Response to Consultation Documents:

Comments on Integrated Resource Plan Proposal Consultation

CONFIDENTIAL Information for the Submission of
ENERGY CONSUMPTION REDUCTION

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Having thoroughly read the submission guidelines for the IRP we provide a list of responses to the IRP submitted by BELCO and the 8 responses received and accepted by the Regulatory Authority as perspective alternatives to consider for Bermuda's Energy paradigm for the foreseeable future. We also provide a list of potential amendments to provisions we believe were omitted or should be modified to enhance future IRP submissions.

Amendments to Consider for Future IRP Process

1. Section V a) 43 (pg. 10) of the Integrated Resource Plan (IRP) Proposal Consultation document states, "*In preparing the IRP Proposal, the TD&R Licensee should consider (i) all possible resources, including new generation capacity, demand side resources (including demand response and energy efficiency), and retirement of generation capacity; and (ii) a range of renewable energy and efficient generation options, and a prudent diversification of the generation portfolio. The IRP Proposal should also (i) prioritise actions that most meet the purposes of the EA, conform to Ministerial directions, and be reasonably likely to supply electricity at the least cost, subject to trade-offs contained in the Ministerial directions or instructions from the Authority; (ii) include recommendations on whether any resources should be procured through competitive bidding; and (iii) propose limits for total distributed generation capacity over the planning period*."

The word "*consider"* should be changed to ensure a clear deliverable associated with the provision. As it relates to demand side resources and energy efficiency, the IRP submission simply acknowledges that technologies exist but provides no solutions or plans for the adoption of these strategies and/or technologies. Consequently, there is no incentive for the TD&R licensee to pursue demand-side-management (DSM) or energy efficiency (EE) strategies.

As a result, the utility avoids demand control which could lower costs and simply matches supply with uncontrolled demand. DSM and EE should play a key role in the National IRP and we believe the monopoly TD&R licensee should be mandated to provide a plan for the adoption of these technologies. In the past they have seen fit to sponsor pilot programs for hot water heater insulation and efficient shower heads to curb waste on the system. Nonetheless, we have not seen any other programs in the last two decades.

A larger demand capacity translates to a higher cost system. If the focus is just on "least cost" vs "lower cost" the utility may simply seek the least cost solution for a 100MW system when a 90MW system would potentially be less expensive to build and a lower cost to the customer. If BELCO were truly interested in lowering cost I would expect them to be pushing DSM strategies like time-of-use and dynamic pricing to improve their load factor and EE strategies such as solar hot water heating, LED lighting or power factor correction to eliminate waste for their customers. These technologies combined could lower demand capacity requirements without adversely impacting kwh sales.

2. The provisions fail to hold BELCO accountable for the information provided or demonstrate how they align with the targets set out in the Government's National Energy Policy. Figure 13(from the National Energy Policy) below shows the Government's indicative targets - BELCO's plan should indicate how it measures up to the national targets.

The remaining requirements of Section V a) 43 (pg. 10) of the IRP seem to be completely ignored. There are no:

i. prioritise actions that most meet the purposes of the EA, conform to Ministerial directions…

ii. recommendations on whether any resources should be procured through competitive bidding;

iii.propose limits for total distributed generation capacity over the planning period

Failure to respond to these requirements make it difficult for the RA to perform its duties under Section 14(1) of the EA and could easily lead one to conclude that BELCO is not interested in the National Plan but simply driving their age-old agenda focused on higher returns and resulting higher rates.

Figure 1 - Bermuda National Energy Policy - Targets

4.1 Targets

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

Table 4.1: Targets for Electricity Performance

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

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

Section 1.8 and Section 2.7 of the IRP indicates that BELCO has no plans to invest in energy efficiency, solar thermal heating, renewables or DSM. The utility simply relies on the market to bring those technologies to bear.

Section 3.4 of the Oxera report states:

