table 3.

Comparisson of National Electricity Sector Policy (NESP) Energy Targets to BELCO's IRP Energy Targets based on Scenario 3.

Target	Energy Generation Technology		2020		2025		2035	
			NESP	IRP	NESP	IRP	NESP	IRP
Share of renewable generation	%		8.00%	9.90%	35.00%	17.80%	38.00%	16.49%
Share of generation by source	Natural gas %		92.00%	0.00%	65.00%	79.70%	62.00%	79.47%
	Waste to Energy %		3.00%	2.90%	3.00%	2.80%	3.00%	2.80%
	Bulk Scale Solar PV % & Distributed Solar PV	Bulk	2.00%	2.40%	2.00%	6.80%	2.00%	6.22%
		PPA	0.00%	0.00%	0.00%	2.20%	0.00%	2.02%
	Distributed Solar PV Rooftop %		1.00%	0.50%	2.00%	0.80%	6.00%	0.78%
	Solar water heaters %		2.00%	4.10%	2.00%	5.20%	2.00%	4.67%
	Future Renewable Energy Base Load %		0.00%	0.00%	26.00%	0.00%	25.00%	0.00%

This distorted projection of higher bulk solar and lower rooftop solar also does not seem to consider that Bermuda lacks many big areas of relatively low cost land on which solar farms can be installed compared to most jurisdictions, whereas we have a huge resource of unused roof space which could be used for solar PV.

Load Forecast and Generation Mix for the Near Term

We are concerned that Leidos have relied heavily on GDP projections to predict the near term peak load and apparently overlooked the additional load that will be imposed by the new airport, Morgan's Point and the St. Regis development. To a lesser extent we are also now seeing a trend where office buildings in Hamilton that have laid vacant for several years or more are now being purchased for re-occupancy, thus adding load back onto the grid. Given the proposed North Power Station Construction and the retirement of BELCO's Generators E-1, E-2, E-3 E-4 and the OPS recips, we anticipate that there will be a significant increase in the use of BELCO's inefficient Gas Turbines (GTs) to meet peak daily demand in both the warmest and coldest months, starting in 2019 with further increases in 2020. In our opinion, this will result significantly higher fuel adjustment rates for all BELCO customers, even if oil prices remain at present levels. Solar PV, with or without battery storage is the renewable energy technology best suited to offset the future use of these inefficient and costly gas turbines, so we question why Liedos/BELCO is modelling the end of solar PV installations by 2024?

LCOE Levels for Renewables

We are concerned that Leidos on page 20 of Appendix I lists an assumed cost for the airport finger solar farm as $170/MWh when news reports said the PPA was valued at under

$110.00/MWh. This appears to distort the true low cost of utility scale solar to make fossil fueled resources look relatively better in the IRP documents. Similarly, in Table 2 of the same appendix Leidos lists the cost of a 100 kW commercial solar PV system at $4,000/kW DC. Recent commercial solar bids using Tier 1 modules and sophisticated module level electronics have come in substantially below this cost. Also Table 2 lists Annual Degradation at 0.8% when most local providers have warrantied degradation rates of less than half of that for 25 to 30 years. The 2 kW residential system listed in Table 2 is far smaller than the average residential PV system size here and thus does not include the economies of scale that apply to larger systems.

We also believe that Liedos have used absurdly high maintenance costs for distributed solar to help justify the continued widespread use of fossil fuels and also not portray the true lower LCOE of distributed solar PV.

Also, Liedos do not appear to have factored in the ever lowering cost of renewables, particularly solar PV, nor the ever lowering cost of battery storage, again distorting the LCOE of solar PV and battery storage compared to traditional generation. We note that a speaker at last year's Energy Summit stated that Barbados had cancelled its plans for LNG based future generation because they projected that solar plus storage would provide a lower LCOE than re-gasified LNG fired generation by 2022. Why has Bermuda not done the same analysis with independent consultants to see when solar plus storage would be more economical for utility scale, commercial and residential systems here?

The net result of the above is a significantly inflated cost for residential, commercial and utility scale solar projects in the IRP, which attempts to make fossil fuel systems look better in comparison than they actually are. We also note that Leidos did not do any LCOE projections for solar PV plus battery storage, which will achieve ever wider adoption worldwide.

Solar PV and Other Renewables Adoption over the next 30 years

We note in Appendix II, page 5 that Leidos lists Distributed Solar PV (Rooftop) at 1 GWH in 2018, reaching a peak of 5 GWH in 2022, with no further growth through 2037. We estimate that this resource is already close to 5 GWH in 2018, although residential growth has slowed substantially since the FIT was introduced by the RAB. Non rooftop distributed solar is also shown peaking in 2022 at 15 GWH with utility scale solar PV shown peaking in 2024 at 45 GWH. In contrast, Rooftop solar thermal is shown peaking at 34 GWH in 2021, when uptake of this technology has almost come to a standstill because of its poor economics compared to other water heating technologies and solar PV.

Given the ever increasing adoption of solar PV worldwide, we have to question why did Leidos show no growth in these technologies after 2024 and how would the continued or escalating growth after 2024 affect the economics of their LPG and LNG scenarios? Under the latter, would Bermuda be stuck with a huge regasification plant stranded asset in ten or fifteen years from now?

LNG vs LPG

We are concerned that according to the normalized tables for LNG and LPG in appendix II C, the base all in future price of LNG and LPG are almost identical, but that the first cost prices listed for LNG appear to be significantly below the EIA's LNG export price history. Given the better emissions of both fuels, but the huge infrastructure cost of LNG compared to LPG, we question whether LNG will in fact be the less expensive option, particularly if the adoption of renewables is faster than Leidos predicts. We support the idea of buying dual fuel generation assets for the NPS, to keep Bermuda's options open, but suggest that we are some years off making a final decision on the possible gaseous fuel type to be used in several year's time, if at all.

Also we question why Liedos would even assume that the present relatively low customs duty rate on LNG per MMBTU would continue rather than be normalized to be equal to the present rate per MMBTU of HFO and LFO. Surely BELCO should realize that Government relies on the present level of total duty paid by BELCO on its fuels and to even consider Government would not normalize the LNG duty rate to maintain the income from BELCO's fuel would be naïve. In fact, given previous government decisions to raise these BELCO fuel duty rates when fuel prices drop, we consider it likely that Government may look to an LNG conversion to increase the normalized duty on LNG above the present rate for HFO and LFO.

CHP and CCHP

We are pleased to see that CHP and CCHP are included in the LCOE Scenarios 3 and 4 modelling in the appendices, as this is a technology with significantly improved energy efficiency over other fossil fueled generation technologies, that should be utilized here. However we question why it was not included in Scenario 2 and why the modelling shows deployment staring in 2022 under Scenario 2, but not until 2031 in Scenario 3? The distribution infrastructure for both diesel and LPG deliveries is already mostly if not entirely in place, so both fuel types could be used for distributed CHP and/or CCHP within the five year window that this IRP is supposed to cover. However, no LNG or NG distribution infrastructure exists for distributed CHP and CCHP. So have Liedos/BELCO factored in the capital costs for the NG distribution infrastructure needed to fuel future NG fueled distributed CHP and CCHP installations?

Electric Vehicles

We believe that the adoption of electric vehicles (EV) modelled in the appendices is too low and represents a future additional load not presently accounted for. This belief is based on the continuously falling price of the batteries used in these vehicles and several major European countries banning the sale of gasoline and diesel cars by 2040. As the European auto market is of such vital importance to most of the manufacturers presently selling cars here, gasoline and diesel cars will become increasing harder to buy here as we get closer to 2040 and electric or hybrid electric cars may provide better value long before 2040. Additionally, the recently released National Fuels Policy (NFP) is targeting an 18% energy savings in the transportation sector by 2035, but the numbers for EVs carried by Liedos represent a much smaller percentage of EV adoption.

Conclusion

Given the shortfall of renewable generation targets in the IRP compared to the NESP targets, we suggest that the IRP falls short on the requirements for more reliance on renewable energy, let alone battery storage. Given its total lack of new rooftop solar PV installations after 2022 and its omission of the large scale future base load renewable, this IRP does not comply with the sustainability requirements of Sections 6 (a) and (f) of the EA, nor the renewables requirement of 6 (c). The IRP has been written as if Liedos had their head in the sand in respect to the widespread, ever expanding adoption of renewable energy in other jurisdictions. We recommend that the RAB reject the present IRP and have BELCO recalculate the LCOE for its thermal generating assets using two or three continuous growth rates for renewables, rather than the zero growth rate after 2024 contained in their scenarios 2, 3 and 4. At the same time, they should model wider adoption of battery storage. These renewable growth patterns should also include the ever dropping cost of solar PV and battery storage.

We also recommend that the Government and RAB should seriously look at offshore wind or other large scale renewable technologies to replace the large sale renewable technology contained in the NESP aspirational matrix, as the latter does not appear to be applicable to Bermuda.

Yours Sincerely,

C. E. Nash, P. Eng.

Engineering Manager

CEN/nec

Cc The Department of Energy
Solar Energy Association
Nick Duffy

NON-CONFIDENTIAL

17 August 2018

Regulatory Authority of Bermuda
1st Floor Craig Appin House
8 Wesley Street
Hamilton HM11
Bermuda

Dear Regulatory Authority of Bermuda,

Bermuda Engineering Co. Ltd (BE Solar) believes that Bermuda and Bermudians deserve a sustainable, resilient, safe, reliable and affordable energy strategy and solution.

Thank you very much for the opportunity to provide comment and recommendations on the recent Integrated Resource Plan (IRP) submitted by the utility.

In regards to the Integrated Resource Plan (IRP) consultation, please find enclosed our 'Alternative Proposal for Bulk Generation and Demand Side Resources' for your review and serious consideration.

Additionally, please find enclosed our 'Response to Consultation Document: Comments on IRP Proposal Consultation'.

Our vision is an efficient Bermuda significantly powered by affordable renewable energy.

Our mission is to provide the highest quality energy solutions, accessible to all.

We trust that this alternate proposal will provide powerful insights and clarity on how to effectively and successfully approach Bermuda's future energy supply strategy and implementation.

Every Bermudian household and business is directly affected by electricity planning. We at BE Solar believe it is crucial that we are conscious of how these decisions will impact Bermuda now and for the coming decades and future generations.

Thank you for your time and consideration, and please contact us should you have any questions or require any additional information.

For our future.

Yours sincerely,

Stuart Kriendler
Managing Director
Bermuda Engineering Company Limited
(BE Solar)

Response to Consultation Document: Comments on IRP Proposal Consultation

August 17, 2018

CONTENTS

1.0 SUMMARY

The IRP Process currently overseen by the RAB creates a tremendous opportunity to shape Bermuda's energy future for decades to come. BELCO and Leidos have produced an IRP Proposal consisting of four separate scenarios that are dominant in fossil fuels, with a consistent portfolio of renewable energy sources and demand side management. Bermuda Engineering Company Limited (BE Solar) submits this document as a response to the IRP Proposal under consideration.

The IRP Proposal is thorough and follows many industry best practices, but fails to take several key areas into consideration. In particular, the IRP neither considers environmental impacts nor human health impacts in great detail. In addition, the Procurement Plan as outlined in in the IRP Proposal is the most expensive option considered, relying on significant electricity sales over the lifetime of the proposed assets. This plan could both result in continued high electricity prices while also failing to put Bermuda on a path to achieving long term carbon reduction.

Several assumptions made in the creation of the IRP Proposal have had a significant impact on the results presented. The qualitative comparison of technologies is arbitrary, and can potentially be manipulated to make certain technologies more favorable, for example making the more expensive Scenario 3 the most attractive. There is also a failure to address the trends in renewable energy and energy efficiency.

Bermuda Engineering Company Limited (BE Solar) is a fourth-generation, 80 year old Bermudian company. The company was founded in 1935 by Gordon H. Burland, he pioneered the first wind turbine and micro-grid in Bermuda and also designed 'The Bermuda Sun Heater', a solar water heating system for application in Bermuda in the mid 1930's. Now in the 21st century, G.H. Burland's legacy is continued with a dynamic, young and innovative team of Bermudians working to help strengthen and improve Bermudas energy supply and future.

As a dominant provider of electricity and a natural monopoly, the TD&R licensee holds a position of unique responsibility. Its investment decisions have long term consequences that not only affect its shareholders, but all residents of Bermuda. These consequences are diverse, ranging from electricity prices to climate change and the health of residents of Bermuda. With respect to the TD&R licensee as the owner and operator of the electricity grid, it is therefore justified that long-term strategic decisions made by the TD&R licensee are subject to open scrutiny.

The following responses highlighted below are supplemented by further analysis in a report commissioned by BE Solar in partnership with UK based sustainability firm Etude. This report titled “Alternative Proposal for bulk generation and demand side resources” has been submitted to the RAB.

2.0 RESPONSES TO THE REGULATORY AUTHORITY OF BERMUDA'S CONSULTATION QUESTIONS

This section provides responses to the six questions posed by the Regulatory Authority of Bermuda. Particular consideration was given to the environmental and financial impacts of the Preferred Plan to residents of Bermuda and in particular, to ratepayers. The views and commentary expressed have been developed based upon thorough review and consideration of the following:

- The Regulatory Authority of Bermuda's Integrated Resource Plan consultation documents, including the Oxera review
- The Integrated Resource Plan documents submitted by the TD&R licensee
- The Electricity Act 2016
- The views of a wide range of stakeholders in the Bermuda energy industry
- Discussions with a range of subject matter experts in Bermuda and Europe
- Respected global agencies such as the International Energy Agency, the International Renewable Energy Agency and the Intergovernmental Panel on Climate Change
- A variety of peer reviewed scientific papers

2.1 PROVISIONS FOR MODIFICATION

Question 1: Are there any provisions in the IRP Proposal that should be modified? Please include any reasoning and evidence in your answers.

The scope of the IRP is quite inclusive in terms of what is necessary for decision makers to judge the Proposed Plan. Specific recommendations about assumptions, methodology and conclusions are included in section 2.5 of this document. One significant omission that is worth mentioning is the impact on both human health and the environment of the various technologies considered.

2.1.1 Environmental Sustainability

We find that there should be increased emphasis placed on the environmental impacts of the various scenarios presented by BELCO and Leidos. Continuing to generate electricity according to the global status quo presents major risks to a nation like Bermuda, both in facing the threats of climate change as well as the direct impacts on human health that result from the combustion of fossil fuels.

See [SECTION 3.3] of the Etude report commissioned by BE Solar for more details.

2.1.2 Human and Environmental Health

The impact of fossil fuel combustion on human health is not discussed within the IRP, though it can have a significant impact on Bermudian society. Emissions from fossil fuel combustion can affect humans through both airborne exposure and through contamination of drinking water. The real costs associated with these health impacts can be quantified, and any IRP should consider these costs, in addition to the costs of potential capital expenditure needed to avoid such emissions. The resulting analysis would favor scenarios with renewable, LNG or LPG options.

See Section 2.5.10 for further details about the health impacts of fossil fuel combustion.

2.2 APPROPRIATENESS OF PROCUREMENT STRATEGY

Question 2: Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?

The short-term procurement plan set forth by the TD&R Licensee is appropriate given the state of the utility's assets now, but the procurement strategy beyond the Replacement Generation is potentially irresponsible. Section 2.7 of the TD&R licensee's IRP functions in the context of the Electricity Act 2016 outlined in Appendix B, though the plan does create risks, as detailed below.

2.2.1 Replacement Generation

We accept that the replacement generation assets were urgently required by the TD&R licensee and support the Replacement Generation plan for the 56MW of new generators at the North Power Station and the 10MW Battery Energy Storage System (BESS). This represents a low-regret option that allows for future integration of renewable energy, LNG and/or LPG. The TD&R licensee's decision to integrate a BESS represents a departure from past practice and should be recognised as a progressive move.

2.2.2 Economic Risks to the TD&R Licensee and to Bermuda

We believe the proposed Procurement Plan would expose Bermuda to an unnecessary level of economic risk, with little clear benefit or justification. The plan risks locking the TD&R licensee and consequently its customers into a higher cost scenario than could be developed through a range of alternative approaches that better meet the priorities of the Electricity Act 2016.

A particular risk is presented by the greater uptake of customer-cited energy efficiency and distributed renewable energy. A range of recent technological developments in HVAC, lighting, water heating, IT and consumer electronics have resulted in step change reductions to the levels

of energy consumption required to provide the same service[1]. Limited uptake of distributed solar technology by early adopter has reached between three and four megawatts in just a few years. These changes are only just being reflected through a reduction in electricity demand.

Widespread further deployment of these technologies should be expected and encouraged as it offers a least cost solution to many of the TD&R licensee's customers and a low-regrets option to Bermuda as a whole. This presents a risk to the Preferred Plan through the reduction in demand for electrical energy that would result.

The substantial capital investment in LNG infrastructure is only the least cost option if the cost can be spread out over a large enough number of kilowatt hours of electrical energy. A large reduction in the number of kilowatt hours the TD&R is able to sell from LNG generation could significantly increase the cost per kilowatt hour. This could easily render the Preferred Plan more expensive than a range of other scenarios, including some not assessed in the IRP.

Conversely, there appears to be little risk, from the perspective of Bermuda as whole, in delaying any investment in LNG infrastructure indefinitely, while pursuing cost-effective deployment of energy efficiency and renewable energy generation.

2.3 USE OF COMPETITIVE BIDDING

Question 3: Which generation resources should the TD&R Licensee procure using competitive bidding, if any?

All new generation assets should be procured via competitive bidding. Renewable energy resources, energy storage and DSM should be bid competitively. Such competitive bid processes have yielded very low-cost resources in jurisdictions looking to increase renewable energy generation.

2.4 ALTERNATIVE SCENARIOS

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?

Yes, there are scenarios which were not covered by the IRP proposal, particularly those that looked to establish a deeper penetration of renewable energy and energy efficiency. The IRP

[1] Individual homes and businesses across Bermuda have repeatedly demonstrated that cost-effective reductions in energy consumption of 30-50% are commonly achievable at the building level. Individual measures such as lighting automation and retrofit can result in reductions as high as 90% relative to a baseline of 1980's-1990's technology.

Proposal presented by BELCO and Leidos "focused on a series of predefined scenarios," with placement occurring at scheduled retirements of current BELCO infrastructure. All of the scenarios fix levels of renewable energy and DSM, whereas the IRP could have optimized for a level of cost effectiveness, carbon emissions, or both.

See [SECTION 6.0] presented in the submitted report by Etude.

2.5 ADDITIONAL VIEWS ON ASSUMPTIONS, METHODOLOGY AND CONCLUSIONS

Question 5: Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?

In practical terms, the assumptions used in the IRP process are likely to have a much greater influence on the final conclusions than the methodology. The variety of methodologies that can be adopted is somewhat limited and in any case the TD&R licensee has generally followed industry best practices. For example, well understood methods for calculating the levelized cost of energy, load forecasting, capacity gap analyses and planning reserve margin have been followed and explained in the IRP.

Assumptions

Considering the range of core assumptions required to adequately conduct the IRP process is quite limited, there appears to have been insufficient effort placed on researching, subsequently explaining and justifying them. As a result, several key assumptions are not deemed adequately robust to support the Preferred Plan and therefore justify over $104,000,000 of capital investment. The impact of a range of core assumptions and methodologies is discussed in more detail below.

2.5.1 Future Costs for Renewable Energy and Battery Storage

The capital assumptions used for renewable energy technologies will significantly impact the sensitivities around renewable energy penetration, and since these costs are changing so regularly it is necessary to use the correct forecasts. The RAB's consultation document indicates:

> *"Accordingly, this plan should incorporate the latest evidence on the costs and technical characteristics of different generation and load management technologies in order to evaluate the least-cost capacity expansion plan for the electricity market of Bermuda."*

Some of the assumptions around renewable energy technology are not up-to-date in the IRP Proposal. For example, the Bren wind study is from 2014. Significant cost reductions have occurred since then. Future cost curves for solar PV, wind and battery storage systems are as relevant to the IRP as future fuel cost projections, yet none are included. Their inclusion and proper analysis would result in a completely different optimum resource plan for Bermuda.

2.5.2 Demand-Side Resources Definition

The definition of Demand-Side Resources (IRP p 1-10), and the technologies that fall under it, could be altered. In particular, distributed generation should be reclassified as a supply-side resource. As it currently stands, the utility is largely looking into what generation assets—thermal or large-scale renewable energy—are needed to meet demand that is net of distributed renewable energy sources. By reclassifying distributed generation as a supply-side resource, the utility could more greatly consider the integration of distributed generation. This would achieve a more optimal distribution and cost for such resources because the utility best understands where distributed generation resources are most needed on the grid, and they can obtain a lower cost of capital than most other participants in Bermuda's energy system.

The utility should also expand upon and further identify the DSM bundle. In the IRP Proposal, Leidos has included an "Undefined" (IRP, p 1-10) bundle of EE measures, which relies upon standard and generalized assumptions about EE uptake. Greater increases in energy efficiency are possible given today's technology, and this opportunity should be defined better before proceeding with agreement on the which thermal assets are needed to meet that demand.

The additional submission from BE Solar known as the "Alternative Proposal for Bulk Generation and Demand Side Resources" details more specifics on the potential for energy efficiency improvements in Bermuda in Section 5.0.

2.5.3 LCOE Assumptions

While we support the LCOE methodology, the assumptions used do not appear to be sufficiently robust to support the conclusions of the IRP with any confidence. The LCOE calculations also fail to account for probable future changes to some assumptions that could easily have been examined in a sensitivity analysis. The seven key assumptions required for an LCOE calculation are summarised in the table below, within the context of the TD&R licensees IRP.

Assumption	Comments
Capital Cost	The cost of renewable energy systems is naturally dominated by capital costs as they have no fuel costs. LCOE analyses for renewables are therefore highly sensitive to capital cost assumptions.
WACC	Due to the dominance of capital costs, renewable energy technologies are also highly sensitive to WACC assumptions. Reductions in WACC for solar and offshore wind technology as they have matured has been one of the key drivers behind reductions in LCOE.
Lifetime	The assumed lifetime of generators directly affects the lifetime energy production, which is the main denominator in LCOE calculations. As renewable energy technologies have high capital costs, low operational costs and no fuel costs the marginal cost of energy generation is minimal, therefore longer lifetimes reduce the calculated LCOE.
O&M Costs	Overly conservative assumptions with respect to O&M cost, particularly for small solar energy systems, can easily result in a significant and often unjustified increase in LCOE. Most solar photovoltaic systems in Bermuda are effectively maintenance free.
Capacity Factor (annual energy generation)	The capacity factor for solar systems depends on their tilt, orientation, inverter technology and a range of other technical characteristics. The capacity factor for offshore wind farms also depends on specific turbine characteristics. As lifetime energy production is the main denominator in LCOE calculations, accurately forecasting capacity factor is essential to establishing a robust LCOE.
Fuel Costs	Applicable to fossil fuel plant only, which are naturally sensitive to fuel cost assumptions. There is a noticeable disparity between the amount of work that has gone into projecting fuel costs in the IRP, relative to the other key assumptions in this table, particularly those which affect solar and wind technologies.
Efficiency	Applicable to combustion generation only. Generally easy to predict based on known performance of similar generator characteristics

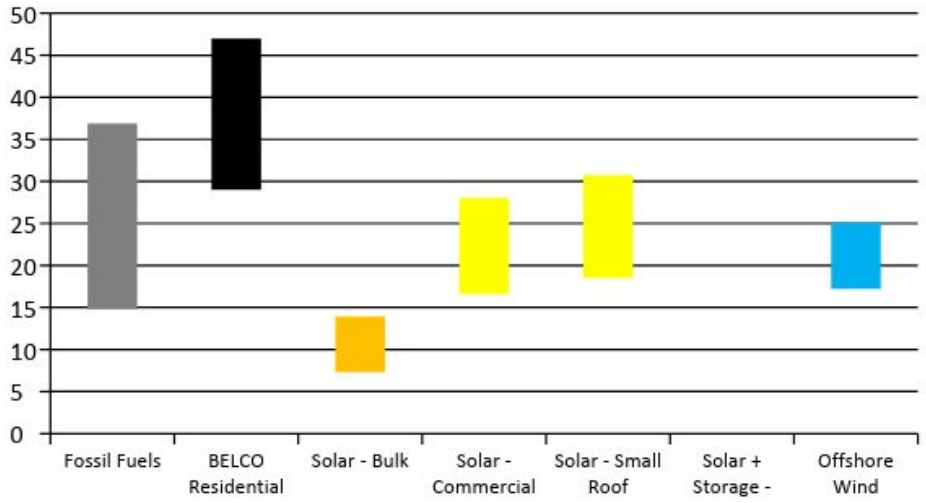
Accurately forecasting LCOE for competing technologies on an LCOE basis requires the use of best and worst-case scenarios developed through iterative sensitivity analysis. This should consider that the sensitivity to each of the seven key assumptions varies according to technology. As an example, fossil fuel generators are highly sensitive to fuel costs, but less

sensitive to WACC. Conversely a solar photovoltaic system would be highly sensitive to capital cost, WACC, lifetime, O&M costs and capacity factor.

A further consideration is the frequency with which a best or worst case assumption is expected to apply to the technology in question. For example, high fuel prices could reasonably be expected to apply to all fossil fuel generators over a prolonged period of time and are therefore a key assumption to test in a worst case scenario. Conversely, while there may be the potential for some solar energy systems to be more expensive due to installation complexities that are specific to a handful of properties, the frequency of this occurrence is low and therefore this is not a valid basis to form an assumption for the worst case LCOE for solar technology.

A revised set of LCOE calculations were developed based on guidance from a variety of energy experts in Bermuda (for solar data) and Europe (for offshore wind data). These were combined and cross-checked with a range of other data points including dozens of recently installed solar energy systems in Bermuda, operational energy data from solar energy systems in Bermuda, the power purchase agreement price for the airport solar project, wind and solar data from Bermuda Weather Service and a variety of international reports.

A detailed set of assumptions are provided in Appendix C, which may be compared with those made in the TD&R licensee's IRP. The results of this analysis are presented below.



2.5.4 Electric Vehicle and Energy Efficiency Uptake

The basis for the supply-side resource optimisation is based on total demand, it is imperative to have appropriate assumptions on the main drivers for electricity demand, including Electric Vehicle (EV) and Energy Efficiency (EE) uptake. EV adoption and EE uptake are forecasted to increase at averages of 34.9% and 17.3% per year throughout the study period.
See [SECTION 4.1.1] presented in the attached report by Etude.