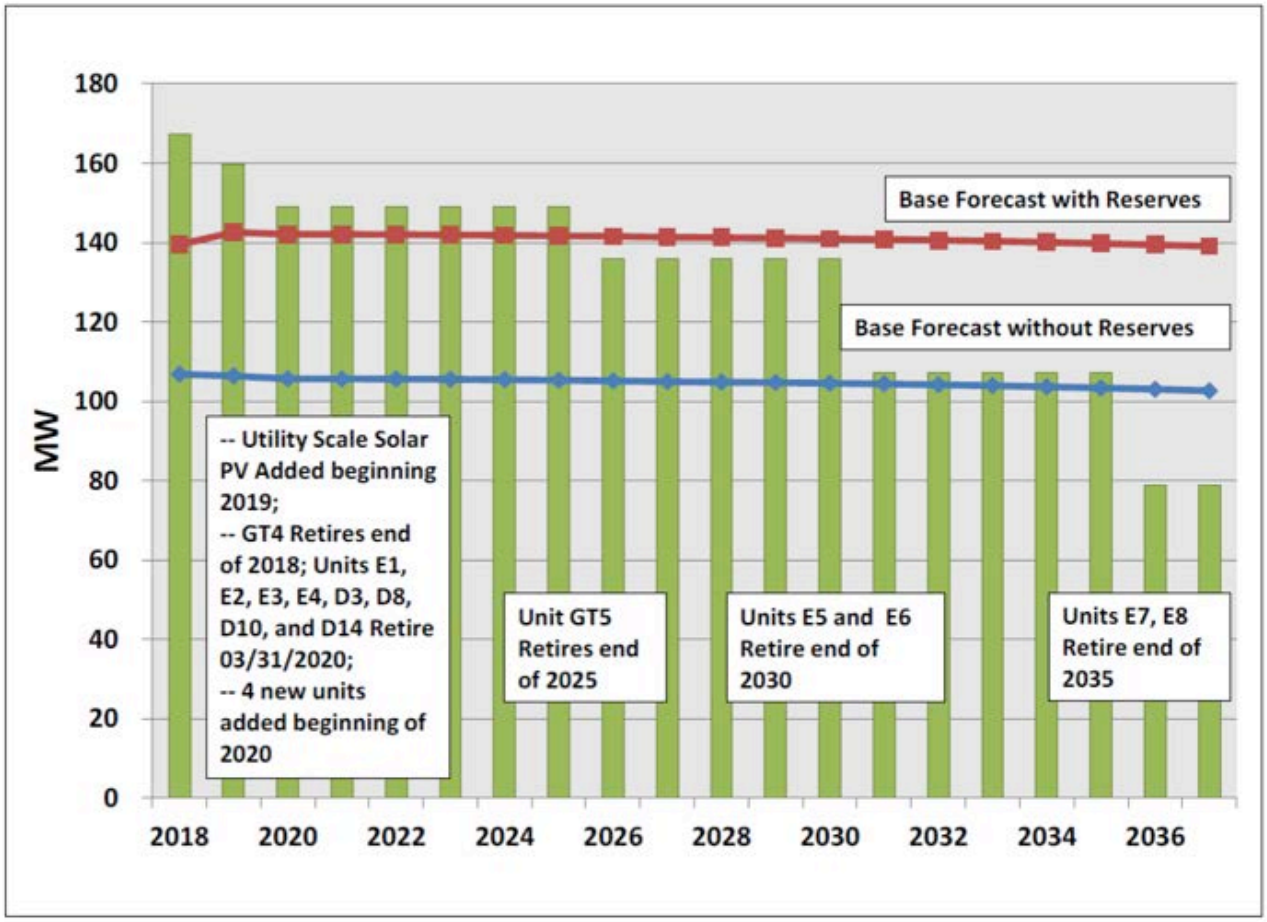
> *"3.4 The IRP must therefore be credible, comprehensive in its treatment of available resources (whether currently available or anticipated to be available in future), auditable, and robust to identifiable sources of uncertainty in order to enable the Authority to:*
>
> - *approve the least-cost, or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

There doesn't appear to be any attempt on the part of the utility to: "*evaluate the merits of applications by prospective IPPs or other licensees as well as other proposals that entail deviations from the IRP, in particular by calculating their benefits, costs, and risks to the electricity system.*"

There is mention of Tynes Bay and the planned 6MW system on "The Finger". However, there is no indication of whether Tynes Bay's future plans are incorporated in the IRP, nor are there any indications they have solicited input from known potential IPPs on the island.

The combination of these facts leads us to conclude that the procurement strategy outlined in the IRP Proposal is not appropriate and has not satisfied the requirements of the guidelines. In addition, allowing BELCO to replace 56MW as part of the NPS approvals without a competitive bidding process, further compounds the issue as it does not ensure least cost solutions and eliminates any significant competition for generation until 2030.

BELCO Integrated Resource Planning Proposal – Capacity vs Load



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

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

As discussed above, allowing BELCO to replace 56MW as part of the NPS approvals without a competitive bidding process, provides a significant barrier to entry for potential IPPs. In addition, it will almost certainly require a rate increase for the end-users. We

believe the 56MW replacement approval should be disapproved under Section 6.3 of the RAA and should then be put out to competitive bidding.

Are there any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

In short Yes.

Commonly expressed perceptions of BELCO are; their only business interest is to sell more energy, rate increases are inevitable and there is a disconnect between their business model and the legislation and regulatory direction found in the National Energy Plan. There is no driver for them to reduce demand and no substantive plan to allow the penetration of renewable technologies and/or the introduction of technologies which enable the transformation to new technologies over the shorter term. This results in the need for a larger system. A larger system translates into higher costs. Unfortunately, BELCO's IRP submission and their current business model further supports these perceptions.

The National IRP should more appropriately reflect the goals and objectives of the National Energy Policy and Targets (Figure 1). Clearly, the TD&R Licensee has no interest in funding initiatives that will promote Distributed Generation or IPPs, Demand-Side-Management, Energy Efficiency, or any initiatives that will reduce their kilowatt hour sales and revenue. Hence, their submission "considers" these technologies but offers no solutions or programs to pursue any of them.

Several of the submitted proposals introduce commercially applied technologies that will:

i. Enable the country to better manage our energy usage through awareness, conservation, and energy efficiency, and
ii. provide a clean, affordable, and reliable alternative that will enable us to more quickly transition away from fossil fuels and traditionally large "brown-fill" footprints for energy production.

Nonetheless, Demand and Commercial Customer Energy Efficiency Programs should be added to the mix.

Researchers estimate commercial buildings account for 20% of all the energy used in the U.S. and concludes that as much as 30% of that energy is wasted. The Ascendant Group 2017 Annual Report indicated that commercial consumption accounts for 49% of all energy used in Bermuda. We have found, in our 7 years of operations that the energy wasted in commercial businesses range from 8%-28% and averages close to 15%. The older the building the higher the waste is likely to be.

These results infer we can (in the most conservative case) shave 5% off our national energy demand by promoting energy efficiency to commercial consumers on the island.

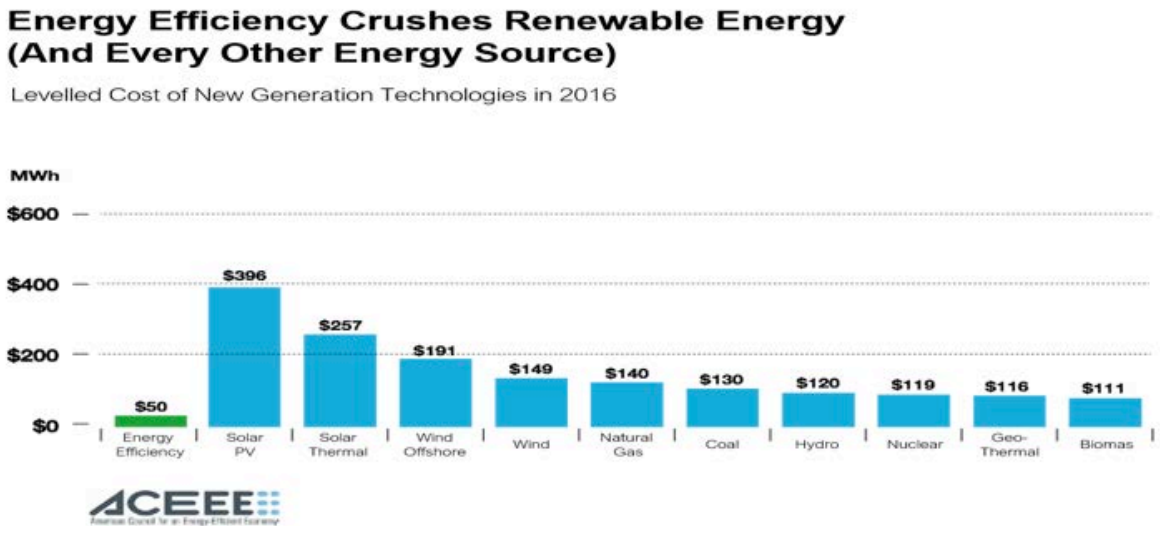
However; to realise these reductions in consumption and related demand, energy audits are required to:

1. Determine the areas of waste, and
2. Recommend the technologies and/or best-practices required to eliminate the waste.

We believe the National IRP should include energy efficiency programs which mandate energy audits for large commercial customers (BELCO's "Demand" customers) and provide incentives for small and medium size customers to follow suit.