2.5.5 Fuel Price Forecasts

Fuel price forecasts have a dramatic impact on the relative competitiveness of various thermal assets considered in the IRP Proposal. For example, under the current Proposal, the most likely scenario results in LNG providing a more expensive option on a levelized basis than the other fossil fuel-based options. A LNG solution performs the best in high fuel cost scenarios.
The fuel price forecasts were reviewed in the attached Etude Report. [SECTION 6.2].

2.5.6 Definition of 'Least Cost'

In reviewing the IRP and developing this response it was apparent that the meaning of 'least cost' varies between the TD&R licensee and its customers. This difference is fundamental to the outcome of the levelized cost of energy screening and ultimately the scenario that is presented as 'least cost', yet does not appear to be recognised in the IRP. This alone appears to invalidate the conclusions of the IRP as it is such a fundamental criterion to the scenario evaluation.

As an example, a rooftop solar system generating electricity for a levelized cost of $0.25/kWh may be the least cost option for a customer relative to purchasing electricity from the TD&R licensee at the current rate of $0.29 - $0.47/kWh[2]. The same system would be regarded as more expensive than oil, LNG or LPG generation by the TD&R licensee in the IRP, and therefore excluded on a cost basis despite being the least cost option to the customer.

2.5.7 Levelized Cost of Energy

We support the use of the Levelised Cost of Energy (LCOE) approach in principle. It results in a simple set of numbers that are likely to be understood by a broad number of consultation respondents. It also allows respondents to attempt to replicate the assumed LCOE's and to test sensitivities, as has been done in this response. We note Oxera's preference for the use of mathematical models over LCOE, however these may be more difficult for respondents to understand and therefore scrutinise. Considering the existing complexity of the IRP process, we believe this is valid consideration.

[2] Including the fuel adjustment surcharge.

2.5.8 Qualitative Comparison

One exception to the statement at the beginning of this section which referred to the methodology usually being benign is the qualitative assessment utilised in the IRP. This comparison is subjective, using arbitrary scales and scores which can be highly subjected to manipulation.

It is important to note how this approach can positively influence certain technologies, in particular LNG. On an LCOE basis, Scenario 3, the LNG-focused scenario, is the most expensive options (IRP, p 2-3). This runs against the criteria for "least-cost" set out by the RAB. True, there are other factors to consider such as environmental sustainability, and the qualitative assessment attempts to account for that. The report, however, is potentially biased it its reporting, claiming that any weighting results in LNG as the top option when considering both qualitative and quantitative factors. However if you drop the quantitative weighting to 10%, then Scenario 2 becomes the most attractive option.

Beyond the weighting, the qualitative analysis is subject to arbitrary scoring which can influence the results. For example Logistics is weighed roughly twice as high for NG/FO as for LPG, despite the increased complexity surrounding importing and storing LNG. And though Scenario 3 is a lower emissions option than the other options, the environmental quality of LNG is half that of a zero-carbon resource. These ratings are largely subject to the scorer's interpretation, and in this case are leveraging up the attractiveness of NG.

2.5.9 Environmental Impact

The Preferred Plan places Bermuda on an unsustainable plan from a carbon perspective. The International Energy Agency has revealed that emissions from electricity must fall from the 2015 rate of 411 g/kWh to 15 g/kWh by 2050[3]. The TD&R's plan does not place Bermuda on a pathway toward meeting this target. Scenario 3, the plan with the lowest carbon intensity, produces over 300 g/kWh. The transition phase away from fuel oil leverage this result up compared to a purely natural gas option, but still there is no indication that the utility will reach the required emissions levels by 2050. As a member of the global community, and one that will be more adversely affected than others by its impacts, the plan should place Bermuda on a track to support this global imperative.

[3] IEA (2016) *Re-Powering Markets: Market design and regulation during the transition to low-carbon power systems*. (Paris)

2.5.10 Impact on Human Health

The resulting impact of fossil fuels on human health is not discussed within the IRP, though it should play a vital role. There are well-established health impacts of NOx, SOx, PM10, PM2.5, nickel, chromium, and other heavy metals[4] through airborne exposure. These pollutants can result in asthma, various types of cancer, heart disease, and birth defects. A recent study[5] discovered a 20-25% decrease in the rate of premature births following the closure of oil and coal power stations.

Health impacts could be particularly relevant for Bermuda considering the proximity of electricity generation to households on the island. Combustion residues that collect on Bermuda roofs can directly enter water supplies for drinking water. These impacts should be investigated, quantified, and considered in any IRP exercise, since this will result in a real cost to society.

Considering health externalities could vastly change the economics in consideration throughout the IRP. Technologies to reduce emissions such as electrostatic precipitators and flue gas desulphurisation could significantly impact LCOE, thereby favoring scenarios with renewable, LNG or LPG options.

2.6 ALTERNATIVE PROPOSALS FOR BULK GENERATION OR DEMAND SIDE RESOURCES

Question 6: Do you have any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

Bermuda Engineering Company Ltd. has appointed an independent consultancy firm with expertise in this subject matter based in London to develop an Alternative Proposal. This consultation document is provided as a supplemental submission to this consultation phase attachment titled [Bermuda IRP Alternative Proposal - Bermuda Engineering Company Ltd. (BE Solar) and has been submitted via the RAB website.

[4] Pudasainee et al (2008) *Hazardous air pollutants emission from coal and oil-fired power plants.* (Pohang)
[5] Casey et al. (2018) Retirements of Coal and Oil Power Plants in California: Association with Reduced Preterm Birth Among Populations Nearby. (Berkeley)

3.0 FEEDBACK OUTSIDE THE SCOPE OF CONSULTATION QUESTIONS

The questions posed by the RAB sufficiently address the IRP Proposal and generally the IRP process well, however they do not accommodate commentary on the broader energy planning process.This section highlights some of these areas.

3.1 Lack of inclusivity

Bermuda would benefit from a broader, more objective and long-term outlook when conducting strategic energy planning exercises such as the IRP. The current process completely relies on the goodwill of citizens and individual companies to provide their views to the RAB, while placing the TD&R licensee in the centre of the process. This allows the licensee to 'plan out' forms of electricity generation that represent a threat to their market share.

Inherent in the planning process is the potential for bias in hope of attaining financial benefit. In relying on the sole TD&R utility to build the IRP, the RAB is relying on them to act in good faith for consumers and allowing them to dictate energy planning for the island. The utility has a fiduciary responsibility to maximize profit for its shareholders, so it would not be a surprise if they used the planning process as a way to ensure continuity of their hold over market share of the electricity market in Bermuda. Though the RAB is aware of the potential for bias here, it is worth noting again the potential for bias.

3.2 Unequal resource distribution from government

The Bermuda government has paid, presumably a large amount, for a detailed study into the costs and feasibility of LNG. It has also changed its energy policy goals to align with the TD&R licensee's preferred plan without robust justification. Similar efforts should be invested in investigating the potential energy efficiency, solar power, offshore wind, battery storage, and demand response. Following an analysis of the feasibility for such resources, an implementation plan should be drafted that includes pragmatic steps to ensure the adoption of such technologies.

3.3 Potential for grid defection

Unless the TD&R licensee can figure out a way to reduce the cost of power and offer affordable clean electricity, there is a real risk of grid defection as the cost of solar + storage becomes cost-competitive. A few customers in Bermuda are already implementing these systems on their own, out of an interest in the technology and the potential to reduce their carbon footprint. As the costs of solar and particularly battery energy storage come down, the cost-competitiveness of power provided by the TD&R licensee could seriously be threatened. This could lead to a utility death spiral.

The TD&R licensee can get ahead of this issue by becoming a major player in the rollout of new technologies. It is likely that utility scale storage will incur lower overall financial and environmental costs than distributed systems. There is a clear role for the TD&R licensee to play in providing professionally operated storage facilities. They have substantial engineering expertise and a financially stable background.

To avoid the issues raised in this section, the TD&R licensee, solar industry, RAB, Government and wider community need to work together to develop an inclusive plan for Bermuda that allows the TD&R licensee to maintain profitability in a future business environment where it's core revenue streams transition toward delivering electricity, coordinating demand response, storing energy at utility scale and providing back-up power for a grid primarily powered by renewables.

APPENDIX A – PURPOSE OF THE ELECTRICITY ACT 2016

The Electricity Act 2016 clearly outlines the legislative priorities for Bermuda's energy supply. In developing this consultation response, we are responding specifically to the purposes of the **Electricity Act 2016**, which are outlined in Section 6 of the Act:

a) to ensure the adequacy, safety, sustainability and reliability of electricity supply in Bermuda so that Bermuda continues to be well positioned to compete in the international business and global tourism markets;
b) to encourage electricity conservation and the efficient use of electricity;
c) to promote the use of cleaner energy sources and technologies, including alternative energy sources and renewable energy sources;
d) to provide sectoral participants and end-users with non-discriminatory interconnection to transmission and distribution systems;
e) to protect the interests of end-users with respect to prices and affordability, and the adequacy, reliability and quality of electricity service;

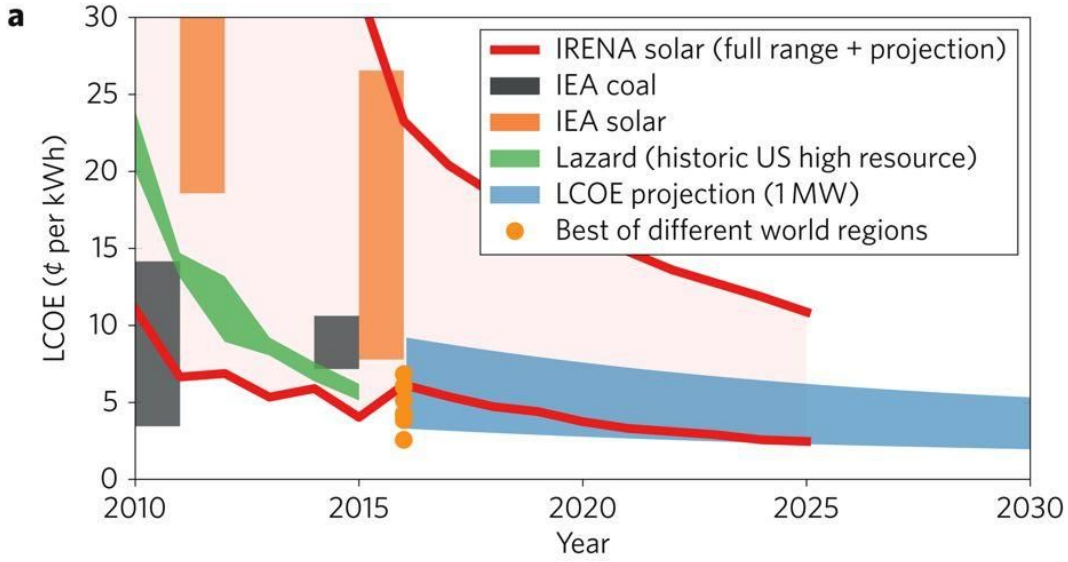
to promote economic efficiency and sustainability in the generation, transmission, distribution and sale of electricity.

APPENDIX B – LEVELISED COST OF ENERGY CALCULATION ASSUMPTIONS

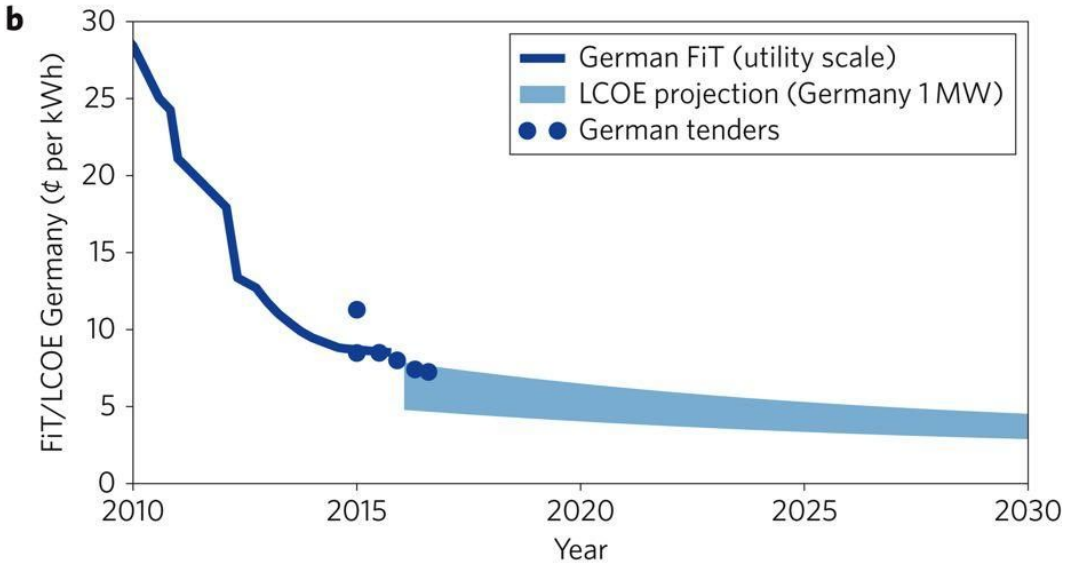
	Solar Photovoltaic (best case)	Solar Photovoltaic (worst case)	Offshore wind (best case)	Offshore wind (worst case)
Capital Cost	Residential: $4,000 Commercial: $3,570 Based on system prices in Bermuda. Bulk: $1,500 Based on system prices in Europe and North America. Sense checked against airport solar contract price.	Residential: $4,990 Commercial: $4,540 Based on system prices in Bermuda. Bulk: $2,000 Based on system prices in Europe and North America.	$4,500	$5,600 Based on Bren study from 2014. Variety of industry sources suggest prices have reduced since then
WACC	6.25% based on HSBC green loan	8% based on TD&R licensee IRP	7.5%	8% based on TD&R licensee IRP
Lifetime	30 years based on power output warranties of this period being commonly available.	25 years based on this still being a common power output warranty and microinverter warranty period.	25 years based on Danish Vindeby offshore wind farm. The first ever to be decommissioned after 25 years.	20 years based on standard industry design criteria
O&M Costs	$10 per kW per year nominal sum as many systems are effectively maintenance free.	$20 per kW per year	$40/MWh based on Bren wind study	$40/MWh based on Bren wind study
Capacity Factor (annual energy generation)	19% based on several years operational data from dozens of systems	17% based on several years operational data from dozens of systems	45% less turbulence wake losses of 12.4%, line losses of 3% and availability of 96%	45% less turbulence wake losses of 12.4%, line losses of 3% and availability of 96%
Fuel Costs	N/A	N/A	N/A	N/A
Efficiency	N/A	N/A	N/A	N/A

APPENDIX C – GLOBAL DECLINE IN SOLAR PHOTOVOLTAIC LEVELIZED COST OF ENERGY

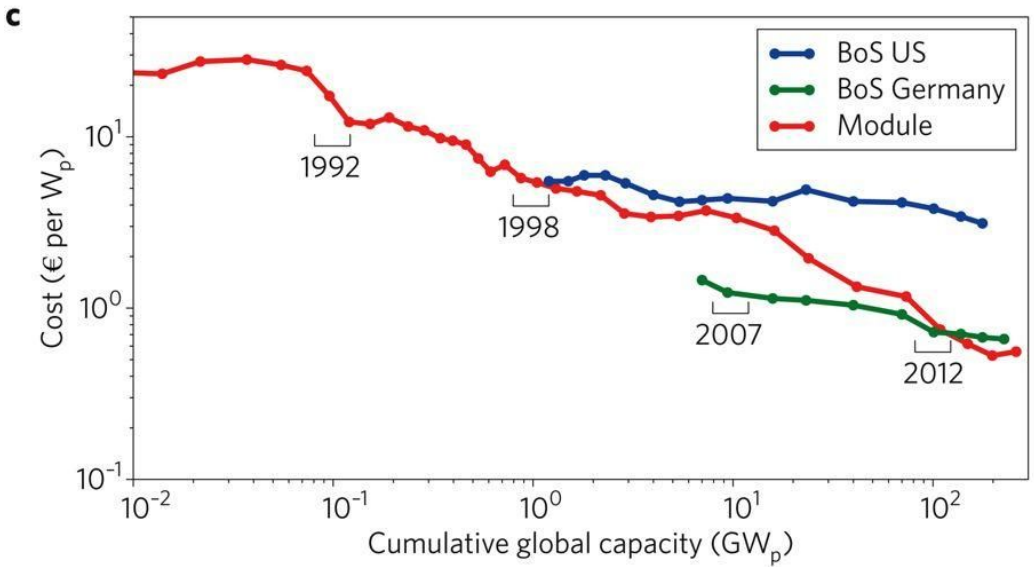
The following figures and text are taken from the 2017 scientific paper *The underestimated potential of solar energy to mitigate climate change*, written by Felix Creutzig et al and published in the journal Nature Energy. They indicate the rapid rate in decline of the cost of electricity from solar photovoltaic technology. Importantly, data from various sources consistently projects stable long-term cost reductions; a stark contrast to both the volatility and inflation attributed to oil, LNG and LPG prices.



*"**a**, Past, present and future solar LCOE. Past data taken from IEA[91] for solar and coal, Lazard consulting [92] for utility-scale US projects with high irradiation and IRENA[83] for global projects with systems >1 MW. The values assume a discount rate of 10% for both coal and solar. The larger spread of the 2010 values in comparison to the 2015 values is due to the number of technologies included, changes in fuel price, and other assumptions. The LCOE range does not contain technologies with CCS. IRENA data shows the range of LCOE utility-scale PV projects from 2010 to 2015 (left-hand side) and the potential cost reductions from 2015 to 2025 (right-hand side) using a capacity-weighted average LCOE with a weighted-average cost of capital (WACC) at 7.5% for OECD countries and China and 10% for the rest of the world [83]. The historic data from Lazard[92] is based on crystalline utility-scale solar with single-axis tracking in high-insolation jurisdictions (for example, southwest United States) at the lower end, while the high end represents crystalline utility-scale solar with fixed-tilt design. Values for 1 MW utility-scale plants were taken from ref. 93. The lower end corresponds to a high insolation region (Spain) with low WACC of 2%, whereas the higher end corresponds to low insolation and a higher WACC of 8%. The set of achievable solar LCOEs based on recent purchase agreements was compiled by the World Bank and includes the UAE, Mexico, the United States, Peru, Chile, India, South Africa and Zambia [94]. Future LCOE projections were taken from IRENA and Vartiainen et al.[93]"*



*"**b**, Evolution of the German FiT[95] along with the results of recent German solar tenders and LCOE projections for south Germany [93]. The LCOE projection for the insolation level of Munich was taken with the range denoting WACC between 2% and 8%."*



*"**c**, Cost evolution as a function of global cumulative capacity for modules [36] (global average), and BOS in the United States [96] and Germany (EuPD; which is based on rooftop systems). The US BOS data costs were estimated as the difference of install prices for each system but using nationally averaged module prices. Capacities of 0.1 GW_p were reached in 1992, 1 GW_p in 2000, 10 GW_p in 2007, and 100 GW_p in 2012."*

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Our Ref: B-R86

POSTED ON WWW.RAB.BM

2 July 2018

Regulatory Authority
1st Floor, Craig Appin House
8 Wesley Street
Hamilton HM 11

Attention: Monique Lister

Dear Sirs,

Re: Response to Consultation Document: Comments on Integrated Resource Plan Proposal Consultation

This letter provides the response of Bermuda Electric Light Company Limited ("BELCO") to the consultation document entitled, "Integrated Resource Plan (IRP) Proposal Consultation" dated 2 May 2018 (the "Consultation Document"). The Consultation Document seeks public comment on the Integrated Resource Plan ("IRP") proposal submitted by BELCO to the Authority on 15 February 2018 (the "IRP Proposal"). The Consultation Document includes, at Appendix B, an assessment produced by Oxera, the Regulatory Authority's (the "Authority") consultant (the "Assessment").

The question posed in the Consultation Document to which BELCO wishes to respond is addressed below using the numbering set out therein, but BELCO reserves all rights and remedies available to it, now and in the future, to provide additional and/or complementary submissions in relation to the subject matters contained either in the Consultation Document, including the Assessment, or in this letter and/or otherwise to modify and amend its position as set out herein, including with respect to the Assessment.

56. Interested parties are invited to comment on the IRP Proposal from the TD&R Licensee, in particular in relation to the following questions:

…

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

BELCO wishes to take the opportunity to address the concerns raised in the Assessment. In the Assessment, Oxera states that the IRP Proposal is broadly in line with the Guidelines (as defined below) but notes some concerns about the documentation provided by BELCO relating to methodological issues, replacement generation and qualitative assessment. BELCO will address each concern in turn.

I. Methodological Concerns Relating to BELCO's IRP

The Assessment expresses concerns that the levelised cost of energy (the "LCOE") screening employed to develop the four feasible planning scenarios set out in the IRP Proposal may only approximately gauge the efficiency of alternative generation options.

In response, BELCO asserts that, in fact, Leidos Engineering LLC ("Leidos") took three broad steps in performing the quantitative assessment to prepare the IRP Proposal as follows:

(a) An LCOE analysis of a wide range of potential candidate power supply resources and fuel types;

(b) Selection of feasible resource expansion scenarios for detailed dispatch analysis; and

(c) Detailed production cost modelling using PROMOD.

In the first step, in order to simplify the production cost modelling process, the LCOE analysis was used to screen potential candidate resources to eliminate alternatives that were significantly less economically attractive and therefore impractical for Bermuda. The process of screening out unfeasible alternatives to simplify the modelling process is common in the creation of an IRP and is necessary for unique island systems such as BELCO's. The approach was explained in the IRP Proposal, at Appendix IIF, as follows:

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> “At the commencement of the IRP process, BELCO TD&R recognized that there exists an abundance of supply side and demand side generating resources that could be considered as potential candidates to assist BELCO TD&R in meeting its established objectives for the power system. However, it was determined that the choice of resources for the quantitative evaluation would focus on technologies (both to serve load as well as to abate load) and fuels that have been tested and proven, or display a high likelihood of technical and economic success based on a global energy industry outlook. The purpose of this document is to provide a high-level discussion of technologies that were not included in the quantitative analysis. BELCO TD&R will continue to monitor these options for improved economic attractiveness and/or improvements in technology that foster commercial deployment.”

In the second step, three primary scenarios, in addition to the reference scenario, were developed to examine alternative fuel “futures”: a fuel oil future, a natural gas future and a propane future. When discrete futures are possible but not certain, scenarios like this are defined prior to any modelling work in an IRP process. In the case of BELCO, fuel was determined to be the key differentiator in creating the scenarios. Scenarios are not an output of the modelling process. Defining and then analysing various scenarios during the modelling process allows stakeholders to compare and evaluate not only the costs of the discrete scenarios but also to consider other non-economic or qualitative factors. The list of feasible power supply resources from the LCOE analysis were then incorporated into the scenarios.

With respect to the third step, the detailed production cost modelling step incorporates a mathematical portfolio optimization tool that serves to automatically optimize the resource selection for each scenario to determine the least cost portfolio. This approach is most advantageous when dealing with large numbers of alternative resources or variables. In the case of the IRP Proposal, the number of alternatives and variables to be considered in each scenario was limited due to the practicalities affecting Bermuda. Assumptions regarding the timing of existing unit retirements were based on the useful lives of the units and renewable additions were limited to planned additions plus additional capacity deemed feasible pending

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a more detailed renewable resource feasibility study. The remaining variable to be optimized was the selection of resources to fill the capacity shortfall left by the retirement of existing resources. Given the limited number of candidate resources available for selection and the known timing of the resource need, new resources were added manually to PROMOD rather than selected with a portfolio optimization model. Given the limited amount of freedom to select new resources BELCO considers this methodology produced results comparable to a portfolio optimization model and allowed for the proper evaluation of the scenarios described in the IRP Proposal.

The three step process described above, which incorporates the LCOE analysis, is commonly used in the electric utility industry for the purpose of integrated resource planning.

II. Omission of Replacement Generation from Integrated Resource Plan

The Assessment criticizes the IRP Proposal for failing to evaluate BELCO's approved proposal to replace certain of its ageing assets with four dual-fuel engines totaling 56 megawatts to be known as the North Power Station (or "NPS") and a battery energy storage system (together with the NPS, the "Replacement Generation") (the "Proposal"). In particular, the Assessment notes the following:

> "The IRP Proposal does not evaluate BELCO's replacement generation proposal–that is, the IRP Proposal assumes that the replacement generation proposal will be built under all scenarios. Therefore, the IRP Proposal provides limited information on whether the replacement generation proposal represented the best option for the development of the energy market in Bermuda.
> …
> [T]he 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

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generation relative to the other options for new generation capacity that are available."

Given the background relating to the approval of the Proposal, BELCO now sets out its response.

The Background

On 16 November 2017, at the 2017 Energy Summit for Bermuda held one day prior to the issuance of the notice requiring BELCO to provide the IRP (the "Notice"), the Authority's staff announced that any replacement generation constructed by BELCO would not fall to be considered as part of the IRP to be required to be submitted by BELCO in due course.

On 6 December 2017, approximately three weeks after the Notice was issued, the Authority sent BELCO guidelines to be followed for the production of the IRP (the "Guidelines"). Replacement generation was not linked to the IRP in the Guidelines, and instead, the Guidelines provided that:

"3.19 Any replacement of generation assets (permanent or temporary) needs to be consistent with section 20 of the Bulk Generation Licence (License number BG2017102701-02). In particular, the Authority will make a determination on whether the net benefits resulting from the replacement of the generating facilities are commensurate with the net benefits of other options that may be available in the market, particularly within any proposed timeline for any such replacement of generation assets.

3.20 The Authority would expect any notification under section 20 of the Bulk Generation Licence to be consistent with the obligations and responsibilities of such licence, with regards to ensuring security, reliability of supply and meeting performance standards. The Authority notes that the BG Licensee is currently subject to 'Transitional' conditions relating to various aspects of performance standards."

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The Proposal was made pursuant to Condition 20 of BELCO's bulk generation licence. It was made to enable BELCO to address the issue of its ageing infrastructure which posed a threat to safety and security of electricity supply. The Proposal stated that the Replacement Generation would enable BELCO to continue to meet its statutory obligations with respect to the supply of electricity to Bermuda.

On 6 March 2018, approximately three weeks after the IRP Proposal was filed with the Authority, the Authority issued the Order approving the Proposal in relation to BELCO's Proposal (the "Order"). The Assessment sheds light on the Authority's decision as follows:

> "Under the EA 2016 and the Regulatory Authority Act 2011, the Authority has a duty to ensure security, adequacy, and reliability of electricity in Bermuda while also seeking least-cost electricity supply. In this instance, the Authority considered that any delays to the commissioning of the NPS was unduly risky as well as uneconomic. Put differently, the Authority deemed that the importance of ensuring security of supply considerations outweighed potential concerns over value for money, leading to the Authority's approval of BELCO's replacement generation."

BELCO notes that the IRP Proposal includes the Replacement Generation and the 6MW solar plant that is slated for construction on the Airport Finger site (the "Airport Solar Farm") as base assumptions given that they are planned resources (as compared with candidate resources).

The position set out in the Assessment contradicts the Authority's publicly-stated view that the Replacement Generation falls outside the IRP Proposal. BELCO notes that the Order was granted after the IRP Proposal had been submitted in the interests of ensuring security of supply for Bermuda. BELCO further notes that the Assessment does not criticize the exclusion of the Airport Solar Farm. The Assessment singles out the Replacement Generation as not being evaluated but does not call for like treatment of the Airport Solar Farm when both the Replacement Generation and the Airport Solar Farm were base assumptions in the IRP Proposal.

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III. Qualitative Assessment in the Integrated Resource Plan

The Assessment expresses concern that the qualitative assessment employed in the IRP Proposal is inherently subjective and has a large influence in selecting the preferred scenario.

Qualitative assessment is generally utilised in BELCO IRP processes to inform the overall ranking of scenarios. The qualitative assessment criteria and the applicable scoring assignments were developed prior to the production cost modelling of the feasible planning scenarios and, therefore, without knowledge of the outcome of the quantitative analysis and without consideration of how the scoring might impact the outcome of a specific scenario. The goal of incorporating a qualitative assessment component in the final scores that are used to rank the scenarios is to balance the objectives of the National Electricity Sector Policy of Bermuda dated 5 June 2015. In the absence of specific instruction from the Authority, the IRP Proposal was drafted using best judgement as to the five criteria for qualitative evaluation and scoring. Each selected criteria was judged to be of equal importance to the IRP stakeholders and, thus, each was assigned equal weighting for scoring purposes.

While the addition of the qualitative scores can theoretically alter an overall ranking provided by quantitative scores alone, as can be seen from Table 2-13 of the IRP Proposal, the overall rankings were not particularly sensitive to the range of quantitative/qualitative weighting factors.

BELCO looks forward to the publication of a general determination in connection with this public consultation.

Yours faithfully,

Sean Durfy
President and Chief Executive Officer

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August 17, 2018

The Bermuda National Trust's Response to the Integrated Resource Plan (IRP) Proposal

The Bermuda National Trust welcomes the Integrated Resource Plan (IRP) Proposal as a good start to a process that will help to ensure the advancement of power generation in Bermuda. Bermuda is at a crucial junction between fossil fuel and renewable energy generation as renewable energy technology advances. Over the study period of the IRP, 20 years, we believe that Bermuda can significantly move away from its dependence on fossil fuels – more than the maximum 15.8% renewable use forecast amount in the proposal.

The Trust appreciates that as a small island the range of renewables open to us is limited. But given the explosion of the use of renewables over the last 10 years and the advancement of the technology in this sector, we are confident that this growth will continue at an exponential rate. As such, we believe that it is important and prudent for Bermuda to invest in cleaner, efficient and more diverse renewable energies and we would like Bermuda's IRP to approach renewable-use in a more active way.

By considering only four scenarios in the IRP Proposal, put forward by BELCO, the in-depth study of other technologies such as biomass, solar and hydro marine energy generation, is limited. Therefore, we cannot be confident that the proposal has looked at all feasible energy generating options or various potential combinations of renewables and fossil fuels as is required by the Electricity Act.

Based on the quantitative analysis there was no scenario identified as being particularly advantageous. Scenario 3 (Liquefied Natural Gas (LNG)) is only marginally identified as the best option using qualitative data, which is inherently subjective. Scenario 3 also benefits from additional data obtained during feasibility studies that have already taken place.

We hope that the Regulatory Authority will address the issues identified by Oxera with regard to the methodology of the IRP to better identify and/or refine the best possible scenario. Integrated and reliable datasets would also provide more reliable results, with qualitative data used in a supporting capacity. Feasibility studies for all potential resources should be conducted.

The Bermuda National Trust appreciates that LNG is a better fossil fuel than what is currently used and will only require relatively minor alterations to the existing power generating units at the BELCO site; it is a cleaner burning fuel with lower carbon emissions at the point of consumption and is cheaper. The new pipeline and associated gasification facilities, we hope, can be limited to refurbishing/repurposing existing electricity generating infrastructure and be subject to an Environmental Impact Assessment.

Whilst LNG is a useful fossil fuel stopgap as renewable technology advances, it must be recognised that its production, transport and contribution to greenhouse gasses means that it is not a long-term global solution.

The Trust looks forward to the submission of IRPs from the renewable sector that actively consider the realistic potential Bermuda has for becoming energy independent.

Given our position in the world and our economy, there is no reason why Bermuda should not be a leader in small-island power generation. We should actively work with other isolated island communities to pool resources, knowledge and share experiences of successes and failures as it relates to dealing with the unique challenges of energy generation in our environments.

Submitted by:

Lawrence A. Doughty
Conservation Officer
Bermuda National Trust

2018 IRP Public Consultation Submission

Bermudians deserve a plan that fast-tracks clean,

affordable and secure renewable energy.

BEST Energy Committee

About BEST

The mission of the Bermuda Environmental Sustainability Taskforce or BEST (Bermuda Registered Charity #858) is: "to preserve and enhance the quality of life in Bermuda for present and future generations by engaging with the community to advocate for sustainable management and development of the physical, social and economic environments."

The impacts, both positive and negative, of generating, distributing and consuming energy span the physical, social and economic environments and are fundamental in many ways to the quality of life in Bermuda. BEST is committed to advancing the sustainable management of this vital resource in a way that fast-tracks clean, affordable and secure renewable energy for the benefit of all Bermudians.

Submission compliance note

The sub headings, apart from the abstract and conclusion, have a reference number that corresponds with the IRP relevant questions numbers, as set forth in Section 7 of the Consultation Document and which are shown below.

Consultation questions

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

2. Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?

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

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)?

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

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

Abstract (1,4 & 5)

"Climate Change is the single biggest threat to life, security and prosperity on Earth," - UN Climate Change Executive Secretary Patricia Espinosa.

In response, the UNFCCC Paris Agreement (COP 21), ratified by 175 states including the UK and European Union, requires all Parties to put forward their best efforts in order to strengthen the global response to the threat of climate change.

Bermudians should expect nothing less from our public officials who should already be working hard to fast-track clean, affordable and secure renewable energy.

While thinking globally we must act locally to reduce our carbon footprint and address the public health costs associated with relatively high levels of airborne micro particulate, to strengthen the economy by lowering the cost of electricity and stemming the outflow of capital for foreign oil and, to increase the security of supply by diversifying our energy supply mix.

With that end in mind we need to start with a new, highly ambitious but achievable "aspirational mix".

If this fundamental building block is to lay a solid foundation upon which we build our energy future, it must be informed by input from all the major stakeholders. These include rate-payers, non-Governmental Organizations (NGOs), the Transmission Distribution and Retail (TD&R), Independent Power Producers (IPPs), distributed energy producers (DERs), associated energy professionals, Government and the Regulatory Authority of Bermuda (RAB).

We suggest the following aspirational mix is realistically achievable and will fast-track clean, affordable and secure renewable energy sources for the benefit of all Bermudians.

Fuel/Resource Type	2023	2028	2038
HFO	80%	20%	
LPG		15%	15%
Utility Scale Renewables	5%	10%	30%
Distributed Solar	5%	15%	25%
Energy Efficiency & Conservation	10%	20%	30%

Global need for clean energy (1&5)

The greatest threat to life, security and prosperity on Earth is climate change. Except for the glaring anomaly of the Trump Administration, the rest of the world is taking this warning from the United Nations very seriously and so we should.

The UNFCCC Paris Agreement (COP 21) was ratified by 175 states including the UK and European Union and requires all Parties to put forward their best efforts in order to strengthen the global response to the threat of climate change.

As a matter of common sense, we should be doing the same and moving aggressively towards a socio-economic divestment of our unsustainable reliance on fossil fuel as soon as possible.

For information on climate change, we recommend the NASA Global Climate Change web site https://climate.nasa.gov the NOAA climate web site, https://www.climate.gov/ The UK Government Climate change site https://www.gov.uk/guidance/climate-change-explained and the United Nations climate change site United Nations Framework Convention on Climate Change (UNFCCC).

Local need for clean energy **(1&5)**

Not only is burning fossil fuels in Bermuda contributing to a global crisis, it is very likely compounding public health costs here as well.

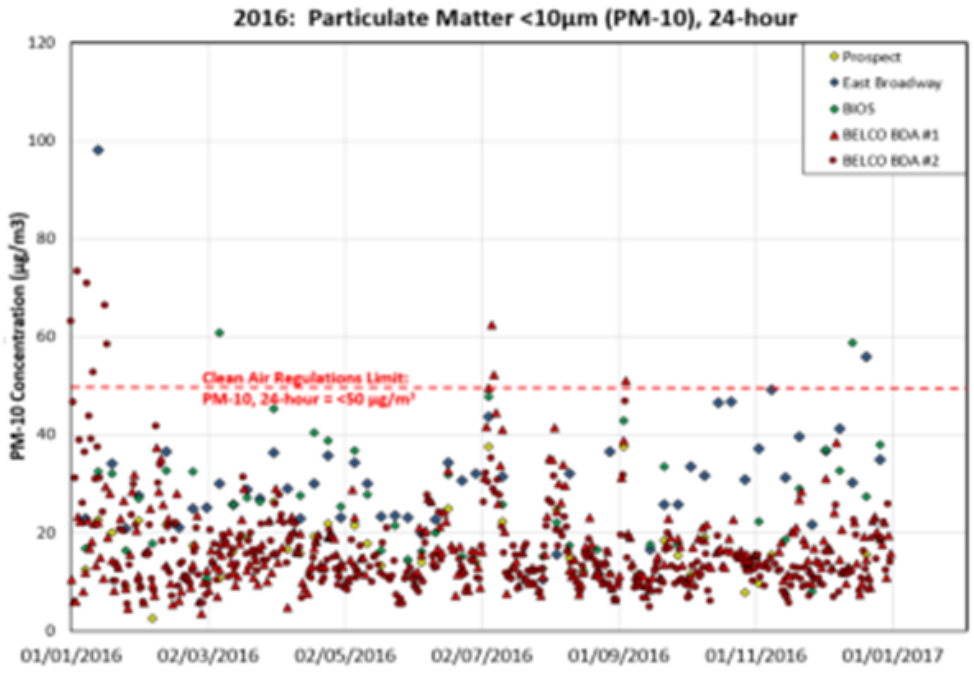
Independent studies from researchers at the US Environmental Protection Agency outlined in this Forbes article www.forbes.com/sites/justingerdes/2013/04/08/how-much-do-health-impacts-from-fossil-fuel-electricity-cost-the-u-s-economy/#71db7fc2c679 and the Union of Concerned Scientists paper: *The Hidden Costs of Fossil Fuels* www.ucsusa.org/clean-energy/coal-and-other-fossil-fuels/hidden-cost-of-fossils#bf-toc-2 put the "public health added cost" of burning for the generation of electricity at between 8 and 19 cents/KWh.

The economic value of the health impacts in these studies was based on premature mortality, workdays lost, and other direct costs to the healthcare system resulting from emissions of fine particulate matter, NO_x, and SO_2. The health impacts valuations presented in the study come from national benefit per ton figures developed from a Community Multi-scale Air Quality (CMAQ) model, which is regularly used in EPA Clean Air Act rulemaking.

Local air quality monitoring by BELCO and BIOS (see Tables 11.1 and 11.3 from the 2017 ENVIRONMENTAL STATISTICS COMPENDIUM published by the Bermuda Government, Department of Statistics show high levels of Total Suspended Particles (TSP) which are respirable airborne particles and associated with a wide range of health issues including chronic bronchitis and aggravated asthma.

Figure 11.1

24-hour Average PM_{10} Concentration, 2016



Source: Department of Environment and Natural Resources

Table 3.1

Reported Cases of Environmentally-Related Diseases by Sex, 2012 - 2016

Cause	Sex	2012	2013	2014	2015	2016
Gastroenteritis [1]	Female	359 r [2]	337 r [2]	354 r [2]	373 r [2]	264
	Male	299 r [2]	244 r [2]	230 r [2]	309 r [2]	202
	Total	658 r [2]	581 r [2]	584 r [2]	682 r [2]	466
Malaria (imported)	Female	—	—	— r [2]	—	—
	Male	—	1	2 r [2]	2	—
	Total	—	1	2 r [2]	2	—
Dengue (imported)	Female	—	—	—	—	—
	Male	—	—	—	2	—
	Total	—	—	—	2	—
Accidental pesticide	Female	—	—	1	—	1
	Male	1	—	1	1	—
	Total	1	—	2	1	1
Poisoning	Female	49	37	51	53	44
	Male	32	26	41	42	33
	Total	81	63	92	95	77
Diarrhea	Female	55	63	75	81	65
	Male	55	45	51	53	51
	Total	110	108	126	134	116
Respiratory diseases (all) [3]	Female	3,160	3,090	2,869	2,875 r [2]	2,844
	Male	2,537	2,540	2,442	2,492 r [2]	2,380
	Total	5,697	5,630	5,311	5,367 r [2]	5,224
TOTAL CASES, all causes	**Female**	**3,623 r**	**3,527 r**	**3,350 r [2]**	**3,382 r**	**3,218**
	Male	**2,924 r**	**2,856 r**	**2,767 r [2]**	**2,901 r**	**2,666**
	Total	**6,547 r**	**6,383 r**	**6,117 r [2]**	**6,283 r**	**5,884**
Percentage change (%)	**Female**	**+4.08 r**	**-2.65 r**	**-5.02 r**	**+0.96 r**	**-4.85**
	Male	**+7.38 r**	**-2.33 r**	**-3.12 r**	**+4.84 r**	**-8.10**
	Total	**+5.53 r**	**-2.50 r**	**-4.17 r**	**+2.71 r**	**-6.35**

Sources: Department of Health and Bermuda Hospital Board

[1] Includes inpatient discharges and emergency encounters.
[2] Includes cases that may have been inadvertently coded as non-infectious gastroenteritis.
[3] Respiratory diseases (all) includes acute bronchitis, chronic sinusitis, asthma, pneumonia, etc.

Table 3.1 - *Reported Cases of Environmentally-Related Diseases by Sex* from the 2017 ENVIRONMENTAL STATISTICS COMPENDIUM shows that 88% of all environmentally related diseases in Bermuda are Respiratory diseases including acute bronchitis, chronic sinusitis, asthma and pneumonia.

The impacts are particularly severe among the young, the elderly, and those who suffer from respiratory disease.

Typically, the "public health added costs" of oil-fueled electricity are disproportionately borne by those who can least afford it.

Although there are no definitive studies linking emissions with environmental respiratory diseases in Bermuda, it seems logical that, if there were, the results would mirror those found in other jurisdictions.

The cost of peak energy (1,3,4&5)

Saturn Energy Ltd has signed a deal with the Bermuda Government to build and operate a 6 MW AC utility scale solar project on the Finger at the L F Wade International Airport. The project will sell electricity to BELCO for 10.3 cents per KWh.

One of the benefits of solar is that it generates power at peak demand and the Finger will replace power that would have otherwise been generated by one of BELCO's gas turbine "peakers" which, we see from BELCO's 2018 IRP. Levelized Cost of Energy (LCOE) analyses below, costs them on average, 36 cents/KWh to produce.

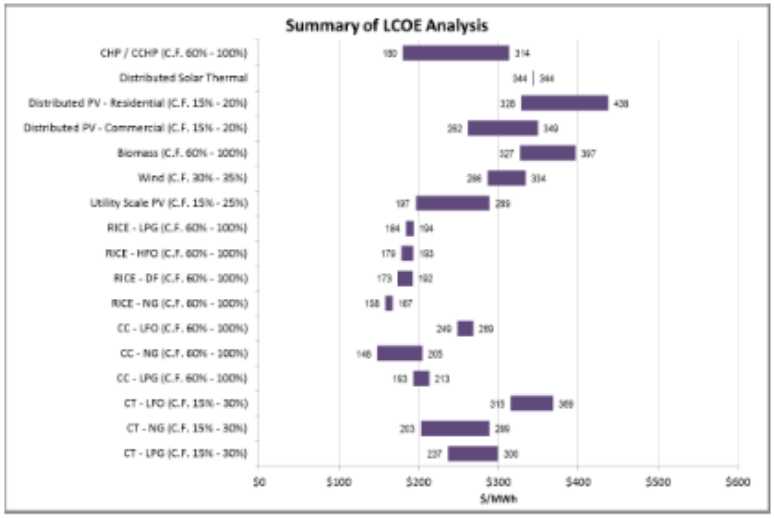


Figure 2.1 – NPV Summary of LCOE Analysis Results

Also, it is apparent in their analysis that the LCOE (levelized cost of energy) calculation of utility scale solar is too high and our research shows a similar mistake for distributed solar which makes their analysis of wind and bio-mass suspect as well. However, given the ability to directly monitor their generating plant, we have confidence that they have calculated the correct LCOE for their gas turbine "peakers" (shown as CT – LFO above).

As we see from the Finger project, utility scale solar is more than three times less expensive than traditional peak demand resources. Coupled with battery storage, solar is competitive with gas turbine peaker plants without incurring the "public health added cost" associated with burning fuel oil.

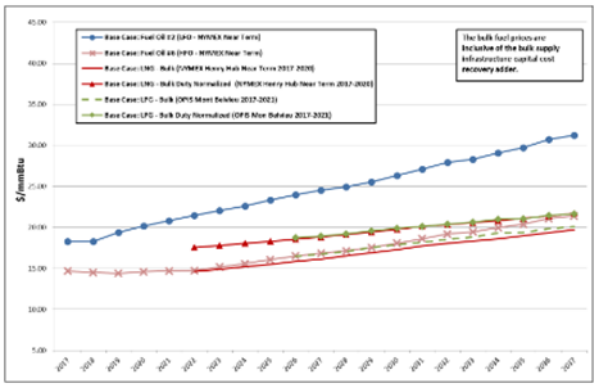


Figure 1.4 – Base Case Delivered Cost Forecast

Looking forward, an important consideration is that the cost of batteries and renewables is largely based on technology trends. These costs have been declining at an impressive pace, and prices are predicted to continue falling over at least the next decade. The cost of fuel oil and LNG generation, on the other hand, is closely tied to the commodity price of oil and gas, which BELCO predicts will continue to rise. (figure 1.4 from the IRP)

In planning for our energy future, it is vital to stay abreast of current industry trends and the following synopsis from the Renewable Energy World article titled: *Declining Battery Storage Costs Raise Questions About the Role of Natural Gas* provides a good overview of the market value of solar plus battery storage.

https://www.renewableenergyworld.com/ugc/articles/2018/07/17/declining-battery-storage-costs-raise-questions-about-the-role-of-natural-gas.html?cmpid=enl_rew_energy_storage_news_2018-07-19&pwhid=912a9a24819ad64d22de18d36420e1e0298c438ddcc94ba98b4057c3503fbd105afce52c99b561f65e42149c661c8683813eb9a6507a101e6fc376e4b0832292&eid=392788567&bid=2178043

According to independent analysis — GTM Research/Wood Mackenzie, National Renewable Energy Lab, Rocky Mountain Institute, Bain & Company, and Raymond James & Associates to name a few — the intersection between falling solar and battery prices and rising natural gas and oil prices is likely to occur within the next few years.

In the real world, it's already happening.

Last year, Kauai Island Utility Cooperative (KIUC) signed a long-term contract for solar power delivered during peak evening hours after the sun has begun to set. The 28-megawatt solar facility paired with 100 megawatt-hours of battery storage will meet evening demand at 11 cents per kilowatt-hour.

More to the point for Bermuda which, unlike Kauai, does not have the land necessary to develop significant amounts of utility scale solar but does have a very high density of distributed energy resource potential: a proposed gas plant in Oxnard, California was scrapped last year when the California Independent System Operator determined that a mix of batteries and distributed generation could meet local needs without negatively impacting the air quality and health of already disadvantaged surrounding communities.

In 2017, Tucson Electric Power set a US record for solar paired with storage with a 20-year power purchase agreement rate below 4.5 cents per kilowatt-hour. The Arizona project pairs 100 megawatts of solar with 120 megawatt-hours of storage.

Arizona added another two battery peaker projects to its power mix in 2018 when the Arizona Public Service tapped a 65-megawatt solar and 135-megawatt-hour battery system to meet peak demand between 3 p.m. and 8 p.m. The solar plus storage project directly beat out bids from natural gas peakers.

Xcel Energy reported solar plus storage bids ranging from 3.0 to 3.2 cents per KWh for projects in Colorado and a 101-megawatt solar project paired with 100 megawatt-hours of battery storage in Nevada posted an electricity price of 3.1 cents per kilowatt-hour.

While solar and battery prices will continue to decline, strengthening their role as an alternative to fossil fuel, BELCO has demonstrated in its IRP that it will be slow to embrace the carbon busting potential of distributed solar combined with energy efficiency and energy conservation that makes up Bermuda's abundant, clean, affordable and secure distributed energy resource (DER) if left to its own devices.

Bermuda's DER resource **(6)**

Solar and battery storage is only part of our distributed energy resource. According to one industry expert, residential demand would drop by 30% if every household switched to energy efficient appliances, replaced iridescent lightbulbs with LED and employed simple conservation measures like putting timers on hot water heaters and switching off lights, TVs and computers when not in use.

The potential savings for large commercial space is even greater. One large company in Hamilton slashed their electricity bill by 50% when they replaced their chilled water AC system with Variable Refrigerant Volume (VRV) equipment along with employing industry standard energy efficiency and energy conservation measures.

While Bermuda has limited space for utility scale solar, the distributed solar resource (which even BELCO admits is price competitive with their peaker plant) is much greater. According to Mandy Shailer MSc (GIS), GIS Mapping Analyst, Government of Bermuda, **Department of Environment and Natural Resources**, the total building footprint and therefore corresponding roof area, in Bermuda is 4.97 km^2.

We think 20% of the total roof area is a reasonable aspirational goal for distributed solar which, at 17.25 KM of solar per 100 m^2 of roof area, is a resource potential of 172 MW installed DC "nameplate" capacity. When converted to daily average AC production using a 3.7 to 1 multiplier (i.e. a daily average of 3.7 KWh of AC power for every KW of installed solar), amounts to 40% of BELCO's load forecast.

The evidence shows the potential of distributed energy resources in Bermuda is orders of magnitude greater than the average 2.8% shown in BELCO's IRP energy supply mix scenarios (see below). The evidence at hand leads us to believe it could reach 50% of demand by 2028 if, what have become generally accepted clean energy goals in other island jurisdictions (see Appendix II), are set for Bermuda and a progressive regulatory regime is put in place to achieve those goals.

Table 2-3
Energy Supply Mix – Fuel Oil (Scenario 2)

Resource / Fuel Type	2018	2023	2028	2033	2037	Study Period Total
Fuel Oil	95.3%	79.7%	79.4%	79.5%	79.1%	81.4%
NG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LPG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Renewables	4.4%	18.3%	17.5%	16.7%	16.2%	15.8%
EE / EV	0.3%	2.0%	3.0%	3.7%	4.7%	2.8%

Solar with battery storage is already competitive with fossil fueled "peakers" with prices predicted to continue to drop for another decade at least while the cost of energy efficiency and conservation is already beating wholesale rates for baseload.

The economy (5)

Developing our distributed energy resource is not only cost effective, it also will increase economic stability by providing a hedge against rising oil and gas prices. Further economic benefit will be derived if DER is self-funded with Bermuda dollars through reduced outflow of cash for imported oil and repayment of foreign sourced CAPX, keeping more money in the local economy thus improving the balance of trade and in turn, growing GDP.

We will need fossil fuel generators for some time to come, but their role will shift to backup for clean, affordable and secure, renewable energy as it comes online. The sooner we develop distributed energy in the outer perimeters of the grid the better it will be for our economy.

Security of supply (4)

During his presentation at the Ocean Risk Summit held this year at BIOS, the Honourable Dr. Kedrick Pickering, Deputy Premier of the British Virgin Islands, strongly advised Bermuda to diversify its energy

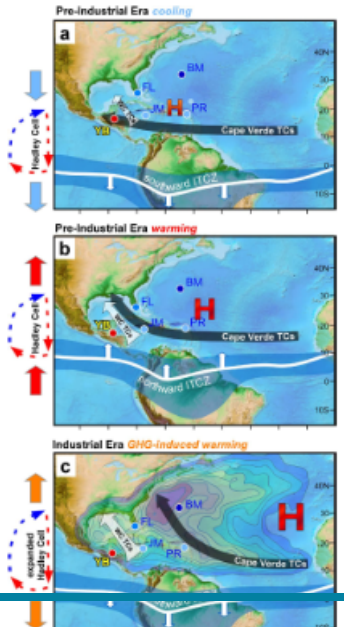
supply mix in response to the threat of climate change. (Personal communications from Dr. Anne F, Glasspool and Dr. Mark Guishard).

He was talking from experience.
"BVI took the full force of Hurricane Irma on 6 September, it was the most powerful Atlantic hurricane ever recorded, with winds that averaged 185mph, gusting to 215mph. Less than two weeks later, the islands were hit for a second time by Hurricane Maria.

Such was the force of the wind that even boats secured in the most sheltered lagoons cartwheeled huge distances – as did cars, shipping containers and roofs. Almost every tree was stripped of leaves and bark, then broken or blown away." (the Guardian 11/20/17)

According to the The UK Government Climate change site https://www.gov.uk/guidance/climate-change-explained, "The height of extreme sea levels caused by storms has increased. Warming is expected to cause more intense, heavy rainfall events. In North America and Europe, where long-term rainfall measurements exist, this change has already been observed."