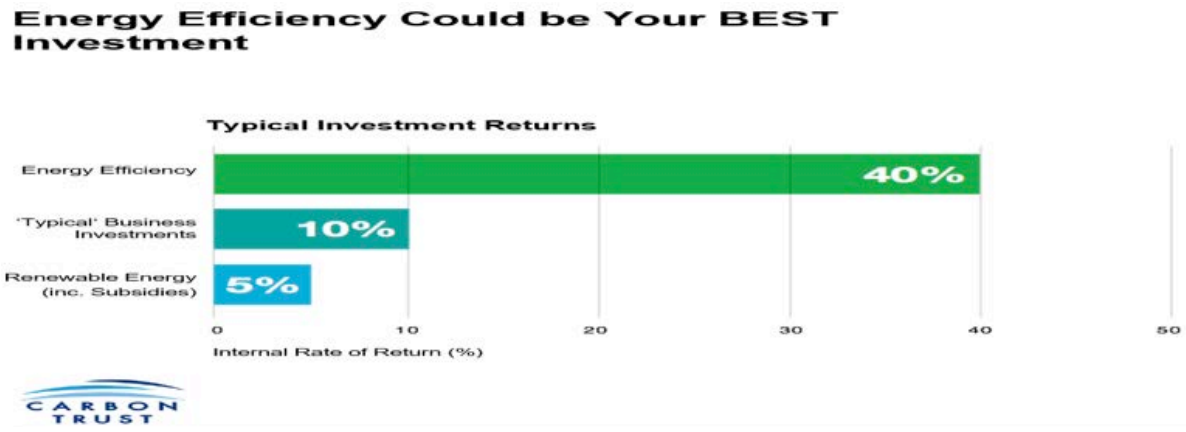
The investment in energy efficiency is proven to be far less expensive than traditional power generation costs. Figure 5 compares the investment of energy efficiency technologies with other commonly deployed power generation technologies.

Figure 5 – American Council for an Energy-Efficient Economy – Levelled Cost of New Generation Technologies



Also, Figure 6 illustrates how the return on investment could far exceed other investments in the company and the resulting smaller energy footprint and lower energy costs will more than justify the investment.

Figure 6 - Carbon Trust - Typical Investment Returns



Demand and Commercial Customer Energy Monitoring

At AESG we believe "*You can't improve what you don't measure!*" BELCO provides commercial customers with a monthly bill that states how much they have used in kWh and kW demand to calculate how much they owe BELCO and for collecting their revenue. This is great for BELCO, but it does little to help the customer manage their energy consumption and save money on their electricity bill.

Metering & Control technologies solve this problem and provide a whole lot more. They provide real-time information usage including; month-to-date kWh, real-time demand, and the associated costs, so that customers know what they have spent to date and can forecast what they will spend for the remaining billing period. This knowledge gives our clients the opportunity to make informed decisions about how they will operate their facilities prior to receiving their next bill.

Energy Monitoring Benefits:

If we are to achieve the targets shown in proposals such as the *Bermuda Better Energy Plan*, we believe the National IRP should include mandatory energy monitoring systems for large commercial customers (BELCO's "Demand" customers) and provide incentives for small and medium size customers to follow suit. Regulators across the globe are moving toward mandatory energy monitoring, for large consumers, in an attempt to raise awareness around energy consumption and to change end user behaviours contributing to energy waste and peak demand. The tables below, highlight regulations being deployed in the U.S.

Figure 8(a) – ASHRAE 90.1 vs. Title 24

2015 IECC vs. ASHRAE 90.1 2016 vs. Title 24 2016

Control Type	2015 IECC	ASHRAE 90.1 2016	Title 24 2016	Summary of Requirements
Service Metering/ Disaggregation of Electrical Circuits	-	✓	✓	- Measurement devices must be installed in new buildings to separately monitor energy use - Requirements include user accessible metering of total electrical use - Specifications for the separation of 10 types of electrical loads for switchboards, panels and motor control centers required to be disaggregated

Figure 8(b) – Title 24 – Minimum Requirements for Metering Electrical Loads

Table 130.5-A: Title 24

Minimum Requirements for Metering Electrical Loads

Meter Type	Services <50 kVa	Services 50-250 kVa	Services 250-1000 kVa	Services >1000 kVa
208V 3PH	0-139	139-690	690-2775	>2775
480V 3PH	0-60	60-300	300-1200	>1200A
Instantaneous (at the time) kWh demand	Required	Required	Required	Required
Historic Peak Demand (kW)	Not Required	Not Required	Required	Required
Resettable kWh	Required	Required	Required	Required
kWh per rate period	Not Required	Not Required	Not Required	Required