On August 2017, Hurricane Harvey broke all the records after it made landfall at San Jose Island, Texas as a cat 4 hurricane then downgraded and stalled further along the coastline dropping torrential and unprecedented amounts of rainfall over the state. Many areas received more than 40 inches of rain as the system slowly meandered over eastern Texas and adjacent waters, causing unprecedented flooding.



Researchers at MIT have found there has been a 6 % increase in the chance of a Harvey scale rainfall event over the last two decades. http://news.mit.edu/2017/texas-odds-harvey-scale-rainfall-increase-end-century-1113

Researchers at the University of Durham studying the climate record captured in the chemistry of stalagmites from caves in the Caribbean and Bermuda show that the mean track of Cape Verde tropical

cyclones shifted gradually north-eastward from the western Caribbean toward the North American east coast over the last 450 years.

Since ~1870 A.D., these shifts were largely driven by anthropogenic greenhouse gas and sulphate aerosol emissions.

Their results strongly suggest that future emission scenarios will result in more frequent tropical cyclone impacts on the financial and population centers of the northeastern United States (and therefore Bermuda as well).

While multi-model ensemble studies predict that overall tropical cyclone frequency will decrease through the 21st Century while the frequency and intensity of the largest storms will increase. https://www.researchgate.net/publication/310706225_Persistent_northward_North_Atlantic_tropical_cyclone_track_migration_over_the_past_five_centuries

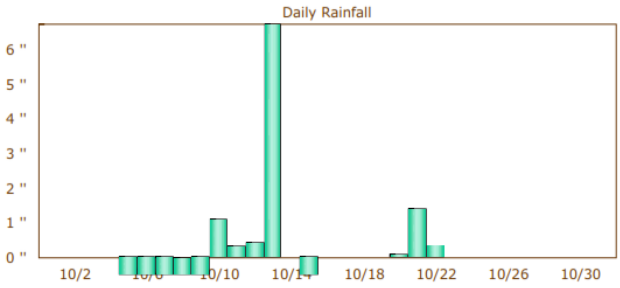
Fire and flood (4)

BELCO's hub and spoke grid attached to a central generating plant located on land, shown on plans submitted to the Department of Planning by BELCO for the North Power Station (NPS) as having an average contour of 2.3 feet above OS datum, is vulnerable to flooding.

Last year we saw a series of extreme tides, most notably the 18th October 2017, "King Tide", a confluence of highest astronomical tide (HAT) and a warm water eddy, that flooded Town Square and would have put the NPS site under 18" of water.

HAT is 2.6 feet above the ordinance survey (OS) datum. The warm water eddy put the water level another 1.5 feet above HAT for a combined 3.1 feet above OS datum. *See NOAA tide data Appendix I*

If a heavy rain event, like hurricane Harvey which hit Texas last year, coincided with an extreme high tide, we could see unprecedented flooding in the low-lying area around BELCO because high winds, storm surge and an extreme high tide would prevent storm water running off the surrounding hills from draining away through Mill's Creek as it would in normal circumstances.



Such a storm would not be unprecedented in Bermuda, on the 13th October 2016 Nicole, a fast-moving, intense hurricane moved over the island. The Esso Pier Tide Gauge recorded a storm surge of 4 feet, mitigated by the fact that it was low tide when Nicole passed over. Localized flooding occurred as Nicole brought about 7 inches of rain in 2 hours. (Graph shows rainfall for October 2016)

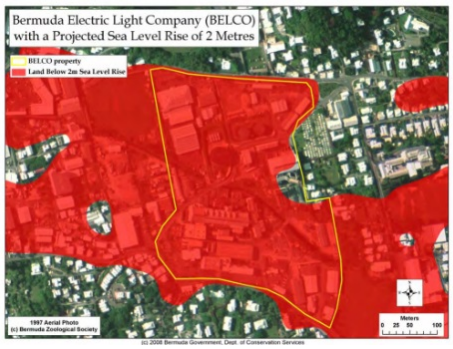
If Nicole had been a slow-moving storm like Fabian or had stalled over Bermuda, things could have been far worse.

Even in such an extreme case, BELCO's new NPS generators, which are to be installed on pedestals 14 feet above OS datum, will likely be OK. However, other vital infrastructure like transformers, switching gear and transmission lines along with many of their gas turbines would be inundated.

It is not likely that BELCO would go down completely but, their generating capacity, especially their ability to meet peak demand, could be seriously impacted; possibly over a long period of time.

Storm related flooding is not the only security risk to the central plant, dangerous fires like the one in September 2014, when insulation around the exhaust system of an engine ignited and in October 2013 when a switch caught fire and took over an hour to extinguish also pose a serious threat to our security of supply.

Decentralizing the energy supply mix (1,4,5&6)



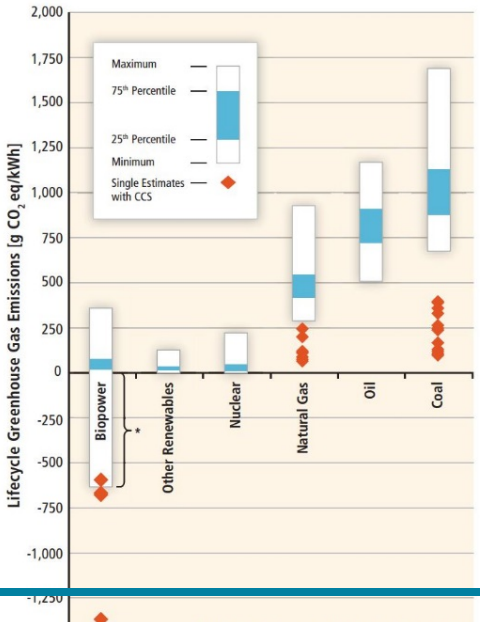
All things considered, it would be more than prudent to heed Dr. Pickering's advice and take proactive measures to spread the risk by diversifying our supply mix as soon as possible.

The bottom line is that the more distributed energy we connect to our grid, the more secure our energy supply will be and consequently the more resilient the whole system will become.

Residential and small commercial solar along with energy efficiency and energy conservation are valuable distributed energy resources (DER) and provide highly diversified energy sources that feed the grid from the outside in providing an important buffer in the case of a partial or catastrophic central plant failure. Properly engineered solar arrays are proven to withstand cat 5 conditions. https://www.rmi.org/news/solar-under-storm-designing-hurricane-resilient-pv-systems/

Conclusion (1,4,5&6)

Although LNG burns cleaner than fuel oil and is being touted as a bridge fuel to renewables, The Union of Concerned Scientists paper: *The Hidden Costs of Fossil Fuels* www.ucsusa.org/clean-energy/coal-and-other-fossil-fuels/hidden-cost-of-fossils#bf-toc-2 shows that it is only marginally cleaner, especially when the full life cycle cost is taken into account. When compared to renewables like bio-mass, wind and solar, LNG is the clear looser.



LNG will do nothing to strengthen security of supply because it will not diversify our energy supply mix, nor will it promote energy independence.

It will however, lock us in for 20 years of increased energy costs pinned to rising natural gas prices and required to pay off the debt service on capital development costs.

While Bermuda does not have enough land to develop significant amounts of utility scale solar leaving offshore wind and bio-mass as the only mature, utility scale renewable energy options available, what we do have is a very dense distributed energy resource that includes distributed solar, energy efficiency, energy conservation and electric vehicles.

Coupled with battery storage situated along the 4KVa distribution network to square up the solar load profile during time of production and to supply evening peak demand, DER can lower energy costs by replacing ultra-expensive gas turbine peakers and increase security of supply by diversifying our energy supply mix.

Then, as prices continue to fall, solar plus battery storage will take on baseload along with offshore wind and bio-mass reducing the need for fossil fuel to a relatively small LPG back up plant.

The RAB can help facilitate this alternate energy future with a regulatory regime that includes rate incentives for distributed solar generators like the degressive rate structure (see appendix III) and for energy efficient consumers calculated on an energy density, KWh per square foot formula.

By not taking the public health added cost and environmental damage caused by fossil fuel combustion into consideration when comparing competing energy sources, the RAB would be shirking its responsibility to act in the overall best interests of the people of Bermuda.

Bermudians deserve an Integrated Resource Plan that fast-tracks the uptake of clean, affordable and secure distributed energy and sets ambitious but achievable goals for bringing utility scale renewables like offshore wind plus battery storage and bio-mass generation plants on line to replace fossil fuel generation in the earliest possible time frame.

Appendices:

Appendix I

Absolute Differences Between Hydrographic and Topographic Datums — UPDATED April 2015

Main Side of Table

HAT	0.206	0.285	0.300	0.500	0.700	0.790	1.000	1.044	1.068	1.200	1.300	1.400	2.097
	MHHW	0.079	0.094	0.294	0.494	0.584	0.794	0.838	0.862	0.994	1.094	1.194	1.891
		MHW	0.015	0.215	0.415	0.505	0.715	0.759	0.783	0.915	1.015	1.115	1.812
			MHWS	0.200	0.400	0.490	0.700	0.744	0.768	0.900	1.000	1.100	1.797
				MHWN	0.200	0.290	0.500	0.544	0.568	0.700	0.800	0.900	1.597
0.663	0.457	0.378	0.363	0.163	MSL	0.090	0.300	0.344	0.368	0.500	0.600	0.700	1.397
					0.127	OS Datum	0.210	0.254	**0.278**	0.410	0.510	0.610	1.307
					0.337		MLWN	0.044	0.068	0.200	0.300	0.400	1.097
					0.381			MLW	0.024	0.156	0.256	0.356	1.053
					0.405				MLLW	0.132	0.232	0.332	1.029
					0.547					MLWS	0.100	0.200	0.897
					0.637						LAT	0.100	0.797
					0.737							Chart Datum	0.697
					1.434								Esso Sta. Datum

Use these values when referencing to **NOAA MSL**; otherwise use main side of table

Source Data Notes:

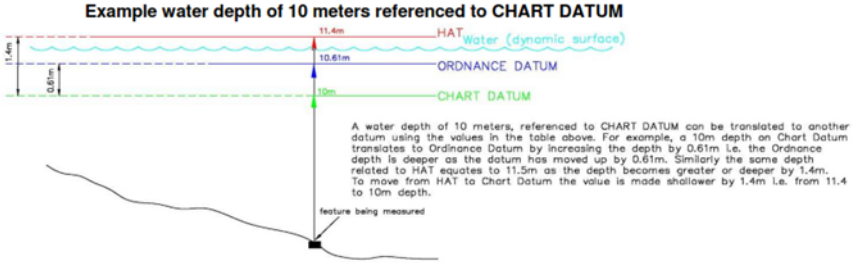
Elevation diff btwn MLLW and OS Datum, for Tidal BM # 4, also known as GBM 80225 (G1/9)

Data as stated on Savage OS Map Series

Data obtained from Admiralty Tide Tables, Vol 2, 2012 p.xxxviii

Data obtained from email, noaa, Thomas Landon regarding Station Datum values above Station Datum, Esso Pier Benchmark Sheet for 2695540 dated 11/23/2011

Example water depth of 10 meters referenced to CHART DATUM



Appendix II

KIUC by the numbers

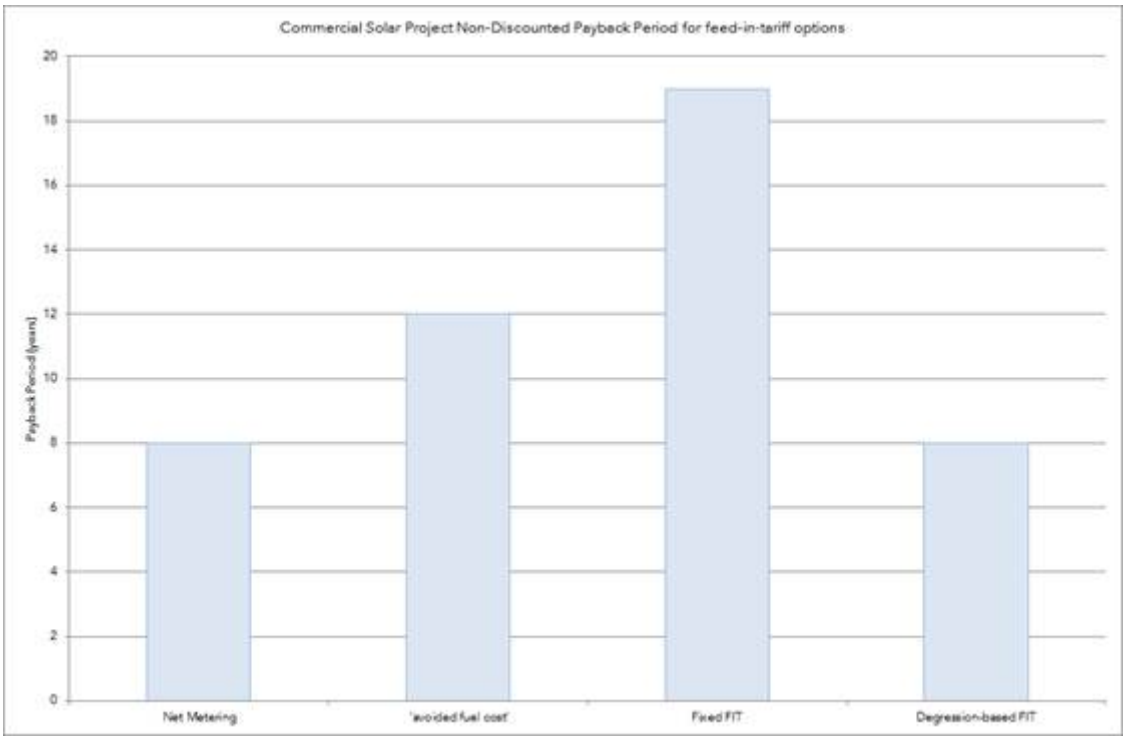
- 33,562 – Number of meters (electric accounts) served by KIUC.
- 24,745 – Number of active member-owners
- 562 – Number of square miles in KIUC's service area
- 1,400 – Miles of 57.1kV transmission and 12.47kV distribution lines owned and maintained by the co-op
- 151 – Employees delivering safe and reliable electricity to the citizens of Kauai
- 40+ – Percent of KIUC's electricity that comes from renewable energy sources
- 70 – Percent of electricity KIUC is committed to generating from renewable resources by 2030
- $26 million – Amount of money returned to members as patronage capital and refunds since the co-op was established
- 125 – Total generating capacity (in megawatts) of KIUC's existing power plants
- 3,273 residential solar rooftop systems in service
- 99.96 percent system reliability each year from 2014-2016
- 90 percent or more renewable power utilized in daylight hours on most sunny days

Appendix III

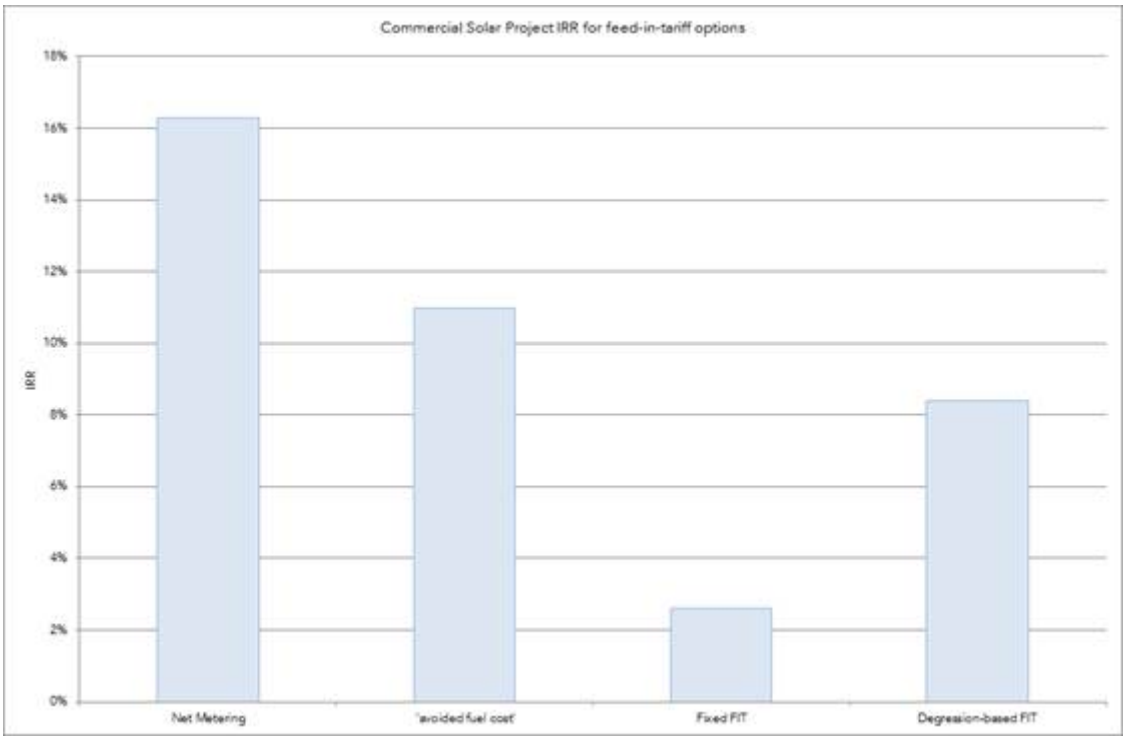
Four graphs that probably show best the financial performance of four main tariff options:

1. **Net metering (assuming a cost of 38c/kWh increasing at 6.8% a year)**
2. **Avoided fuel costs (starting at 18c/kWh and increasing at 10% a year)**
3. **Fixed FiT of 17c/kWh (similar to what is currently in place, assuming 1.5% annual inflation in line with retail price index or similar)**
4. **Degression based FiT, at 50c/kWh for 5 years, then 30c/kWh for 10 years then 0.08c/kWh for 15 years. (overall, solar subsidizes fossil fuels in this scenario)**

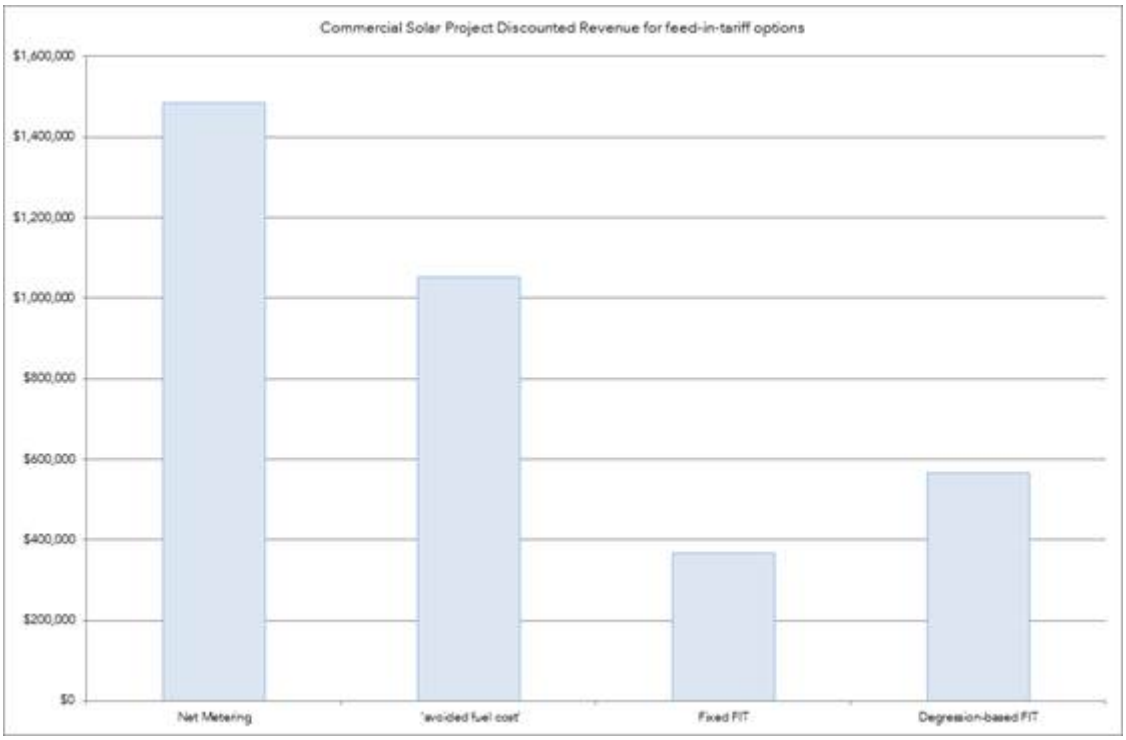
Payback period - The simple payback period is too long for the avoided fuel cost and the fixed feed in tariff rates to encourage any significant investment in solar. Net metering and the degression based FIT are just about short enough for sustained investment.



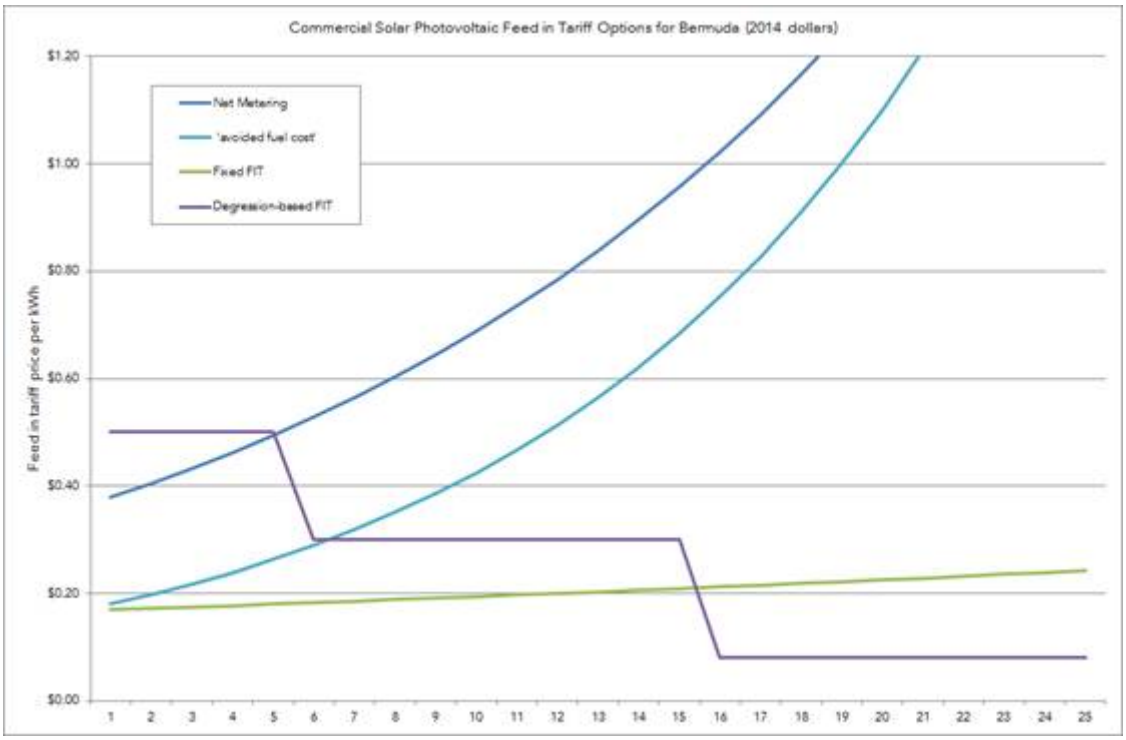
Internal rate of return (IRR) - Net metering offers excessive IRR, at the cost of all ratepayers, while avoided fuel cost is quite generous though few systems would have been installed if an avoided fuel cost rate was adopted as the simple payback would be too long. The IRR for the Fixed FiT is so low that combined with the lengthy payback period there would be little investment. The degression based FiT offers a fair return of around 8%, similar to BELCO (historically perhaps!) and other 'good' investments. It is straightforward to adjust the FiT to reduce the IRR if necessary.



Discounted total revenue - this offers an indication of the total benefit to the system owner, but also the total cost to the rate payer. It shows that net metering comes at excessive cost to ratepayers, which is too high a price to pay to achieve the payback period required for investment. The avoided fuel cost also overpays owners of solar, without even achieving a payback period short enough to encourage investment. The fixed FiT has the lowest overall cost to ratepayers, but is too low to encourage investment so is a non-starter in any case. The degression based FiT offers the second lowest overall cost to ratepayers. If calculated, the average cost per kWh would be much lower than provided by oil generation.



Here's an overview of the different tariff options over time, showing the price per kWh that would be paid for each. Some of them look a bit silly, but that's just due to the relatively high historical inflation rates for fuel and electricity in Bermuda, which quickly compound to push the cost per kWh up very quickly. The area under the graph is effectively a proxy for the total cost to ratepayers over time, which I think is a very elegant way of demonstrating how the degression based system works. Effectively, it is leveraging the size of the ratepayer base to enable overpayment for PV systems early in their lifetime without any perceivable difference to electricity prices. As more and more PV systems are installed over time, you end up in a position with a large percentage of total kWh's coming onto the grid for as low as 8c/kWh.


Commercial Solar Photovoltaic Feed in Tariff Options for Bermuda (2014 dollars)
Net Metering
'avoided fuel cost'
Fixed FIT
Degression-based FIT
Feed in tariff price per kWh
$1.20
$1.00
$0.80
$0.60
$0.40
$0.20
$0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

BLDC
BERMUDA LAND DEVELOPMENT COMPANY LIMITED

Regulatory Authority of Bermuda
c/o Monique Lister
1st Floor, Craig Appin House
8 Wesley Street
Hamilton, Bermuda

Dear Commissioners:

Re: Matter: 20180502 - Bermuda Integrated Resource Proposal ("IRP") Response

By issuance of the Consultation Document dated May 2, 2018, the Bermuda Regulatory Authority (the "**Regulatory Authority**") has invited interested parties to submit written comments regarding the Integrated Resource Plan Proposal ("**IRP Proposal**") which the current Transmission, Distribution and Retail Licensee ("**BELCO**") submitted to the Regulatory Authority on February 15, 2018.

Bermuda Land Development Company Limited ("**BLDC**") has an interest in the IRP Proposal because it issued a Request for Qualifications (RFQ) on March 27, 2018 for developers to build/operate a 20-Megawatt (MW) energy plant at Ships (Marginal) Wharf in St. George's Parish. We therefore want to ensure that the IRP Proposal provides for the anticipated increase in competition in the generation of electricity in Bermuda. As such, BLDC is pleased to present its responses to Question 3 and Question 6 posed in the interrogatory portion of the Consultation Document posted by the Regulatory Authority on May 2, 2018.

BLDC Background

Established pursuant to an act of the legislature in 1996, BLDC is a private company owned by the Bermuda Government and charged with the management, maintenance, marketing, and promotion of publicly owned lands located in Bermuda, as well as the strategic planning and development for those lands.

As one of Bermuda's largest landholders, BLDC oversees these significant assets, managing them for the benefit of all the Island's residents. Totaling almost 400 acres, BLDC's lands comprise approximately 3% of Bermuda's total landmass with strategic features and locations well-suited for an energy project development to benefit all Bermudians.

BLDC's role is to manage and develop the lands under its control in a manner that reintegrates these properties into Bermuda's social and economic fabric and increases employment opportunities for present and future generations of Bermudians. The Energy Plant project at Ships Wharf (the "**Ships Wharf Energy Plant**") represents an excellent opportunity to do exactly this by utilizing publicly owned lands to develop low-cost, reliable baseload electricity supply while at the same time diversifying the energy supply mix on the Island, enhancing competition in the Bermuda energy sector, lowering energy costs, and creating direct and indirect employment.

The Ships Wharf Energy Plant

As previously disclosed, BLDC has invited energy plant developers to build and operate a power plant at Ships Wharf which will deliver at least 20 MW of generating capacity into the Island's electricity grid, representing almost 20% of the Island's current baseload electricity requirement.

The Ships Wharf Energy Plant is envisaged to use a low-cost, low emission fuel to generate fully dispatchable baseload power. This project parallels an adjacent proposed cargo port redevelopment project at Ships Wharf which could provide transport facilities.

The project has been scaled to be able to deliver power for the airport and the east end of the Island via the BELCO distribution grid. The Ships Wharf site is of sufficient size to deliver a larger capacity - which may yield economies of scale. It is intended that the successful project proponent will obtain the necessary project site clearances, a license to operate as an energy generator in Bermuda, and any licenses that may be required for the delivery and storage of fuel. The location of the Energy Plant at Ships Wharf allows for the introduction of lower-carbon energy source generation, utility scale energy storage facilities, and the integration of significant additional solar energy resources on BLDC lands adjacent to Ships Wharf. All of this will reduce Bermuda's reliance on imported fuel oil, flatten mid-day peak energy demand, and reduce Bermuda's carbon footprint and its exposure to unpredictable world energy prices.

The project delivery timescale is planned to be approximately 36 months.

Interrogatory Responses

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

Competitive procurement for the Ships Wharf Energy Plant officially began in 2014 and is now mid-way to completion. To facilitate completion of this public procurement process, we respectfully request the Regulatory Authority to direct BELCO to work cooperatively with BLDC to support development of the Ships Wharf Energy Plant. BLDC further asks that the Regulatory Authority take such proactive and specific measures as it sees fit to promote energy sector competition and protect the interests of Bermuda consumers. As the sole vertically-integrated generator, transmitter, and distributor of electricity on the Island, the Regulatory Authority should ensure that BELCO fosters a positive working relationship with BLDC and the developer/operator of the Ships Wharf Energy Plant.

The Ships Wharf Energy Plant represents a unique opportunity for Bermuda to replace a significant portion of the current energy generation capacity with lower cost supply located on publicly owned lands. More importantly, the Plant will create diversity of electricity supply on the Island and create competitive price pressure to help lower electricity rates for Bermudians.

In order to complete the Ships Wharf Energy Plant procurement process currently underway and be able to introduce fair and cost-effective competition into Bermuda's energy sector, BLDC will require the following:

(a) Power Purchase Agreement Terms

(b) Interconnection Agreement Terms

(c) Active BELCO and Regulatory Authority Support

Each of these items is addressed in more detail below:

(a) Power Purchase Agreement Terms

BLDC is currently flexible with regard to the price structure of the proposed Power Purchase Agreement ("**PPA**") terms. The initial concept was that the competitive procurement would provide fixed land-lease terms for the site with prospective development proponents bidding on the effective lease rate. An alternative scenario, which may be preferable to the Regulatory Authority, is that the lease rate and lease terms for the site be fixed by BLDC in advance so that market participants, be invited to bid a per kWh electricity contract price instead.

Under either scenario, it is critical to the public competitive procurement process that PPA contract terms be known in advance and that they meet minimum international market standards.

As previously discussed, the procurement process underway regarding the Ships Wharf Energy Plant is based on an iterative procurement model with market sector input and commentary sought at key development stages. In order to maximize the value derived for the public from the use of BLDC lands, it is absolutely critical that the PPA terms be finalized and presented to project proponents for comment. To emphasize the point, it is also critical that the form and content of the PPA be in line with international market standards and fully bankable.

To that end, the PPA brought to market should be a firm contract with a fixed power purchase price and it should contain comprehensive discriminatory action and dispute resolution provisions. The elimination or diminution of any one of these elements will significantly impair the value of the contract brought to market, reduce competitive pressures, and create a reduction in the value received from the Ships Wharf Energy Plant project or other alternative energy producers.

As BELCO continues to maintain its position as the leading provider and distributor of energy in Bermuda and is the sole supplier of electricity in Bermuda, there are concerns this may be perceived by members of the public as an unwillingness to support the Ships Wharf Energy Plant project and energy market competition in general. Noting that the promotion and preservation of competition is the first principal function of the Regulatory Authority listed in Section 12 of the Regulatory Authority Act, we submit that the active involvement and support of the Regulatory Authority in mandating and directing BELCO will be of the utmost importance to enable the completion of the Ships Wharf Energy Plant.

(b) Interconnection Agreement Terms

Another key element of risk to market participants in the development of the Ships Wharf Energy Plant will be grid interconnection. In this regard, it is also critical that BELCO be directed to provide clear and certain terms for the connection of the Ships Wharf Energy Plant project in advance of the RFP stage of the project procurement.

We rely on the expertise of Regulatory Authority staff to ensure that connection costs are fixed in advance and are either (a) identical to those incurred by BELCO in respect of other similar projects in Bermuda or, preferably, (b) wholly covered by BELCO. The key elements regarding this are clarity, transparency, open-access and fairness. Given the strategic value of the Ships Wharf Energy Plant project to Bermuda, it would be most prudent, efficient and fair to direct BELCO to absorb any grid deficiencies, upgrades and interconnection costs for the Project up to the boundaries of the site.

(c) Active BELCO and Regulatory Authority Support

We strongly urge the Regulatory Authority to require BELCO to diversify the energy supply mix in Bermuda, thereby ensuring competition within Bermuda's energy sector to help lower energy costs for all Bermudians.

To that end, we request the Regulatory Authority provide provisions in the IRP Proposal to:

1. Reserve at least 20 MW of planned baseload capacity for the Ships Wharf Energy Plant project;
2. Assign legal and technical staff resources within the Regulatory Authority to work directly with BLDC to conclude the development of the document suite required to finalize this project's RFP documentation now being drafted; and
3. Supervise, direct and work with BELCO to facilitate the power purchase agreement and grid connection arrangements for the Ships Wharf Energy Plant project.

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

We share the general community concern that BELCO may operate - *or be perceived to operate* - as an impediment to the development of an independent and competitive electricity supply in Bermuda. The public perception of the approval of BELCO's proposal to develop the North Power Station (to be constructed on BELCO's Pembroke campus) in December of 2017 underscores this concern.

The procurement process run by BELCO for the North Power Station dates back to 2011, and as this decision was made prior to the launch of the current public IRP Proposal process and not by public tender, BLDC concurs with the conclusion stated by Oxera Consulting LLP – the Regulatory Authority's IRP Proposal technical consulting advisor, "it has not been possible for the Authority to test if the price offered by successful tender currently represents good value for money". By permitting the development of the North Power Station as proposed, we respectfully submit this will be at the cost of all Bermuda rate payers and will substantially diminish Bermuda's freedom of action regarding energy supply mix planning, competitive supply opportunities and its continued reliance on imported fossil fuels.

We note Oxera's concluding observation regarding this decision, "Given that the Authority only recently accepted BELCO's replacement generation programme, **there may be opportunities to revise the parameters of this programme in response to the outcomes of the IRP consultation process and any other changes to system requirements.**" BLDC believes it is in Bermuda's interest for the Regulatory Authority to reassess the parameters of the North Power Station and direct BELCO to engage a minimum of 20 MW of power from the Ships Wharf Energy Plant to promote and preserve competition and innovation, to the benefit of Bermuda's residents and consumers.

We hope these comments might be accepted and of assistance to the Regulatory Authority and sincerely wish the Commissioners and entire Regulatory Authority team all the best as they work to finish completing the IRP Proposal in the best interests of the Bermuda consumer and in the promotion of competition.

Sincerely,

Francis R. Mussenden
Chief Executive Officer

Hello Monique,

I am writing to ask two questions related to the Integrated Resource Plan Proposal Consultation:

1 - Licence Threshold

In the consultation, the Authority invites interested parties to submit detailed proposals for bulk generation or demand side resources for potential inclusion in the IRP. The Electricity Act 2016 defines 'bulk generation' as generation using a system with an installed capacity at or above the licence threshold. What is the actual licence threshold in terms of kW or MW installed capacity?

2 - Distributed Generation

There is significant potential for distributed generation, such as rooftop solar photovottaic systems, to contribute toward an electricity supply that is more consistent with the purposes of the Electricity Act 2016 using technology that is already in use in other jurisdictions. The consultation document does not however appear to invite alternative proposals for distributed generation, instead requesting proposals for bulk generation or demand side resources, neither of which apply to rooftop solar systems based on the definitions of these terms contained within the Electricity Act 2016. Could you please confirm that alternative proposals for bulk generation, distributed generation and demand side resources will all be accepted?

We would be grateful for any clarification you could offer on these matters.

Best regards,

--

Chris Worboys

Energy Consultant **|** Certified Passivhaus Consultant

Etude

T 020 3176 4464 | **W** www.etude.co.uk

3 Dufferin Avenue | London EC1Y 8PQ

19 HInsons Island

Warwick

2367854

July 13'18

Dear RA

I wanted to express my concern over the actions of our power company BELCO.

For years BELCO have had the opportunity to move us forward towards a more sustainable power future, incorporating renewables in their power mix. There was even an economic incentive to do so, as the pay back on hot water heaters on roofs is less than 6 years. As well, the price of PV solar has been coming down so quickly that this technology is now competitive with fossil fuels. With battery power pricing also reducing at great speed there is a good argument to support moving forward with renewables plus battery storage decentralizing our power supply.
This diversification in the industry is exactly what was recommended by several of the speakers at both energy summits I attended at the Hamilton Princess. "Don't put all your eggs in one basket" was another quote from one of the experts.
I am greatly concerned that you will allow BELCO to commit us to LNG which will require a massive investment and lock us into an aging technology for years to come. A lot of years. Meanwhile the world will march on with ever more exciting technologies that will pass us by because we are committed to a natural gas whose price will be unpredictable but we will have no choice.

"The new study, published Thursday in the journal Science, puts the rate of methane emissions from domestic oil and gas operations at 2.3 percent of total production per year, which is 60 percent higher than the current estimate from the Environmental Protection Agency. That might seem like a small fraction of the total, but it represents an estimated 13 million metric tons lost each year, or enough natural gas to fuel 10 million homes"……
"But methane, the main component of natural gas, can warm the planet more than 80 times as much as the same amount of carbon dioxide over a 20-year period if it escapes into the atmosphere before being burned."
https://www.nytimes.com/2018/06/21/climate/methane-leaks.html?

The other issue with fossil fuels is the environmental costs of burning them are not factored into the price thereby distorting their efficiency. AS an island nation we need to be seen to be doing our part in averting climate change and curtailing our emissions. I realize that burning natural gas is better than burning dirty diesel but alternative energy is the future and we must set up a regulatory environment to make it thrive.

Further to that point, the current price set by the RA towards BELCO buying back extra power from solar generators is too low and only serves to disincentivize anyone considering this investment. This is poor regulating and keeping us in the dark ages. It also goes against the advice of energy diversification mentioned above.

St Thomas researched what would be the best fuel for their power plant and chose LPG. The capital costs are much less and I implore you to closely examine this before allowing BELCO to move forward with LNG. IN order to pay back such capital costs plus generate an 8% return, our electricity rates will become higher for a long time. There is a possibility that our utilities future, if allowed to move us to LNG, will experience a death spiral as more and more people move off the grid with their own combination of solar and batteries. This defection will mean less BELCO customers paying more to cover costs, and is a very possible future scenario.

Thank you for your consideration,

Claire A Smith

Response to Consultation Document: Comments on Integrated Resource Plan Proposal Consultation

Eur. I*ng.* Clyde L. Symonds MSc (Eng. Mgmt.) BSc (Eng.) CEng MAPM
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30 June 2018

Distribution:

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Tab: Submit a Response The Regulatory Authority, Bermuda	Monique Lister Regulatory Authority 1st Floor, Craig Appin House 8 Wesley Street Hamilton, Bermuda

ABSTRACT

The objective of Leidos in conjunction with BELCO to produce a credible and practicable IRP has been adequately met. Suggestions by this reviewer are put forward with references throughout this response directed toward a possible revision in 2023, and hopefully for a major IRP revision in 2028.
This reviewer is in agreement with most assumptions and conclusions in the IRP and recommends that the RAB allow BELCO to proceed with implementation plans without delay.

There are seven (7) criticisms of the IRP detailed within this paper. The bases of this response are fivefold in the context of the six (6) RAB questions posed, they are: (1) Electric Utility Engineering Economics, (2) Optimised Generation & Transmission Planning using Operations Research in the context of the IRP, (3) Mathematical Financial Simulation, (4) Quantitative Power System Reliability Evaluation to provide (5) Power System Security at minimum cost to all classes of electric utility customer.

EXECUTIVE SUMMARY

The objective of 'Leidos' in conjunction with BELCO to provide a credible and applicable IRP has been adequately met. Suggestions are put forward with references throughout this response directed toward a possible revision in 2023 and for a major IRP revision in 2028.

This reviewer is in agreement with most conclusions in the IRP paper, in particular, agreement with the two main conclusions at top of page ES-1 of: (a) average of zero growth during study period and (b) the need for additional resources will be driven by the retirement schedule for the existing generating units. Credit has to be given to BELCO for the Battery Energy Storage System (BESS) proposal which will cover two technical gaps.

There are seven (7) criticisms of the IRP and they are:

1. There has been no attempt to quantify the cost/value of energy outages to bulk consumers at 4.16kV;
2. There is no indication of systematic collection of generation outage FOR and ORR data, and transmission or consumer outage data, or how it is/has been used, in say the Canadian Electrical Association data format, in order to seamlessly progress to probabilistic static and operational planning toward 2028, or slightly beyond;
3. Planning produced appears not to be optimised multi-objective attribute planning, except for PROMOD©;
4. The operational planning approach in the 2018 BELCO IRP use of LOLH (LOLE), does not appear to be completely consistent with static generation planning;
5. There is little reference to best IRP practice in island investor owned public electric utilities, or more importantly benchmarking to either Hawaiian Electric or to Barbados Light & Power, two extremely well managed island (isolated) utilities;
6. There are no references cited to aid reviewers;
7. No information is given on the backgrounds of the persons at Leidos who produced the IRP.

Never-the-less, this reviewer is in agreement with most results and conclusions in the BELCO IRP 2018 and recommends that the RAB allow BELCO to proceed with their implementation plans with a delay of no more than 4 – 6 weeks.

For those reviewers not interested in the details in this SMART Innovations Ltd., (SIL) response, all salient information can be found in this Executive Summary; in the Introduction, in the comments to the six questions posed by the RAB, and in the Discussion and in the Conclusion. However, where readers desire a complete picture of any one Section, they are referred to that Section.

There are other aspects of Power System Planning not considered in this document that are critical to an IRP. The most important of these is Power System Security Assessment, which is exclusively a planning, engineering and engineering economics involvement that is the exclusive domain of the Professional Electric Utility Engineer. Lastly, the cost of reliability in relation to customer outages does not seem to have been addressed in the BELCO Proposal.

As the most important recommendation in the Conclusion and Recommendations, it is proposed that from 2028, BELCO utilise probability methods in static planning in their IRP and use Reserve Margin as backup.

Clyde L. Symonds
SMART Innovations Ltd.

List of Acronyms and Abbreviations

ABB	Asea Brown Boveri
ASAI	System average availability index (ASAI).
BL&P	Barbados Light and Power Company Limited - Barbados, West Indies.
CAIDI	Customer Average Interruption Duration Index
CEA	Canadian Electrical Association
EUE	Expected Unserved Energy
Eur Ing	Ingénieur Européen (European Engineer)
F&D	Frequency and Duration Static Generation Planning
FIDIC	FIDIC is the International Federation of Consulting Engineers
EPC	Engineering, Procurement and Construction type Contract
EPCM	Engineering, Procurement and Construction and Maintain type Contract
Expected (ENS)	Expected Energy not Supplied
IEEE	Institute of Electrical and Electronic Engineers Inc,
IEEE PAS	IEEE Transactions on Power Apparatus & Systems
LOLE	Loss of Load Expectation = LOLH
LOLP	Loss of Load Probability
MRRD	Minimum Revenue Requirements Discipline
OR	Operations Research
ORR	Outage Replacement Rate
Oxera	Economics Consultants
SAIDI	System Average Interruption Duration Index (SAIDI)
SAIFI	System Average Interruption Frequency Index (SAIFI)
SIL	SMART Innovations Ltd.
TPS	Transactions on Power Systems
T&TEC	Trinidad and Tobago Electricity Commission (T&TEC).
VOS	Value of System Reliability

INTRODUCTION

I have only a few criticisms of the BELCO 2018 IRP document, briefly outlined in seven points above. Most of this SMART Innovations Ltd., (SIL) commentary is geared toward what should be looked at by the RAB in the context of 2023 and more so, toward 2028 in follow-up IRPs. First, below, there are responses to the six (6) IRP questions. Then, all responses are treated in the same order as presented in the original BELCO document if they fit into the relevant section, followed by mention in the Discussion. If there is a new item, then it may only be mentioned in the Discussion. Five examples of this latter group are:

- Benchmarking in electric utilities similar to BELCO and general IRP best practice;
- Benchmarking BELCO's IRP specifically with Barbados Light & Power Limited (BL&P) IRP;
- Data collection, correlation and data analysis;
- Cost/value of customer reliability study for each class of service;
- Multi-Objective Decision making subject to Constraints applied to the IRP.

1. There are few if any references given in the BELCO/Leidos 2018 Document.
2. This Consultation document is a little weak on raw data and bereft of quantitative risk analysis recommendations for an investor-owned electric utility.

For the reasons above, I have referred to the Consultation Document page and section numbers first in columns 2 & 3. Then in column 1, I reference answers 1 through 6. References have been inserted as footnotes where possible. However, in other cases, references are given as an integral part of each section of the text. In some cases the same reference has been quoted twice since the information contained therein is relevant to more than two sections of the BELCO document.

The six (6) Consultation Questions are answered first in the following pages, in relation to the content of the IRP.

This response to the IRP is longer than this reviewer would have liked, but it is essential to put the BELCO/Leidos report in context, which has necessitated a slightly extended and more explicatory report.

Concerning the benchmarking comments at the beginning of the 'General Discussion' just before the Conclusion and Recommendations, this reviewer has personnel experience from 1995, that Planning at BL&P was being done by two or even three highly experienced & capable Senior Planning Engineers. Whereas, BELCO had only one very experienced and capable 'Combined Planning & Engineering' Professional Engineer who wore four or five hats, who passed away in 2015.

Secondly, major upgrade delays by successive Bermuda Governments for whatever reasons, has had a devastating influence on planning and capital expansion at the 'electric utility'.

Conversely, because of the Planning, Engineering, Engineering Economics, Regulatory and IRP expertise at BL&P, it is no wonder; they produced the quality IRP that was finalized in 2014.

RESPONSES TO THE SIX (6) QUESTIONS

Q.	Pg.	Section	Response
1			**Are there any provisions in the IRP Proposal that should be modified?** There are no provisions in the IRP that should be modified. There are recommendations below in this section from this reviewer that can improve a possible 2023 revision of the IRP and substantial recommendations for a 2028 revision. Reasoning and Evidence There are two reasons for this. Firstly, most criteria as outlined in EA2016 have been met and confirmed by the 'Oxera' Compliance Review. Secondly, apart from a comprehensive 'Leidos' report, the quality of the document is more than acceptable. The evidence of this comes from three sources. Primarily, the benchmarking by SIL of the BELCO IRP against the 'BL&P IRP of 2014'. Secondly by an analysis of the 'Stochastic Loss of Load Study for the 2011 Integrated Resource Plan – PACIFICORP, USA' https://www.google.com/search?q=Stochastic+Loss+of+Load+Study+for+the+2011+Integrated+Resource+Plan+%E2%80%93+PACIFICORP%2C+USA%E2%80%99&oq=Stochastic+Loss+of+Load+Study+for+the+2011+Integrated+Resource+Plan+%E2%80%93+PACIFICORP%2C+USA%E2%80%99&aqs=chrome..69i57.7443j0j7&sourceid=chrome&ie=UTF-8 Accessed 4:10 pm, 18 June 2018. Also cited is the analysis of: 'Best Practices in Electric Utility Integrated Resource Planning Examples of State Regulations and Recent Utility Plans Authors Rachel Wilson & Bruce Biewald. June 2013.' https://www.raponline.org/wp-content/uploads/2016/05/rapsynapse-wilsonbiewald-bestpracticesinirp-2013-jun-21.pdf. Accessed 4:20 pm, 17 June 2018.
2			**Do you consider that the IRP Proposal procurement strategy outlined is appropriate?** The procurement strategy outlined in the IRP is appropriate. Reasoning and Evidence Procurement using any type Utility Resource Contract is extremely complicated. However in BELCO's case, where there are so many variables associated with procurement, construction followed by commissioning, then operation, with tight time frames, with limited capital, tariff considerations, with the stress of aging generators, anticipating a change from fuel oil to LNG, and incorporating 'Utility Scale Solar PV', while at the same time accommodating a Regulatory process; it has to be concluded that the strategy is appropriate.
3			**Which generation resources should TD&R Licensee procure using competitive bidding, if any?** There are no generation resources the TD&R Licensee should procure using competitive bidding for phase 1, i.e., the 4 X 14 MW Diesels plus the 10 MW BESS

			plant. However there are recommendations that follow on the Phase 2 expansion procurement. Reasoning and Evidence As outlined in the article immediately above, there are no resources that should be procured using competitive bidding. Further in large and complicated projects, it is generally best to keep the number of contractors involved to an absolute minimum to enable the owner to maintain control with conventional contracts. The use of one main contractor is obligatory with a FIDIC type EPC or FIDIC EPCM contract, which is probably the route BELCO should follow for 2018.
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?** There are no significant scenarios to 2018 that are not included in the present IRP Proposal that would be more consistent with the purposes of EA 2016. Reasoning and Evidence More scenarios could be considered or better still; an accurate probability distribution approach used instead of the scenarios in the IRP would be superior. However, with the raw data available to 2018, there is no evidence that a superior result to 2018, consistent with the purposes of the EA2016 would be achieved. The achievement of optimal least cost is difficult to achieve. The data required, the treatment of that data, the expertise of the whole planning team, the models and powerful computer optimisation and subsequent simulation programmes and the manpower and years required, is beyond the capability of most island utilities. Stated again, credit to BELCO for their effort in producing at the least, a sub-optimal IRP. Further delay by the RA or by others to BELCO's generator replacement programme could be fatal to system reliability and to Bermuda's economy, hence to Bermuda's long term survival.
5			**Do you have additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?** SIL has additional views on the assumptions, assessment methodology and conclusions set out in the IRP Proposal, valid for a possible revision in 2023 or for a possible major revision in 2028. Views, Reasoning and Evidence Best Practices in Electric Utility Integrated Resource Planning Examples of State Regulations and Recent Utility Plans Authors Rachel Wilson & Bruce Biewald. June 2013 https://www.raponline.org/wp-content/uploads/2016/05/rapsynapse-wilsonbiewald-bestpracticesinirp-2013-jun-21.pdf. Accessed 4:20 pm, 17 June 2018.

			The Wilson & Biewald paper should be viewed in conjunction with the Introduction and the Benchmarking Section in the Discussion and Conclusion at the end of this document.
6			**Do you have any Alternative proposals for bulk generation or demand side resources that should be considered in the IRP?** • 'SIL' has no Alternative Proposals for bulk generation. However, better generation 'FOR' statistics and demand side resource data for 2023 and for 2028 leading to calculation of SAIDI and SAIFI indexes and then SAIDI and SAIFI Distributions, combined with Cost/value of customer reliability study for each class of service (should be considered, if not already in place). Views, Reasoning and Evidence Refer to the last major section 'General Discussion' at the end of this document, under 'Further Considerations concerning the IRP'.
			IRP PROPOSAL METHODOLOGY
	1-1	1.1	**Project Overview** No comment.
	1-2	1.2	**Description of IRP Goals** No comment.
	1-3	1.3	**Load Forecast** No comment.
	1-5	1.4	**Reserve Margin Planning Criteria** Please refer to the following Section 2.3, 'Reliability Analysis'. The two largest generating units on the system is one of the Contingency Outage Reserve Criterion methods. Whether, the largest, two, or three largest units, all have the following advantages and disadvantages (Direct quote from reference 1 below). **Advantages** 1. Method is easily understood and used to compute required reserve. 2. The method is physically meaningful, the exact nature and the magnitude of the contingency outage is specified. 3. The thought process of a planner using the contingency method more closely approximates that of an operator; for example, setting aside reserves for loss of a specific unit immediately relates to line loading, transformer ratings and other

system parameters after the selected contingency has occurred, Reserve planning as accomplished by other methods does not have the advantage of considering specific operating conditions.

Disadvantages

1. The method is unable to determine the risk of loss of load associated with the level of reserves required by the criteria.
2. The reliability of a system may depart significantly from desired levels when a growing system continues to use the same contingency criteria. It is usually necessary to continually revise the criteria selected for contingency reserve planning.
3. The contingency method does not include proper quantitative evaluation of all the relevant parameters in reserve planning. These parameters, however, are almost always subjectively considered in such planning; and it is unfair to make the out-of-hand conclusion that they are not considered at all.

Probabilistic Planning Analyses Based Applications & Benefits of Outage and Performance Data

Outage and performance data (ref. 3 below), can be used for probabilistic based planning for:

New and Existing Unit Design	Planning Operations & Maintenance	System Studies	Regulatory Requirements
• Design Options • Procurement • Reconfiguration Alternatives • Manufacturer / Vendor Selection • New Technology Assessment.	• Availability Improvement Programs • Peer Unit Performance Benchmarking • Availability Target Setting • High Impact / Low Probability Failure Studies • Life Extension & Performance Reviews.	• Generation Capacity Studies. • Reserve Obligation Determination • LOLP Studies • Production Cost Studies • Forced Outage Prediction. • Fuel Inventory Programs.	RAB – Investor Owned Electric Public Utility Filings, Bermuda.

The fourth reference below by Sullivan has a numerical example of the calculation of the **LOLP** index (more properly designated as the **LOLE** or **LOLH** index) and the Expected Demand of Energy not supplied **Expected (ENS**) index for an isolated power system (such as Bermuda's), that extends through most of chapter 6. To demonstrate the Maximum-Flow/Minimum-Cut Algorithm and most of the calculations, please see only pp 247 – 273 of Sullivan.

Fifth reference below is the IEEE Standard on reliability, availability and productivity.

			References – Probabilistic Planning in Generation + Transmission + Distribution : 1. Edison Electric Institute System Planning Committee. February 1977, p4. Power system Reliability Assessment Phase 1 – Generation Effects. 2. R. Billinton and R. N. Allan. Reliability Evaluation of Power Systems, 1984. Numerical example, pp 16 -18. Pitman Advanced Publishing Program. 3. North American Electric Reliability Council. June 1995, p7. The Generation Availability Data System (GADS): Applications and Benefits. 4. R. Sullivan 1977. Power System Planning. McGraw- Hill Book Company [**LOLP and Expected (DNS**)]. Numerical example, pp 247 – 273 extended beyond static generation reliability evaluation to static generation combined with an imperfect transmission system of two generation buses and one transmission bus. 5. ANSI/IEEE Std. 762-1987. IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity. The IEEE.
	1-5	1.5	**Fuel Forecast** No comment.
	1-8	1.6	**Financial and Other Planning Criteria** No comment.
	1-8	1.7	**Existing Resources** No comment.
	1-10	1.8	**Demand-Side Resource Options** No comment.
	1-10	1.9	**Supply-Side Resource Options** No comment.
	1-11	1.10	**Levelized Cost of Energy Screening** 'Leidos' conducted a screening of candidate resources to create a short list of supply-side and demand-side resources. This was the basis for the production cost modelling using PROMOD©.

	1-12	1.11	**Production Cost Modelling** No detail was provided on the Production Cost Modelling software 'PROMOD' used for the load dispatch modelling, except that it performs an hourly least-cost dispatch of generating units. How is the optimization within constraints performed, i.e., what algorithm(s) is/are used? It is understood that PROMOD© has been used on the Manitoba power system. Leidos could have provided more information. It is this reviewer's research that, ABB's PROMOD© is a Security Constrained Economic Dispatch which can simulate hourly scheduling using an objective function of total costs with various capacity, fuel, transmission and environmental constraints which is a non-linear optimisation problem. It can be used for financial and capacity planning and fuel management.
	1-13	1.11.1	**Production Cost Modelling Scenarios** The four scenarios seem comprehensive, however in the future (2028 and beyond), either more scenarios are required or stochastic models have to be considered, where the risk of sudden, random generating unit failures are considered as a part of the process and the future load to be served is considered to be a probability distribution.
	1-16	1.12	**Quantitative Analysis of Candidate Resources** I was not able to verify the value of the qualitative analysis used, nor the equal weighting system used for all five qualitative factors given in Table 1-3.
	2-1	2.1	**RESULTS**
	2-1	2.1	**LCOE Results** I assume that the formula used for the Capital Recovery Factor is as given below, The specific formulae used in the levelized cost calculations are as follows: LCOE = I + O&M + F Where, I = annualized investment cost (BDS$/kWh) O&M = operation and maintenance cost (BDS$/kWh) F = fuel cost (BDS$/kWh) and I = Capital cost x Capital Recovery Factor Capital Recovery Factor = i(1+i)n / {(1+i)n-1} Cost Levelization Economic screening requires comparing power plants with very different capital costs, operating costs, size, output, and lifetimes. One tool for preliminary economic comparison is to convert the life-cycle costs (LCC) of each power plant option into a uniform (levelized) amount in each year. LCC costs are all the costs to produce electricity over the life of a plant: capital costs, including return on investment; taxes; depreciation; fuel costs; maintenance costs; cost of expected repairs, and decommissioning.

			I have a question. Is LCOE as good as ABB's Optimized Capacity Expansion Program or ABB's Optimized Portfolio Expansion Tool (Program)? . https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf Accessed 4:05 pm 30 June 2018. Lazard's Levelized Cost of Energy ("LCOE") analysis Version 11.0 November 2017.
	2-2	2.2	**Production Cost Modelling Results** The results in Table 2-1, page2-3 are of the right magnitude and the Scenario results are as expected. See also the comments in 2-4 below.
	2-11	2.3	**Reliability Analysis** ABB PROMOD© is a Security Constrained Economic Dispatch which can simulate hourly scheduling using an objective function of total costs with various capacity, fuel, transmission and environmental constraints which is a non-linear optimisation problem. It can be used for financial and capacity planning and fuel management. It is believed that this IRP did not include a robust study involving a load duration curve and forced outage rates for peaking and base loaded units, although operating reserve results appear acceptable for planning to beyond 2028. This reviewer cannot verify the LOLH static analysis produced in this section as applied to pure operations scenarios is valid as compared with LOLE (LOLH) derived from 'FORs' and the Load Duration Curve. Whereas, Operational Planning for operating reserve deals with ORR and LCOE. Please refer to Section 1.4, 'Reserve Margin Planning Criteria'. https://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2011IRP/PAC_2011IRP_LossOfLoadStudy_11-18-10.pdf Accessed 4:10 pm, 18 June 2018.
	2-11	2.4	**Sensitivity Analysis Results** The scenarios presented and examined may only produce sub-optimal not optimal results. Optimal results, even with a program as sophisticated as PROMOD© normally requires good data and probability distributions, not a few scenarios. Never-the-less, the results produced appear valid, mainly because they are of the right order of magnitude and line up as expected. See the comments in 2-2 above.
	2-13	2.5	**Qualitative Evaluation Results** No comment.
	2-15	2.6	**Scoring and Findings**

			No comment.
	2-18	2.7	**Procurement Plan** No comment.
			LIST OF APPENDICES
		I	**IRP Proposal Technical Assumptions** The first recommendation is that this whole IRP should be updated no later than 2028. The second recommendation is that the Reserve Margin Planning Criteria be used as a backup method and that a probabilistic method of Planning be phased in over the period, 2023 – 2028 – 2030 for the reasons outlined in Section 1.4 'Reserve Margin Planning Criteria'.
		II.A	**Load Forecast** No comment.
		II.B	**Resource Characteristics** No comment.
		II.C	**Fuel Price Projections** No comment.
		II.D	**Detailed Levelized Cost of Energy and Scenario Results** No comment.
		II.E	**Combined Quantitative and Quantitative Scoring** No comment.
		II.F	**Discussion Document: Candidate Resources Requiring More In-Depth Study**

			Discussion Document: Candidate Resources Requiring More In-Depth Study 2018 There are no Candidate Resources that require more in-depth study at this time. However, over and above purely renewable generation, are quantitative reliability, transient and dynamic stability at 33kV and security separate to stability, as they affect the power system. These are areas that are vitally important to this reviewer and to the Power Systems Quantitative Reliability Engineer, the HV Protective Relaying Engineer at 33 kV, the Stability Engineer and the HV Electrical Operations Engineer at BELCO and/or their overseas Consultants – disciplines that appear not to be important to everyone else involved in the IRP process. With regard to the comments on Offshore Wind Energy, it would be useful to have more detail on the Elsam report, and the date of completion. I assume this is the firm, Elsam Projekt of Denmark. Reference: Proceedings of the Workshop On Renewable & Alternative Energy Technologies For Bermuda and Other Small Islands. June 2000. Bermuda Biological Station for Research Special Publication No. 36.

GENERAL DISCUSSION

The diagram given 'In Further Considerations' over page, appears again in this section, because it is pivotal to distribution reliability and integral to generation reliability analysis and as such it is crucial to the profound consequences of an IRP.

In that diagram, whether the X axis is labelled 'Customer Reliability', Reserve Margin, LOLP, LOLE, or 'EUE/System Minutes', it is the same diagram, with the same consequences, when optimality is applied to planning, the 'Y' axis remaining unchanged, see page 1489 of reference 4 under 'Distribution System Reliability Analysis', that follows.

Similar Size and Operating Characteristics to BELCO - Island Utility Benchmarking

In benchmarking BELCO with its sister company BL&P, care must be exercised by all stakeholders, because of the vast differences in resources that the Barbados utility has compared with BELCO and the reality of the years of delay to BELCO's generation & transmission expansion, caused by externalities to BELCO. This reviewer has examined carefully the 2014 Barbados IRP and found great discrepancies that explain clearly why the BL&P IRP is so extensive and comparable with many US large investor owned interconnected electric

utilities. Some examples of what Barbados has achieved over BELCO are given below. This reviewer's first experience with Barbados in 1995 found their resources far outstripped BELCO's. Cited, are some main differences.

1. Extensive Generation, Transmission and Distribution Outage statistics;
2. Cost/value of customer reliability study for each class of service (cost of Unserved Energy);
3. Detailed Static Generation Study using LOLH or F&D;
4. Spinning Reserve Study;
5. Stakeholder Analysis and Stakeholder Interviews.
6. In house planning expertise stemming at least from the early 1990's.
7. Extensive references.
8. Adoption of the TQM standard, ISO 9001.

Even greater care must be applied in comparing the BELCO IRP with best Practices in Electric Utility Integrated Resource Planning, such as the reference below.

Reference 1: Best Practices in Electric Utility Integrated Resource Planning Examples of State Regulations and Recent Utility Plans Authors Rachel Wilson & Bruce Biewald. June 2013.

https://www.raponline.org/wp-content/uploads/2016/05/rapsynapse-wilsonbiewald-bestpracticesinirp-2013-jun-21.pdf. Accessed 4:20 pm, 17 June 2018.

Further Considerations concerning the IRP

Collection of Generation, Transmission and Distribution Statistics

Static followed by operational reliability and capacity analysis, requires as a starting point the collection of raw (BELCO) data to complement secondary (desktop) distribution performance data from similar operating utilities, such as BL&P, Hawaiian Electric and/or the 'Canadian Electrical Association'. The sequence being, collection in the right format, analysis, report preparation, then data processing.

The ORR is similar to the forced outage rate (FOR) but:

- FOR is the "steady-state" probability of being in the down state (peaking + base units);
- ORR is the probability of failing in the next (small) interval of time t, and is therefore dependent on the interval of time chosen.

Thus, whereas FOR is a fixed quantity (for base verses generation peaking units) associated with a unit, the ORR is a time-dependent quantity affected by the value of lead time being considered. FOR is used for static planning, whereas ORR is used for operational planning.

This section starts with a direct quote given below the reference: IEEE Transactions on Power Systems, Vol. 12, No. 4, November 1997. "A Review of Emerging Techniques on Generation Expansion Planning". J. Zhu and M. Chow, p 1722.
"Generation expansion planning (GEP) is to determine WHAT generation units and WHEN generation units should come on line over a long term planning horizon. The criteria are to minimize the total cost and /or, maximize the reliability with different types of constraint. The total cost is the sum of capital investment and operational cost. The constraints include capacity constraints, energy constraints, and operational constraints

etc. Generally, GEP is a non-linear integer programming problem which can be solved by linear programming, non-linear programming, dynamic programming and integer programming techniques with certain simplifications."

The above quotation indicates indirectly that probabilistic techniques are utilized with optimisation, to give something like LOLP, or LOLE, or F&D etc. Static generation planning to compare the adequacy of alternative configurations and expansions can also be extended to incorporate generation and major transmission elements into an overall or composite evaluation to provide both transmission load point and overall system adequacy indices.
The sequence of static and operations (spinning reserve planning + quick—start units, both included), should roughly follow the following sequence:

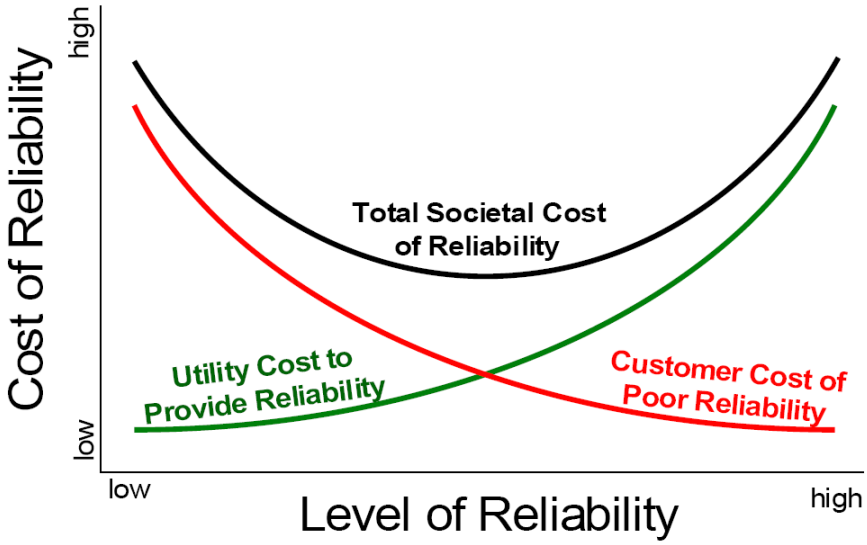
- Static Capacity Planning (utilising LOLP, or LOLE or F&D) using generation database starting with FORs;
- Corporate Financial Simulation following Optimised Static Generation/Transmission Planning;
- Operating Reserve Planning (utilizing spinning reserve + quick start+ LCOE + production cost modelling);
- Evaluation of (Distribution at 4.16 kV) Performance Measures / Metrics such as SAIDI, SAIFI, ASAI and ENS;
- Cost/value of customer reliability study for each class of service.

SELECTION OF A LOLP RELIABILITY TARGET
Traditionally, (as accurately stated in the BELCO IRP), the long-term reliability (static) planning standard has been a one-day in ten year loss of load criterion: 24 hours / (8760 hours x 10 years) = 0.027%. BELCO and PacifiCorp have both adopted this standard for determination of its PRM for IRP portfolio development. An ORR for each generating unit has not been quoted in this paper. Static Planning requires LOLP, LOLE (LOLH) in conjunction with FORs. Operational Planning for operating reserve deals with ORR and LCOE.

PacifiCorp in their paper pages 8 – 10, plotted LOLH verses PRM which shows that as LOLH hours increase, static PRM will increase. Similarly, if you plot 'Static Generation Reserve Margin' against LOLP%, as LOLP increases the Reserve Margin decreases. Here again it is better to refer to LOLH or to LOLE, and again reiterate that LOLH is a superior index to Reserve Margin (Generator Contingency Outage Reserve Criteria N = 2 in this case).

Reference 2 Stochastic Loss of Load Study for the 2011 Integrated Resource Plan – PACIFICORP
https://www.google.com/search?q=Stochastic+Loss+of+Load+Study+for+the+2011+Integrated+Resource+Plan+%E2%80%93+PACIFICORP&oq=Stochastic+Loss+of+Load+Study+for+the+2011+Integrated+Resource+Plan+%E2%80%93+PACIFICORP&aqs=chrome..69i57.4611j0j8&sourceid=chrome&ie=UTF-8 4pm, 18 June 2018.

The diagram immediately below, gives the optimum level of static planning reliablity (the minimum of curve in black), where the green and red curves intersect. See also the papers referenced below, by Yifan Tang, which has the same diagram showing that quantitative reliability measurement in distribution planning (down to 4.16 kV at BELCO), performs similarly to static planning for generation / transmission / enviromental planning, leading to an optimium cost in reliability. The improvement in system reliability level, or the decrease in outage costs usually demands an increase in investment costs. The goal of the reliability optimization is to search for the minimal optimization as indicated in the figure below, using mathematical optimization (OR) techniques.



Static followed by operational reliability and capacity analysis, requires as a starting point the collection of raw (BELCO) data to complement secondary distribution performance data from similar operating utilities, such as BL&P, Hawiian Electric and the Canadian Electrical Association.

Distribution System Reliability Analysis

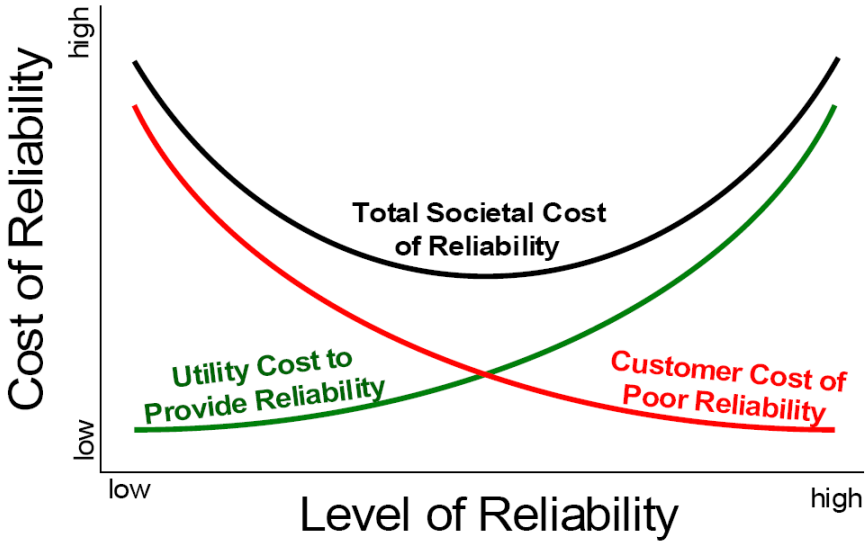
References 1 & 2 (bottom of page) show the use of SAIDI & SAIFI indicies in the Caribbean, while reference 6 shows improved performance of the application of SAIDI and SAIFI distributions in Distribution System Reliability analysis with reference to operational and static distribution reliability planning.

At the least, BELCO could collect statistics that would enable them (if not doing so already) to calculate the SAIDI index, preferably to calculate the SAIDI and SAIFI indicies. For an extensive tutorial, readers are encouraged to consult (Billinton & Allan) Reference 2, Section 1.4, under 'Reserve Margin Planning Criteria'.

Reference 5 treats the Cost/Value of customer reliability study for each class of distribution service. Reference 2 of Section 1.4 'Reserve Planning Criteria' Written by Billinton & Allan, has two extensive chapters on distribution system reliability. The first chapter has two or three examples, plus end of chapter problems.

1. BL&P to March 2010 used SAIDI, SAIFI and CAIDI to report to the Fair Trading Commission of Barbados (results 2007 – 2010). https://www.ftc.gov.bb/library/2010-10-01_annual_report_blandp_sos.pdf accessed 7:25pm, 17 June 2018.
2. Annual Performance Indicator Report for the Trinidad and Tobago Electricity Commission (T&TEC). http://www.ric.org.tt/wp-content/uploads/2017/09/TTECs-Annual-Performance-Indicator-Report-2016-FINAL.pdf accessed 7:33 pm, 17 June, 2018.

See also the paper referenced below, by Yifan Tang, which has the same diagram as in Section 2.3, showing that quantitative reliability measurement in distribution planning (down to 4.16 kV at BELCO), performs similarly to static planning in



generation / transmission / enviromental planning, leading to an optimium cost in reliability. This is the same diagram applicable overall to the subset of generation planning, applicable to a comprehensive IRP, the IRP that has replaced generation planning and has incorporated the 'IRP subset of distribution planning'.

3. Yifan Tang IEEE PAS Vol 11, No.1 Feb 1996. "Power Distribution System Planning with reliability Modelling and Optimization". Pp181 - 189.
4. P. Sanghiv, N. J. Balu, M. G. Lauby; November 1991. Power System Reliability Planning Practices in North America, 1485 -1492. IEEE PAS
5. S. Burns, G. Gross August 1990. Value of Service Reliability. pp 825 – 834. IEEE PAS Vol.5, Number 3 August 1990.
6. R. Billinton and W. Wangdee June 2006. Utilizing Bulk Electric System Reliability Index Performance index Probability Distributions in a Performance Based Regulation Framework. 9th International Conference on Probability Methods Applied to Power Systems KTH Stockholm, Sweden.

CONCLUSION & RECOMMENDATIONS

Please refer to the comments in BELCO/Leidos Appendix II.F, located just before the General Discussion immediately above.

This reviewer has purposely not tried to respond to all sections of the IRP, rather only pertinent ones. However, the six questions posed by the IRP Consultation document have been approached in depth.

The value of benchmarking BELCO against a similar utility such as BL&P, has been clearly indicated and this review has refrained from general electric utility benchmarking, particularly involving large, interconnected, heavy resourced, investor owned utilities.

Below, there are six important findings and recommendations, they are:

The RAB could attempt implementation of a favourable decision toward BELCO in 4 – 6 weeks, with few changes to what the BELCO IRP has proposed. This reviewer is in broad agreement with the BELCO IRP.

Secondly, BELCO (if they have not already done so), should implement a data collection scheme for generation systems, transmission systems at 22/33kV and at 4.16kV, utilising a similar format to that in place at BL&P of Barbados, starting in 2019.

Two years after the above mentioned data collection scheme is inaugurated; the utility should instigate a Cost/Value customer reliability study for each class of customer.

Next, if they have not done so already, BELCO should implement a pilot Stakeholder Analysis and Stakeholder Interview programme.

BELCO should augment their in-house IRP expertise over the next 3 years, and not rely on Consultants, except to plug a short term manpower resource gap, not a knowledge or expertise gap within the company.

Finally, it is proposed that from 2028 onwards BELCO should implement 'probability based planning' with Reserve Margin Planning Criteria, used only as backup.

Author Biography

Eur Ing Clyde L. Symonds is a semi-retired electric utility Chartered Engineer (CEng), specializing in:

- Engineering Management in Government and in an Electric Utility in a small island.
- Multi-Objective Decision making subject to Constraints applied to Optimization.
- Electrical Engineering Economics in electric utilities. Power Systems Quantitative Reliability Evaluation, Hands-on HV Protective Relaying to 33kV, Transient & Dynamic Stability and Generation Control Room 'Training & Operations'.
- ISO9001Total Quality Management (guidelines only), plus the writing of procedures and work documents and tracking of all correspondence & records, using TQM guidelines.

Response to Consultation Document:

Comments on Integrated Resource Plan Proposal Consultation

Submitted to the Regulatory Authority of Bermuda by Enviva and Albioma

22 June 2018

Contents

Executive summary

Enviva and Albioma welcome the Regulatory Authority of Bermuda's (the 'RAB') consultation on the Integrated Resource Plan (IRP) proposal. As a potential independent power producer (IPP) in Bermuda, the outcome of this consultation is critical to defining the role of IPPs and the related significant investment that may be made in the country's energy sector.

Our background is in both the provision of biomass fuel (Enviva) and the construction and operation of Energy plants (Albioma). We are engaging in this consultation as we believe an IRP that treats IPPs equitably, while achieving significant diversification of electricity generation into renewables and being cost effective, is vital for the long-term security and benefit of Bermuda.

An IRP proposal with major methodological flaws and questionable output

Unfortunately, the current BELCO IRP proposal is, in our view, artificially constructed to the point where its methodology and output lack both validity and credibility.

It is essential that the RAB acts to remedy the deficiencies, errors and omissions in the current IRP proposal and, importantly, that the RAB ensure potential IPPs will be evaluated fairly and equally by BELCO (relative to the treatment of its own generating activities) during this consultation process and in the future.

BELCO overstates the cost of renewable biomass electricity by a margin of greater than 50%

With regards to our own specific position as a potential biomass IPP in Bermuda, the margin of error of BELCO's assessment of the cost of electricity from biomass (within the IRP) is in the region of greater than 50% i.e. it has overstated the cost of biomass-based electricity supply significantly. We note that it is the responsibility of the BELCO Transmission, Distribution and Retail (TD&R) licensee to have carried out full and extensive research of all generation options as part of the IRP drafting. As such, the evaluation of a biomass IPP should have been far more thorough and accurate.

Concerns regarding fairness and equality in relation to considering alternatives to BELCO bulk generation

Based on our analysis of the IRP proposal there is much to be done by the RAB prior to the next phase of consultation. Our key concerns are:

- That, until the RAB has resolved the apparent methodological and data issues that characterise the IRP proposal, there is, in effect, no 'level playing' field. *Evaluating IPPs within the IRP process, including via alternative generation proposals or initiating a related competitive bidding process for electricity generation while such problems exist would be an unfair process with undue bias towards BELCO. Under such circumstances, we may be forced to reconsider our interest in investing in Bermuda*.

- That BELCO has included the replacement of approximately 50% of its generating capacity in the IRP proposal without any attempt to show why such replacement is cost efficient in its own right or when compared to IPPs. *In effect, BELCO has excluded itself from the cost evaluation (and justification) exercise that it has applied to IPPs. We suggest this may invalidate the IRP and question whether BELCO has taken advantage of its dominant position as the incumbent provider and we request that the RAB respond to these points specifically.*

- That until accounting separation for the BELCO bulk generation and transmission, distribution and retail (TD&R) licensees has been completed by the RAB, *it is impossible to ascertain whether BELCO's allocation of capital and operational costs to its bulk generation operations (within the IRP proposal) is fair and equitable i.e. that it does not create undue bias towards BELCO's own generating activities versus IPPs.*

We look forward to further consultation phases and submissions to the RAB and hope that this response assists the RAB in this first phase.

Section A: Summary of Enviva and Albioma responses to IRP proposal consultation questions

Question 1. Are there any provisions in the IRP Proposal that should be modified? Please include any reasoning and evidence in your answers.

Forecasted demand for electricity

In the IRP proposal, BELCO has included an unsubstantiated forecast for electricity demand that: (i) is at significant variance with its own forecasts of less than two years ago, and (ii) the basis of the load forecasts is an assumption of zero % GDP growth over the twenty-year period.

BELCO is assuming an economically stagnant twenty-year scenario for Bermuda with no growth and a dramatically reduced forecast of electricity demand compared to prior forecasts. Given the critical role of a thorough analysis and credible forecast for electricity within the IRP process, the fact that BELCO has provided no supporting analysis or data for such a pessimistic forecast of the Bermuda economy is concerning.

With this approach to forecasting the demand for electricity, BELCO risks the perception of deliberately reducing the predicted size of the electricity market to reduce the scope for IPP market entry.

Recommendation A

The IRP proposal forecast for the demand for electricity should be invalidated and a new independent forecast should be commissioned by the RAB, based on credible and transparent sources and data, including a full and proper macro analysis of the Bermuda economy.

BELCO's Weighted Average Cost of Capital (WACC)

BELCO has utilised a WACC that is inconsistent with (and lower) than the WACC levels it has previously identified prior to this IRP proposal. It provides no substantiation for this level of WACC. There are a number of factors that suggest BELCO's WACC may be significantly higher than it proposes.

Recommendation B

That the weighted average cost of capital (WACC) used by BELCO in the IRP proposal be subjected to independent evaluation and calculation (commissioned by the RAB), then be consulted on and revised, as appropriate.

Fuel cost forecasts

BELCO's fuel costs forecasts are both at variance with other forecasts for fuel costs and unsubstantiated.

Via its fuel forecast, BELCO appears to be lowering the cost of using its own preferred fossil fuels versus, for instance, renewable alternatives.

It should also be noted that BELCO has not assessed the extent to which the cost of biomass fuel is less volatile than fossil fuel based alternatives. This is a significant omission as stable biomass fuel prices are a major driver to the long term cost effective supply of electricity and this should be fully evaluated with the IRP process.

Recommendation C

The fuel cost forecasts in the IRP proposal should be invalidated and the RAB should commission an independent fuel cost forecast (that includes an assessment of the relative stability of biomass fuel costs) that can be issued for comment during the next round of consultation.

Omission of Transmission network upgrades

BELCO has omitted significant transmission network upgrade costs (that it has stated to its shareholders, separately outside of the IRP proposal, to be approximately $124 million). This omission significantly weakens the credibility of the IRP proposal. The costs of a 'fit for purpose' transmission network (key to limiting the loss of electricity in the grid, as well as maximising demand side efficiency) are highly material to the various financial aspects of the IRP (including, potentially, BELCO's WACC).

Recommendation D

That the omission, by BELCO, of full transmission network upgrade costs (e.g. $124 million) from the IRP be remedied. There should be full inclusion of these costs in the IRP, including within all relevant financial tables and the calculation of the WACC, or an explanation for why they are not relevant.

The importance of enacted accounting separation to the IRP

The application of accounting separation to BELCO's: (i) bulk generation, and (ii) TD&R, licensed activities is critical to ensuring the appropriate and equitable allocation of costs to these separate activities within BELCO. Without the application of such accounting separation, from our perspective as a potential IPP (and market entrant), there can be no confidence that BELCO's allocation of costs to its bulk generation activities is fair and equitable i.e. it may be allocating costs to the TD&R licensee that should be allocated to bulk generation.

Recommendation E

That accounting separation of BELCO's bulk generation and TD&R operations be completed and transacted by the RAB prior to the next phase of the IRP consultation, to ensure a fair and equitable evaluation of BELCO's, versus an IPP's, generating costs.

Carbon pricing - Lack of correct methodology and analysis

BELCO does not provide an appropriate or justifiable methodology for 'carbon pricing' in the IRP proposal and omits key renewable sources of power generation from any proper form of carbon pricing analysis.

Recommendation F

That the carbon pricing proposals in the IRP proposal should be invalidated and the RAB commission an independent assessment of the carbon pricing and environmental benefits of IPP fuel and generation options, including the full range of renewables.

Significant margin of error in biomass IPP cost of electricity calculations

Given our background in biomass-based electricity supply, our calculation is that BELCO is overstating the cost of biomass electricity by more than 50%.

Recommendation G

That BELCO's calculation of the cost of biomass-based electricity generation is invalidated. That the RAB request a submission from Enviva and Albioma (or any other interested biomass-based IPP) as to the correct calculation of the cost of biomass generated electricity. Given the confidentiality of this area, we can provide specific financial information and data to the RAB on request and on the basis that RAB provide confirmation that such a submission will be treated as confidential.

Apparent changes to Bermuda's reserve margin with no detail or transparency

Within the IRP proposal there is an extremely limited reference to the 'reserve margin' that BELCO has built into its calculations, and there is no disclosure of the level of reserve margin or how it has been calculated. BELCO appears to have significantly changed its approach to the 'reserve margin' for generating capacity (for instance compared to the 2016 IRP). Not only is this issue important to security of supply, but it is an area where IPPs could, potentially, provide differing (e.g. higher) levels of performance.

Recommendation H

That: (i) there should be full disclosure of the assumptions and calculations BELCO made regarding the reserve margin, (ii) the RAB should commission an independent appraisal of this work, and (iii) there should be full disclosure and consultation on this area in the next phase of the IRP consultation.

Question 2. Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?

Enviva and Albioma do not agree that the procurement strategy in the IRP proposal is appropriate. The analysis and information we have provided in response to Question 1, show that BELCO has not provided a credible IRP proposal, including relating to procurement. As such, there has been no proper and justifiable selection of generation resources.

Only when the RAB has addressed the issues and concerns we have identified can there be a proper evaluation of procurement alternatives.

Question 3. Which generation resources should the TD&R Licensee procure using competitive bidding, if any?

Once the RAB has resolved the deficiencies and apparent errors in the IRP proposal there will be an opportunity to discuss a fair evaluation of BELCO bulk generation versus IPP bulk generation. At the point when all parties have confidence that a level playing field has been attained there will be a role for competitive bidding, but not before.

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)?

There are alternatives scenarios not included within the IRP proposal, including biomass-based generation. As our response to question one explains, BELCO's representation of biomass-based generation of electricity is erroneous at two levels:

(i) BELCO's proposed capital and operational costs for a biomass energy plant are too high by a significant factor, as is its proposed cost of electricity via biomass generation. Consequently, BELCO's dismissal of biomass-based supply of electricity is without justification.

(ii) Biomass is a widely accredited renewable fuel for electricity generation with significant emission and environmental benefits (over fossil fuels), a fact that BELCO has ignored in the IRP proposal.

We believe that biomass-based independent power production (which is both renewable and cost competitive) would be fully consistent with both Government policy and the Electricity Act 2016 and could, and arguably should, be a key generating asset in Bermuda's electricity sector.

Question 5. Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?

BELCO's assumption that its own asset replacement is exempt from the IRP process

BELCO's inclusion of the replacement of approximately 50% of its generating capacity as an 'input' to the IRP proposal (rather than an 'output') not only results in no justification by BELCO of the cost effectiveness (or otherwise) of the same asset replacement (which is a central objective of any IRP process), but places BELCO's evaluation of potential IPP generation of electricity on an inequitable and discriminatory basis.

Recommendation I

The RAB should ensure that, in the next version of the IRP, BELCO provides a full evaluation of the cost effectiveness of the $118 million generation asset replacement programme (as approved by the 6 March RAB Order) including the, apparently, additional $40 million in capital expenditure that would occur under BELCO's preferred generation scenario (listed in the IRP as Scenario 3 in Appendix II D4).

Recommendation J

With regards to BELCO including its asset replacement as an input, rather than an output, in the IRP proposal, we request that the RAB: (i) clarify if they have evaluated whether the IRP proposal is consistent with all the relevant provisions of the Regulatory Authority Act (particularly section 85 regarding potential abuse of dominance), and (ii) provide full transparency of any such evaluation.

The weakness of the levelized cost of electricity (LCOE) methodology

There are a wide range of weaknesses to using the LCOE methodology to assess the 'cost of electricity', including:

(i) its inability to properly model 'sensitivity' to key inputs (e.g. interest rates, access to capital, changes in technology, to name a few), and

(ii) the use of 'snapshot' calculations on current generation costs is not suited to identifying costs of generation over the twenty-year period of this IRP.

Combining these methodological weaknesses with BELCO's specific position (where the majority of its assets are past their operating life), then the LCOE methodology is not the optimal basis for an evaluation of the wide range of generation options (including those from potential IPPs) that there may be for Bermuda over the next twenty years.

Recommendation K

The use of the LCOE methodology within the IRP should either be: (i) invalidated and replaced with a more appropriate method of assessing the cost effectiveness of BELCO's capital expenditure profile, or (ii) be supplemented with a more appropriate method and the LCOE methodology and output tested against the same.

Arbitrary qualitative weighting and scoring in the IRP proposal

The qualitative assessment utilised in the IRP proposal is too subjective and without substantiation.

Recommendation L

The qualitative assessment utilised in the IRP proposal is too subjective and without substantiation. There should be a RAB consultation on the role of qualitative assessment as part of the next round of IRP consultation, including methodology. Until that point, the weighting and formal use of qualitative scoring should be removed from the calculation of the generation mix scenarios.

Question 6. Do you have any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

This response makes clear that there are significant problems with the current IRP proposal that mitigate against a 'level playing field' when considering alternative providers of generation to BELCO. These problems need resolving prior to a full and proper process for evaluation of alternatives to BELCO generation. Also, see our answers to questions one to five above.

In the event the shortcomings outlined in the IRP are resolved, Enviva and Albioma are prepared to propose a specific biomass generating project as an Alternative Proposal.

Section B: Enviva and Albioma responses to consultation questions

Question 1: Are there any provisions in the IRP Proposal that should be modified? Please include any reasoning and evidence in your answers.

The RAB's question focuses on 'provisions'. This response understands this to include any, and all, 'terms', 'specifications', and 'stipulations' that may have been made by BELCO in its draft IRP, essentially constituting the key content of the IRP proposal.

Enviva and Albioma believe that the IRP proposal has substantial methodological deficiencies, as well as omissions and inaccuracies. Our response to this question focuses on areas of analysis, assumptions and data used by BELCO that are, in our opinion, factually incorrect or lacking in sufficient substantiation. Our response to Question 5 provides further concerns about BELCO's methodological approach.

1.1 The forecasted significant reduction in demand for electricity

In the IRP proposal, BELCO has provided a forecast of electricity demand that is neither substantiated nor consistent with prior statements made by BELCO.

In the 2018 IRP proposal, BELCO forecasts the level of expected electricity demand for the period of the IRP to be significantly lower (between 75% and 66% lower) than the demand forecasted in the 2016 IRP (submitted to the Energy Commission and Government in June 2016). The effect of this is to reduce the 'size of the market' downwards. The following tables and figures are sourced from the 2016 and 2018 BELCO IRPs (produced by Leidos)

Electricity demand forecast – 2016 BELCO IRP

Sourced from 2016 BELCO IRP (Leidos) – Section 1.4

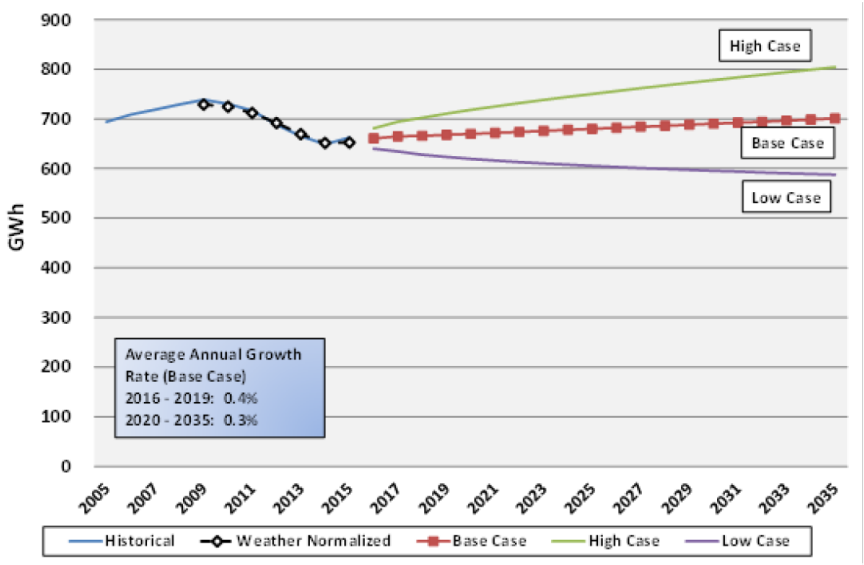


Figure 1-2 – Energy Forecast (GWh)

Electricity demand forecast - 2018 BELCO IRP

Sourced from 2018 BELCO IRP Proposal (Leidos) – Appendix ID.5

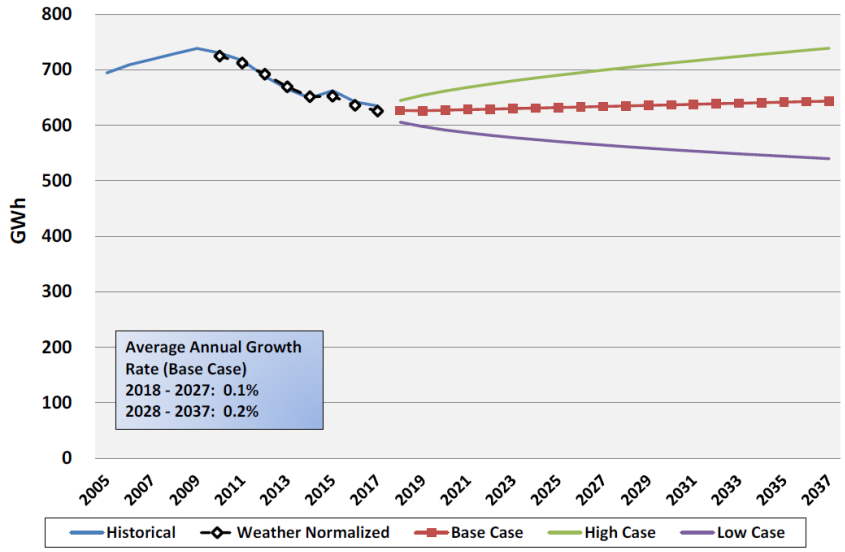


Figure 6 – Energy Forecast

There is no rationale provided by BELCO for this reduction in demand. To justify such a relative reduction in demand for electricity over the lifetime of the IRP, BELCO should provide substantial credible macro-economic analysis. It did not do so. In its place, it has made an assumption of zero % GDP growth for the entire twenty-year period of the IRP (see Appendix ID2 of the IRP proposal). In the 2016 version of the IRP, BELCO provided more detailed analysis of the Bermuda economy to support what was a higher demand forecast.

In simple terms, BELCO is assuming a profound twenty-year scenario for Bermuda of zero % GDP growth and a relative reduction in demand for electricity. No supporting analysis or data is provided for such a negative and diminishing forecast of the Bermuda economy.

With this approach to forecasting the demand for electricity, BELCO risks the perception of deliberately reducing the predicted size of the electricity market to reduce the scope for IPP market entry.

Recommendation A

The IRP proposal forecast for the demand for electricity should be invalidated and a new independent forecast should be commissioned by the RAB, based on credible and transparent sources and data, including a full and proper macro analysis of the Bermuda economy.

1.2 The weighted average cost of capital for BELCO

BELCO has used a weighted average cost of capital (WACC) in the IRP proposal of 8% compared to 9.75% in the 2016 IRP. Furthermore, in its calculations on the WACCs of third party IPP's, BELCO states that such IPPs will have a 10% WACC (see below).

Weighted Average Cost of Capital (WACC) assumptions

SECTION 4.3 – Source 2016 BELCO IRP (Leidos)

4.3 Financial Factors

BELCO provided the following key financial factors for use in the cost analysis:

- Inflation – 2.25 percent.
- Weighted Average Cost of Capital – 9.75 percent.

The Weighted Average Cost of Capital as provided by BELCO is predicated upon achieving an optimal gearing ratio based on the existing regulatory structure in Bermuda and is consistent with other international utility benchmarks. It should be noted that discounted cash flow calculations across the IRP are predicated upon escalation of nominal dollars over the course of the Study Period, and that production costs are discounted back to today's dollars using the Weighted Average Cost of Capital.

SECTION I.C Appendix – Source 2018 BELCO IRP Proposal (Leidos)

I.C Financial Factors

In collaboration with BELCO TD&R, the following key financial factors were selected for use in the production cost analysis:

- Inflation – 2.00 percent.
- Weighted Average Cost of Capital ("WACC")
  - 8.00 percent for traditional base load projects developed by BELCO BG and renewable energy projects by potential bulk renewable energy licensees;
  - 10.00 percent for traditional base load projects and associated infrastructure developed by potential bulk generation licensees such as IPPs.

It should be noted that discounted cash flow calculations across the IRP are based upon escalation of nominal dollars over the course of the Study Period, and that production costs are discounted back to today's (year 2018) dollars using the WACC. The escalation adder used for future capital costs is equal to inflation for the duration of the Study Period.

BELCO fails to explain their use of the proposed WACC of 8% or why it should be lower than IPPs. The net result is a bias towards BELCO bulk generation in terms of WACC.

Enviva and Albioma assert that BELCO's view of its own WACC is incorrect (as is its relative level to IPPs) based on the following six points.

1.2.1 WACC and Bermuda's rating – Contrary to BELCOs lower WACC

In its 2016 submissions to the Energy Commission, BELCO asserted that its WACC range should be taken as between 9 and 10.5%. It based these assertions on the linkage to BELCO's WACC within the context of Bermuda and:

(i) its level of sovereign debt and rating,
(ii) a calculation of a 'risk premium' for investing in assets and operations in Bermuda.

At the time, the rating on Bermuda by Moody's was A1. In June 2016, Moody's downgraded Bermuda's rating to A2 (where it remains:https://www.moodys.com/research/Moodys-downgrades-Bermudas-rating-to-A2-outlook-stable--PR_348731).

This fact, alone, suggests that the WACC used by BELCO in the 2018 IRP proposal should actually be higher than that cited to the Energy Commission in 2016, not lower.

1.2.2 Source of debt and interest rate trends

When discussing its level of WACC, in the 2018 IRP proposal, BELCO fails to explain key components of its capital structure that relate to intended debt:

- *Source of debt*: BELCO has failed to provide any explanation of the source of its proposed debt or the relative price of that debt. This information must be made available to determine whether its WACC assertions are correct or not.

- *Rising interest rates and the pressure on the WACC:* In general macro terms, current trends are upwards for interest rates. It is unclear why BELCO is assuming a lower WACC (than in 2016) when interest rates are increasing (and have been throughout the period prior to the 2018 IRP proposal).

1.2.3 Increasing leverage, the risk premium and WACC levels

We note that BELCO appears to be planning a significant increase in leverage (by taking on significant levels of debt) over the lifetime of the IRP.

While, on the one hand, increasing leverage will tend to lower a company's WACC, for BELCO there are countervailing forces that deserve examination:

- *Ability to service debt:* BELCO may have limited ability to service large levels of debt. In its submissions to the Energy Commission in 2016, BELCO stated that it would have had problems servicing debt in prior financial years.

- *The risk premium and BELCO's forecast for a smaller market – lack of reconciliation:* BELCO's forecast in the IRP proposal is that the demand for electricity is, in relative terms, falling. This implies lower expected growth in revenues over the life of the IRP. Moreover, Bermuda already experiences relatively high retail electricity prices that suggest low public appetite for robust future rate price growth. The IRP does not reconcile BELCO's view of a diminished market and lower revenues with increased leverage and a lower WACC. This indicates there is a risk that future BELCO revenues may not be sufficient to service debt, suggesting an increased risk premium (and upward pressure on the WACC).

1.2.4 The critical role of IRR expectations

In its IRP, BELCO does not indicate what internal rate of return (IRR) it expects from bulk generation activities. Assuming Ascendant shareholders have commercial expectations, it is important to establish whether there is consistency between corporate returns and the capital investment plan put forward by BELCO in the IRP.

1.2.5 The WACC for BELCO will vary over time

Over the lifetime of the IRP, the WACC relevant to BELCO will likely vary. It would be prudent for BELCO to explain how its WACC may fluctuate over time and to highlight the implications. Drivers to changes in the WACC could include negative changes to the risk premium (possibly due to high levels of debt),

technology change, and interest rates. Under these conditions, the projected cost of electricity provision by BELCO would also change.

Importantly, it should be noted that it is possible that BELCO's WACC may vary more than potential IPPs. This is because IPPs are likely to have access to longer term financing and draw from a wider portfolio of international operations, which may provide greater revenue and debt financing stability.

1.2.6 Transmission network capex and its relevance to the WACC

We note in Section 1.4 below that BELCO appears to have omitted from its IRP proposal the approximate $124 million of capital expenditure that it intends for its transmission network (see AGM presentation to Ascendant shareholders of May 2018).

This is an important omission, because this capital expenditure (if funded by debt) would fundamentally impact the WACC of BELCO including the risk premium.

Recommendation B

That the weighted average cost of capital (WACC) used by BELCO in the IRP proposal be subjected to independent evaluation and calculation (commissioned by the RAB), then be consulted on, and revised, as appropriate.

1.3 Fuel forecasts at variance with prior BELCO and third party forecasts

BELCO forecasts significantly lower fuel costs in the IRP proposal than it does in the 2016 IRP (see below).

2016 BASE CASE COMMODITY PRICE FORECAST - SOURCE BELCO 2016 IRP (LEIDOS)

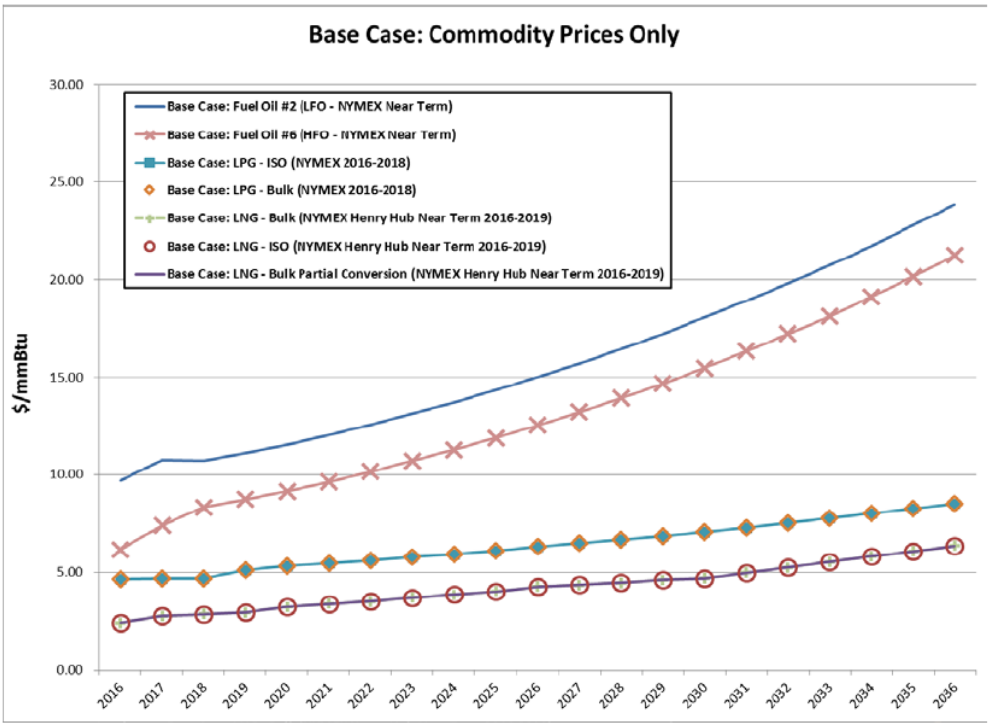


Figure 1-4 – Base Case Commodity Price Forecast

2018 BASE CASE COMMODITY PRICE FORECAST - SOURCE BELCO 2018 IRP Proposal (LEIDOS)

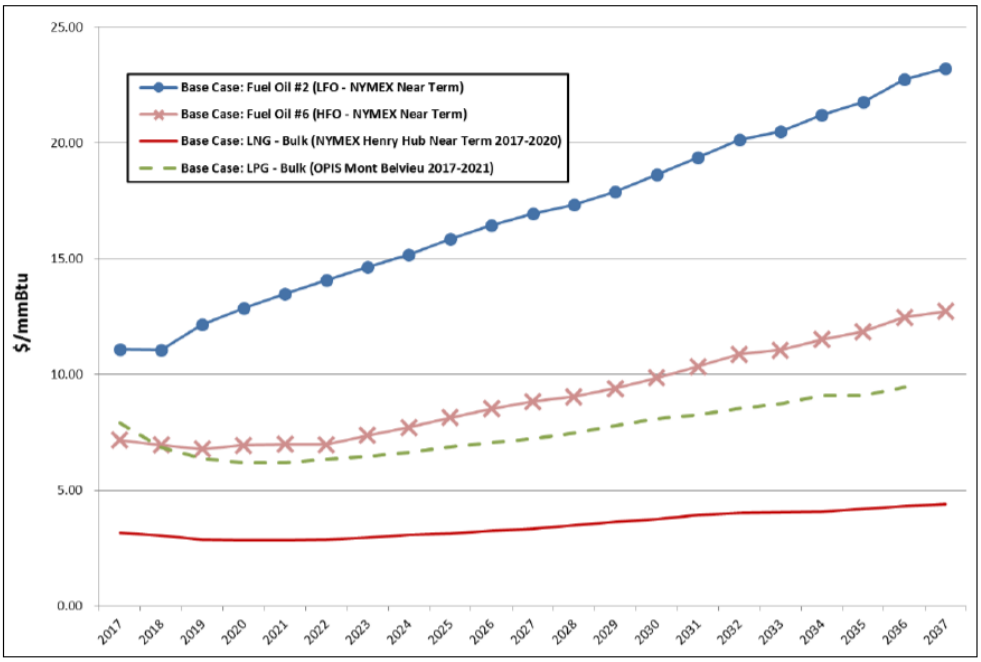


Figure 1.3 – Base Case Commodity Price Forecast

There is no explanation by BELCO for this downward revision in the fuel costs. BELCO notes the use of an 'independent consultant' (Section 1.5 of the IRP proposal) but provides no detail on the consultant or the basis of the output from this entity. As well as being at variance with the fuel cost forecasts that BELCO provided in the 2016 IRP, it is notable that BELCO's forecast for natural gas:

(i) appears to be at variance (lower) than the Bermuda Government's consultant's fuel cost forecast in 2016 (Castalia[1]);
(ii) has less volatility than other forecasts (see above);
(iii) is contrary to the trend of increasing costs of oil and oil-linked fuel products.

There is a risk that, via its fuel forecast, BELCO is unduly lowering the cost of using its own preferred fossil fuels versus, for instance, renewables.

It should also be noted that BELCO has not assessed the extent to which the cost of biomass fuel is less volatile than fossil fuel based alternatives. This is a significant omission as stable biomass fuel prices are a major driver to the long term cost effective supply of electricity that should be fully evaluated with the IRP process.

Recommendation C

The fuel cost forecasts in the IRP proposal should be invalidated and the RAB should commission an independent fuel cost forecast (that includes an assessment of the relative stability of biomass fuel costs) that can be issued for comment during the next round of consultation.

[1] 'Viability of liquefied Natural Gas in Bermuda' March 2016 and 'LNG for Bermuda: What's possible and what are the risks' June 2016

1.4 Transmission network upgrade costs and the IRP

For an IRP to be viable and relevant, the transmission network should be fully articulated in terms of its capabilities and its necessary upgrades (including via capital expenditure). A 'fit for purpose' transmission network is critical to ensure that:

(i) 'line loss' and grid outages are as limited as possible, and
(ii) consumers can implement demand efficiencies with the necessary ease and relevance.

It is notable that BELCO has removed a substantial amount of the transmission network upgrade costs that were included in the 2016 IRP (see Annex A of this response) and which, in May 2018, it had stated to shareholders as being $124 million (Ascendant AGM shareholder presentation May 2018). This appears to be without justification.

The net result of this BELCO omission is:

(i) There is no alignment (within the IRP proposal) between the generation and transmission of electricity (including full analysis of any need to distribute electricity from IPPs), and
(ii) BELCO's costs of electricity supply appear to be lower than they may turn out to be in reality.

Recommendation D

That the omission, by BELCO, of full transmission network upgrade costs ($124 million) from the IRP be remedied. There should be full inclusion of these costs in the IRP, including within all relevant financial tables and the calculation of the WACC, or an explanation for why they are not relevant.

1.5 The critical role of accounting separation

Another concern with the IRP proposal relates to BELCO's projected costs of electricity supply and cost allocation. As per the license obligations placed on BELCO in October 2017, there must be appropriate, accountable cost allocation between the BELCO bulk generation licensee and the TDR licensee. In addition, there must be appropriate and equitable cost allocation from Ascendant to each of BELCO's licensed activities.

We understand the RAB is still consulting on the proposed accounting separation (and associated cost allocation and transparency) of BELCO at the license level. *This raises the concern that BELCO's current projected cost of electricity provision within the IRP proposal (via itself as a bulk generation licensee) neither provides such cost allocation nor is consistent with appropriate and final accounting separation of the same*. As such, there is a risk that BELCO is understating the costs that may relate to its bulk generation license and operations, thereby unfairly diminishing the ability of IPPs to compete in the supply of electricity.

Recommendation E

That accounting separation of BELCO's bulk generation and TD&R operations be completed and transacted by the RAB prior to the next phase of the IRP consultation, to ensure a fair and equitable evaluation of BELCO's, versus an IPP's, generating costs.

1.6 No proper evaluation of carbon pricing and renewables

BELCO's approach to renewables and carbon pricing is both erroneous and deficient. Taking the case of renewable, biomass-based electricity generation we offer two points of concern, as follows.

1.6.1 There is no carbon pricing for alternative IPPs in the BELCO IRP

BELCOs' approach to IPPs and carbon pricing creates a bias against renewables versus BELCO's preferred use of fossil fuels.

In the IRP proposal, BELCO only provides a limited form of carbon pricing for its chosen options for electricity generation. BELCO does not provide a relative carbon pricing analysis of its fossil fuel based approach to generation versus a range of renewables, which should include biomass.

BELCO's rather dismissive, and unjustifiable, statement regarding biomass is as follows:

> While Biomass is a potential candidate resource, the opportunity for significant reduction in emissions that could be achieved by converting to 100 percent gas fuel is eliminated.

BELCO statement: Appendix IIF 2018 IRP - Source BELCO 2018 IRP Proposal (Leidos)

BELCO's assertion is contrary to the classification of biomass as 'renewable' in Europe, the US, and elsewhere. Biomass-based electricity generation has significant emission and environmental benefits over fossil fuel-based electricity (including natural gas) that cannot be ignored within the IRP process for Bermuda.

Leading climate experts have recognized sustainably-sourced wood biomass as a carbon-beneficial energy feedstock when used to displace fossil fuels. Accordingly, nations on the forefront of addressing climate change have included biomass in their renewable energy policies.

Most recently, the European Union finalized new biomass sustainability criteria for their Renewable Energy Directive (RED II)[2] that will increase the share of renewables in Europe's final energy consumption to 32% in a cost-effective manner by 2030. These sustainability criteria include LULUCF (Land Use, Land Use Change and Forestry) requirements that ensure proper accounting of carbon impacts of forest biomass used for energy. In order to meet the requirements, biomass feedstocks must be sourced from a country that includes the forestry and land use sectors in its reporting under the Paris climate accord or from a forest supply area where carbon stocks are either stable or increasing over the long term.

Recommendation F

That the carbon pricing proposals in the IRP proposal should be invalidated and the RAB commission an independent assessment of the carbon pricing and environmental benefits of IPP fuel and generation options, including the full range of renewables.

1.6.2 Biomass is a cost effective and viable renewable source of electricity generation

BELCO briefly assesses the potential of biomass within its 2018 IRP and provides the following data and statements relating to its view that a biomass-based IPP would not be cost effective:

[2] http://europa.eu/rapid/press-release_STATEMENT-18-4155_en.htm
https://ec.europa.eu/energy/sites/ener/files/documents/default_values_biofuels_main_reportl_online.pdf
https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

Relative LOCE as per 2018 IRP (Figure 2.1 – Section 2.1 Page 37)

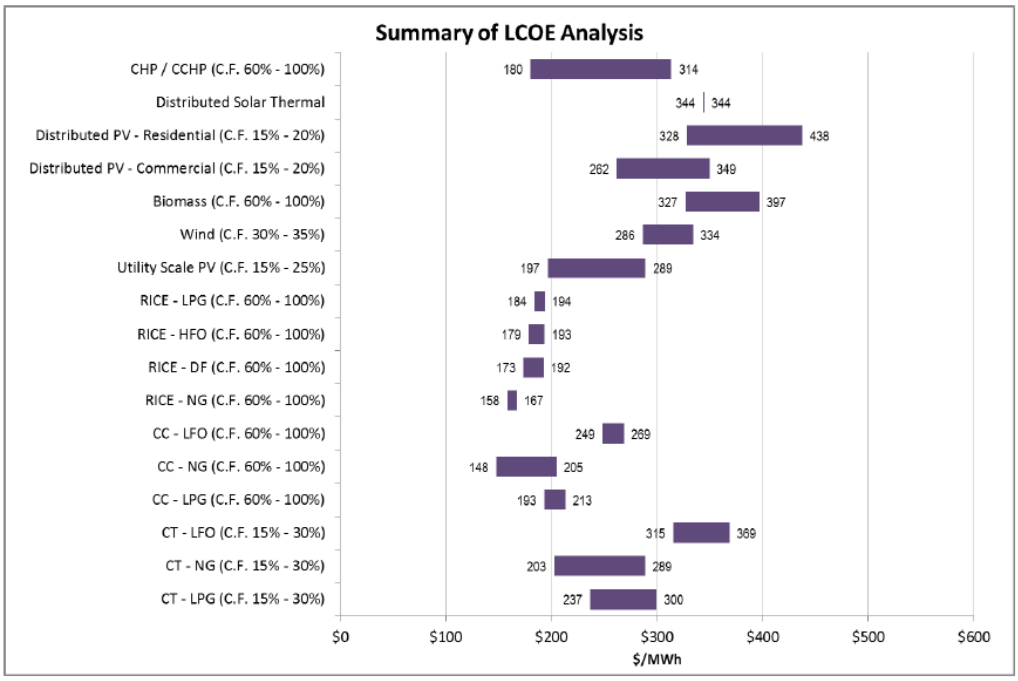


Figure 2.1 – NPV Summary of LCOE Analysis Results

Source February 2018 BELCO IRP Proposal

BELCO's assumptions regarding biomass: Appendix 1 page 19 – 2018 IRP

- ***Biomass***
  - The capital costs were estimated for delivery to and installation in Bermuda. The estimated capital cost for a 54 MW biomass fluidized bed boiler with steam turbine generator is estimated to be approximately $264.6 million (2016 $).
  - The estimated fixed O&M annual cost is estimated to be approximately $11.9 million per year (2016 $).
  - The estimated variable O&M annual cost is estimated to be approximately $4.25/MWh.
  - The heat rate of 15,000 Btu/kWh is estimated based on typical ranges of heat rates for a biomass steam boiler which ranges from 14,000 Btu/kWh to 16,000 Btu/kWh.
  - The capacity factor is estimated to be 89 percent.
  - The fuel cost of the feedstock is estimated at $12 per MMBtu delivered to Bermuda. This cost is assumed to be reflective of a feedstock source from the east coast of the U.S. and all taxes and duties for delivery to Bermuda.
  - The biomass resource is only evaluated in the LCOE model.

Source 2018 BELCO IRP Proposal (Leidos)

Enviva and Albioma strongly disagree with BELCO's views of biomass as an IPP and the Levelized Cost of Electricity (LCOE) that BELCO assign to the same.

Given our background in biomass-based electricity supply, our calculation is that BELCO is overstating the cost of biomass electricity by more than 50%.

Recommendation G

That BELCO's calculation of the cost of biomass based electricity generation is invalidated. That the RAB request a submission from Enviva and Albioma (or any other interested biomass-based IPP) as to the correct calculation of the cost of biomass generated electricity. Given the confidentiality of this area, we can provide specific financial information and data to the RAB on request and on the basis that RAB provide confirmation that such a submission will be treated as confidential.

1.7 No justification of BELCO asset replacement in IRP proposal and concerns as to reserve margin

As our response to Question 5 below explains, BELCO provides no justification (in terms of cost effectiveness) for the replacement of 50% of its generating capacity (that, at the time of its IRP submission, had yet to be approved by the RAB).

An apparent lower reserve margin for Bermuda

Related to the lack of any justification of the asset replacement in the IRP, it also appears as though BELCO has reduced the 'reserve margin' on its generating capacity without justification. Section 4.5 of the 2016 IRP provides a comprehensive set of criteria and calculations of the necessary reserve margin for Bermuda. Conversely, the 2018 IRP does not provide any equivalent calculation of the necessary reserve margin. There is a risk that BELCO has reduced the reserve margin for Bermuda and this, in turn, has reduced the projected capital costs of generating assets (diminishing the head room for IPPs).

The relevance of reserve margin to IPPs

The issue of reserve margin is important as the TD&R licensee has a responsibility to ensure the security and reliability of electricity supply. IPPs may be able to offer more cost effective solutions to a required reserve margin than BELCO generating assets but they cannot do so unless BELCO's own presumptions in this area are transparent.

Recommendation H

That: (i) there should be full disclosure of the assumptions and calculations BELCO made regarding the reserve margin, (ii) the RAB should commission an independent appraisal of this work, and (iii) there should be full disclosure and consultation on this area in the next phase of the IRP consultation.

Question 2: Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?

Enviva and Albioma do not agree that the procurement strategy in the IRP proposal is appropriate. The analysis and information we have provided in response to Question 1 show that BELCO has not provided a credible IRP proposal, including aspects that relate to procurement. As such, there has been no proper and justifiable selection of generation resources.

Only when the RAB has addressed the issues and concerns that have been identified in our response to Question 1 can there be a proper evaluation of procurement alternatives.

Question 3: Which generation resources should the TD&R Licensee procure using competitive bidding, if any?

Once the RAB has resolved the deficiencies and apparent errors in the IRP proposal there will be an opportunity to discuss a fair evaluation of BELCO bulk generation versus IPP bulk generation. At the point when all parties have confidence that a level playing field has been attained there will be a role for competitive bidding, but not before.

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)?

As our response to Question 1 makes clear, we believe that biomass-based independent power production (which is both renewable and cost competitive) could, and should, have a key role in Bermuda's electricity sector.

Question 5: Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?

Our response to Question 1 provides detailed points and concerns about various aspects of the IRP proposal. Here, we explain wider concerns with regards to the overall methodological approach used by BELCO in the IRP proposal.

5.1 BELCO's assumption that its own asset replacement is exempt from the IRP process

We note that BELCO has included the replacement of approximately 50% of its generating assets as an input to the IRP proposal and not provided any justification of the cost effectiveness of this. As Oxera have pointed out (Assessment of the IRP Proposal – 1 May 2018 – issued by the RAB), this asset replacement should be an output from (not an input to) the IRP in that it should be justifiable at the cost efficiency level.

Given that BELCO used its *proposed (as it was at the point of submission of the IRP proposal to the RAB)* asset replacement as an input to the IRP process, rather than an output, this appears to invalidate a significant element of the IRP proposal. As such, Enviva and Albioma would request that the RAB explain how this matter will be dealt with as the IRP consultation moves forward. From our perspective, the fact that BELCO has treated its own asset replacement in this manner within the IRP proposal undermines the ability to provide a full and fair evaluation of IPP generating options within the IRP.

It should also be noted that in the information provided by BELCO (in the appendices to the IRP proposal) it appears that under Scenario 3, BELCO's preferred scenario, its current replacement of generating assets would be $40 million greater (see Appendices - Scenario 3 costs) than the amount specified in the RAB Order of 6 March, approving such asset replacement (which was for $118 million).

Recommendation I

The RAB should ensure that, in the next version of the IRP, BELCO provides a full evaluation of the cost effectiveness of the $118 million generation asset replacement programme (as approved by the 6 March RAB Order) including the, apparently, additional $40 million in capital expenditure that would occur under BELCO's preferred generation scenario (listed in the IRP as Scenario 3 in Appendix II D4).

5.1.1 Potential abuse of dominance by BELCO via the IRP proposal

In relation to the above, Enviva and Albioma note that Section 85 of the Regulatory Authority Act (RAA) provides for action against potential abuse of dominance (by a regulated entity). We note that one potential construct of the current IRP proposal is that the BELCO transmission, distribution and retail (TD&R) licensee may have favoured its own bulk generation activities over that of potential IPPs by not justifying its own generating asset replacement in the IRP proposal, while at the same time, discarding various IPP options. The question is whether, via the treatment of its asset replacement as an input to the IRP proposal, rather than as an output, BELCO has inserted deliberate bias into the IRP against IPPs, which is contrary to Section 85 of the RAA.

Recommendation J

With regards to BELCO including its asset replacement as an input, rather than an output, in the IRP proposal, we request that the RAB: (i) clarify if they have evaluated whether the IRP proposal is consistent with all the relevant provisions of the Regulatory Authority Act (particularly section 85 regarding potential abuse of dominance), and (ii) provide full transparency of any such evaluation.

5.2 Problems with the utilisation of LCOE methodology

The use of the levelized cost of electricity (LCOE) methodology is flawed, in the case of this IRP proposal, for a number of reasons. These can be grouped into two categories, as follows.

5.2.1. LCOE and the inability to pursue credible and equitable sensitivity analysis

We note the concerns raised in Oxera's assessment (1 May 2018) of the IRP proposal with regards to the weaknesses of the LCOE methodology (Oxera, Sections 5.3 to 5.6). In addition, we have additional points.

A commonly acknowledged weakness of the LCOE methodology is that there are significant sensitivities and risks (interest rates, fuel costs, constructions costs, access to capital) that a LCOE analysis ignores.

In Section 2.4 of the IRP proposal (figure 2.1), BELCO provides a limited sensitivity analysis of potential LCOE output values (not of sensitivity within a LCOE value itself) for which we would observe the following:

- In relative terms, BELCO predicts a wide sensitivity for LCOE output for all scenarios (preferred by BELCO) but with natural gas (Scenario 3) being the 'least sensitive'. There is no sensitivity analysis provided for those scenarios (e.g. biomass) that have already been excluded by BELCO. The key point is that BELCO's own, rather limited, sensitivity analysis suggests significant risks to actual LCOE diverging from BELCO's central case in all its preferred scenarios.

- The sensitivity analysis only considers possible volatility with fuel costs, duty, load and carbon monetisation; excluded from the LCOE sensitivity analysis are, for example, interest rate costs and construction costs.

Having carried out this sensitivity analysis, BELCO then state that the output from this is one of the reasons for the preferred scenario of natural gas. We wish to make two important points:

(i) As alternative IPPs are excluded from the sensitivity analysis, it has no validity as a basis to justify BELCO's 'preferred scenarios'.

(ii) The sensitivity analysis carried out by BELCO omits key areas, including interest rate costs. This omission, arguably, invalidates BELCO's use of the sensitivity analysis to determine 'preferred' generation resources.

5.2.2 LCOE analysis and the problems of a 'snap shot' calculation

BELCO has used the LCOE analysis for 'snap shot' calculations of the costs of specified generation technologies (by BELCO) and scenarios.

1.10 Levelized Cost of Energy Screening

As an initial step in the IRP quantitative analysis process, Leidos performed an LCOE screening to assess, on a preliminary basis, the economic competitiveness of the DSM, supply-side resources (including renewable energy), and conversion of existing generating units as power supply technology options that are considered to be feasible candidates for the Bermuda electric system. The LCOE analysis is a "current snapshot" of the approximate economic competitiveness based on the information we know today about costs and performance. This approach is intended to help compare various resource options using the costs today. The results are calculated as a stream of equal $/MWh payments, normalized over the expected energy production period for the resource, that would result in the recovery of all production costs, including financing and a specified return on investment, over an assumed financial life.

Source 2018 BELCO IRP proposal (Leidos)

This statement by BELCO highlights a key weakness in the LCOE approach, which is that it is a 'current snapshot' of approximate 'competitiveness' over the 'expected energy production period' of the resource. This IRP is for a twenty year period. There are clearly flaws in using a current view cost of a resource to project its competitiveness over twenty years. In the case of BELCO, this is accentuated due to the age of all its assets and the fact that a widespread asset replacement programme is required (both in the short term and within the twenty year period).

It is the projected capital expenditure profile of BELCO that we believe further invalidates the use of the LCOE methodology. In the IRP proposal, there are two phases to significant capital expenditure (2020 - 2026 and post 2031) in all the scenarios chosen by BELCO. Put simply, there are large capital expenditures at future points that the LCOE methodology is ill-equipped to properly evaluate. (The previous section noted the issue of sensitivity of key factors most of which will impact on the cost and availability of capital). The inability of LCOE to assess future costs and cost effectiveness is a concern generally, but particularly acute when applied to BELCO's situation.

As a final point, we note that analysis of the financial tables in the Appendices of the IRP proposal makes clear that BELCO's preferred Scenario 3, natural gas, has the highest capex. In its sensitivity analysis, BELCO claims that forecasts of lower operational expenditure for natural gas generation offset this higher capital expenditure, based on the LCOE results. For the reasons stated in this section, we do not believe this is a valid assertion.

Recommendation K

The use of the LCOE methodology within the IRP should either be: (i) invalidated and replaced with a more appropriate method of assessing the cost effectiveness of BELCO's capital expenditure profile, or (ii) be supplemented with a more appropriate method and the LCOE methodology and output tested against the same.

5.3 Concerns as to BELCO's qualitative assessment of scenarios for the generation mix

We concur with Oxera's stated concerns as to BELCO's qualitative assessment of the various generating scenarios and would add that the general lack of substantiation that applies throughout the IRP proposal can be applied to the qualitative assessment pursued by BELCO.

Recommendation L

The qualitative assessment utilised in the IRP proposal is too subjective and without substantiation. There should be a RAB consultation on the role of qualitative assessment as part of the next round of IRP consultation, including methodology. Until that point, the weighting and formal use of qualitative scoring should be removed from the calculation of the generation mix scenarios.

Question 6: Do you have any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

This response makes clear that there are significant problems with the current IRP proposal that mitigate against a 'level playing field' when considering alternative providers of generation to BELCO. These problems need resolving prior to a full and proper process for evaluation of alternatives to BELCO generation. Also, see our answers to questions one to five above.

In the event the shortcomings outlined in the IRP are resolved, Enviva and Albioma are prepared to propose a specific biomass generating project as an Alternative Proposal.

ANNEX

ANNEX A: TD&R network upgrade costs

2016 IRP TOTAL SYSTEM COSTS: CASE 1 - Source BELCO 2016 IRP (Leidos)

TOTAL SYSTEM COSTS

		Levelized	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
BELCO																						
TOTAL DEMAND	GWH	677	665	666	668	670	672	674	676	678	680	682	684	686	688	690	692	694	697	699	701	703
AMORTIZED CAPITAL COSTS																						
Debt Service - Generation	$000	11,248	-	5,130	7,753	12,126	12,126	12,126	12,126	12,126	12,126	14,058	14,058	14,058	14,058	14,058	19,985	19,985	19,985	19,985	19,985	19,985
Debt Service - T & D	$000	8,100	28,055	15,585	16,090	15,033	14,523	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - LPG Infrastructure	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - LNG Infrastructure	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - DSM	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Early Retirement Depreciation Cost	$000	68	185	185	185	185	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OPERATING COSTS																						
Fuel - Existing	$000	44,099	82,964	64,943	45,122	32,896	35,384	36,531	38,277	39,702	41,500	36,584	37,989	39,599	41,445	43,801	23,246	23,965	25,281	26,277	27,430	28,367
Fuel - New	$000	63,237	-	20,673	42,308	57,476	59,327	61,865	63,536	66,102	68,238	76,560	79,721	82,297	86,143	87,983	120,040	125,368	130,212	136,078	140,503	144,409
Variable O&M - Existing	$000	3,659	7,391	5,765	3,921	2,754	2,809	2,864	2,974	3,040	3,148	3,047	3,110	3,224	3,282	3,465	1,774	1,808	1,872	1,911	1,962	2,059
Variable O&M - New	$000	4,943	-	1,957	3,968	5,204	5,286	5,417	5,536	5,669	5,791	5,989	6,154	6,300	6,434	6,594	7,678	7,863	8,044	8,232	8,606	8,983
Fixed O&M - Existing	$000	1,868	3,027	2,628	2,102	1,741	1,685	1,723	1,761	1,801	1,842	1,532	1,567	1,602	1,638	1,675	952	974	995	1,018	1,041	1,064
Fixed O&M - New	$000	1,533	-	411	838	1,453	1,486	1,519	1,554	1,588	1,624	2,017	2,062	2,108	2,156	2,204	2,998	3,065	3,134	3,205	3,277	3,351
Renewable	$000	5,954	4,167	4,376	4,595	4,842	5,065	5,319	5,585	5,886	6,157	6,465	6,788	7,154	7,484	7,858	8,251	8,696	9,097	9,552	10,029	10,570
DSM	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL COSTS	$000	144,708	125,790	121,653	126,882	133,712	137,690	127,363	131,348	135,915	140,425	146,252	151,449	156,343	162,640	167,638	184,923	191,725	198,621	206,257	212,834	218,787
	$/MWh	213.6	189.2	182.7	190.0	199.6	204.9	189.0	194.3	200.5	206.5	214.4	221.4	227.8	236.3	242.8	267.1	276.1	285.1	295.2	303.7	311.3

2018 IRP TOTAL SYSTEM COSTS: SCENARIO 1 – Source BELCO 2018 IRP Proposal (Leidos)

TOTAL SYSTEM COSTS — Scenario 1, Reference

		Levelized	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
BELCO																						
TOTAL DEMAND	GWH	632	626	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644
AMORTIZED CAPITAL COSTS																						
Debt Service - Generation	$000	11,062	774	774	10,569	10,569	10,569	10,569	10,569	10,569	12,260	12,453	12,453	12,453	12,453	18,576	18,576	18,576	18,576	18,576	25,335	25,335
Debt Service - T & D	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - LPG Infrastructure	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - LNG Infrastructure	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service - DSM	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Early Retirement Depreciation Cost	$000	19	-	-	237	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Costs	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OPERATING COSTS																						
Fuel - Existing	$000	33,531	73,848	70,468	25,209	24,772	24,080	26,266	26,666	27,950	28,156	28,821	28,625	28,650	31,962	22,630	23,837	23,541	24,694	27,487	347	146
Fuel - New	$000	46,181	-	-	45,663	46,591	47,405	47,544	48,875	50,082	51,711	52,926	54,112	56,335	55,397	67,548	69,121	70,775	72,042	71,180	103,020	103,385
Variable O&M - Existing	$000	3,474	8,394	7,741	2,522	2,483	2,422	2,673	2,664	2,795	2,692	2,789	2,745	2,745	3,015	2,199	2,291	2,282	2,377	2,657	67	27
Variable O&M - New	$000	2,523	-	-	2,444	2,527	2,616	2,598	2,655	2,690	2,737	2,786	2,881	2,971	2,899	3,709	3,750	3,854	3,903	3,839	6,302	6,349
Fixed O&M - Existing	$000	1,596	3,022	2,828	1,469	1,498	1,528	1,558	1,590	1,621	1,346	1,373	1,400	1,428	1,457	826	843	859	877	894	183	187
Fixed O&M - New	$000	2,561	279	284	2,353	2,400	2,448	2,497	2,547	2,598	2,947	3,006	3,066	3,127	3,190	3,930	4,009	4,089	4,171	4,254	5,086	5,188
Renewable	$000	7,011	3,079	5,284	6,034	6,219	6,431	6,648	6,975	7,114	7,361	7,625	7,913	8,175	8,564	8,779	9,129	9,441	9,793	10,161	10,574	10,956
DSM	$000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL COSTS	$000	107,958	89,396	87,379	96,500	97,059	97,498	100,354	102,540	105,419	109,210	111,780	113,196	115,885	118,937	128,196	131,556	133,418	136,432	139,047	150,916	151,573
	$/MWh	170.8	142.7	139.5	153.9	154.5	155.0	159.3	162.5	166.8	172.6	176.4	178.3	182.3	186.8	201.0	206.0	208.6	213.0	216.7	234.9	235.5