Figure 8(c) – Title 24 – Minimum Requirements for Separation of Electrical Loads

Table 130.5-A: Title 24

Minimum Requirements for Separation of Electrical Loads

Meter Type	Services <50 kVa	Services 50-250 kVa	Services 250-1000 kVa	Services >1000 kVa
208V 3PH	0-139	139-690	690-2775	>2775
480V 3PH	0-60	60-300	300-1200	>1200A
Lighting including exit, egress, and exterior	Not Required	All loads in aggregate	All lighting disaggregated by floor, type, or area	All lighting disaggregated by floor, type or area
Plug load, including appliances rated < 25kva	Not Required	-All plug loads in aggregate -Groups of plug loads exceeding 25 kVa connected load in an area < 5000 ft²	-All plug loads separated by floor, type, or area -Groups of plug loads exceeding 25 kVa connected load in an area < 5000 ft²	-All plug loads separated by floor, type, or area -All groups of plug loads exceeding 25 kVa connected load in an area <5,000 ft²
Charging Stations	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate
HVAC systems and components; chillers, cooling towers, circulator pumps, etc.	Not Required	All HVAC loads in aggregate	All HVAC loads in aggregate and each HVAC load =50kVA or greater	All HVAC loads in aggregate and each HVAC load =50kVA or greater
Domestic and Service Water system pumps and other system components	Not Required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Elevators, Escalators, Moving Walks, etc.	Not Required	All loads in aggregate	All loads in aggregate	All loads in aggregate

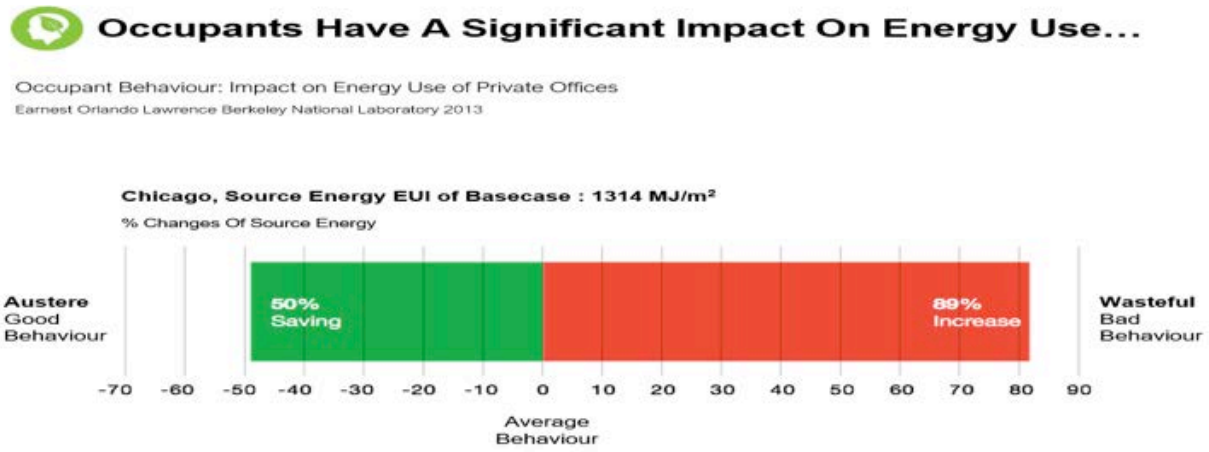
Figure 8(d) – City of Seattle Metering Requirements

City of Seattle Energy Metering Requirements

Totals by Load Type	Energy Use Measurement
1202.1 HVAC System Total Energy Use	Must include all energy for space hearing, space cooling, ventilation, boilers, chillers, pumps, fans for supply, return, relief, exhaust, parking garages
1202.2 Lighting System Total Energy Use	Must include interior and exterior, but not plug-in task lighting
1202.3 Plug Load System Total Energy Use	All energy used by plugged-in task lighting, appliances, and other equipment
1202.4 Process Load Total Energy Use	Non building operations loads >2% of total (or part of Misc)
1202.5 Miscellaneous Total Energy Use	Other categories, including domestic hot water, elevators and escalators, swimming pools

AESG offers its customers a world class energy monitoring system that unlocks all the benefits in illustrated above. We currently have over 100 metering points active on the island today. In addition, we can install multiple public displays that provide real-time energy consumption which enables facility managers to highlight awareness needed to influence staff and guests' energy related behaviours. Clients will also be able to eliminate operational realities like "out of hours" consumption and/or unusual consumption behaviours currently invisible to facility personnel. Just knowing what is consuming and when, can quickly eliminate waste and lower energy consumption in the facility.

Figure 9 – Earnest Orlando Lawrence Berkeley National Lab - Occupant Behaviour Study



Please note the metering solutions described, are over and beyond the "Smart Metering" planned by the utility. We acknowledge utility "Smart Metering" to be an improvement on monthly billing, however; it is still catered to the utility. Allowing it to read meters remotely and carry out demand response for its operating needs and cost cutting but, contributes far less to the operations of the client downstream of the meter than what we are proposing.

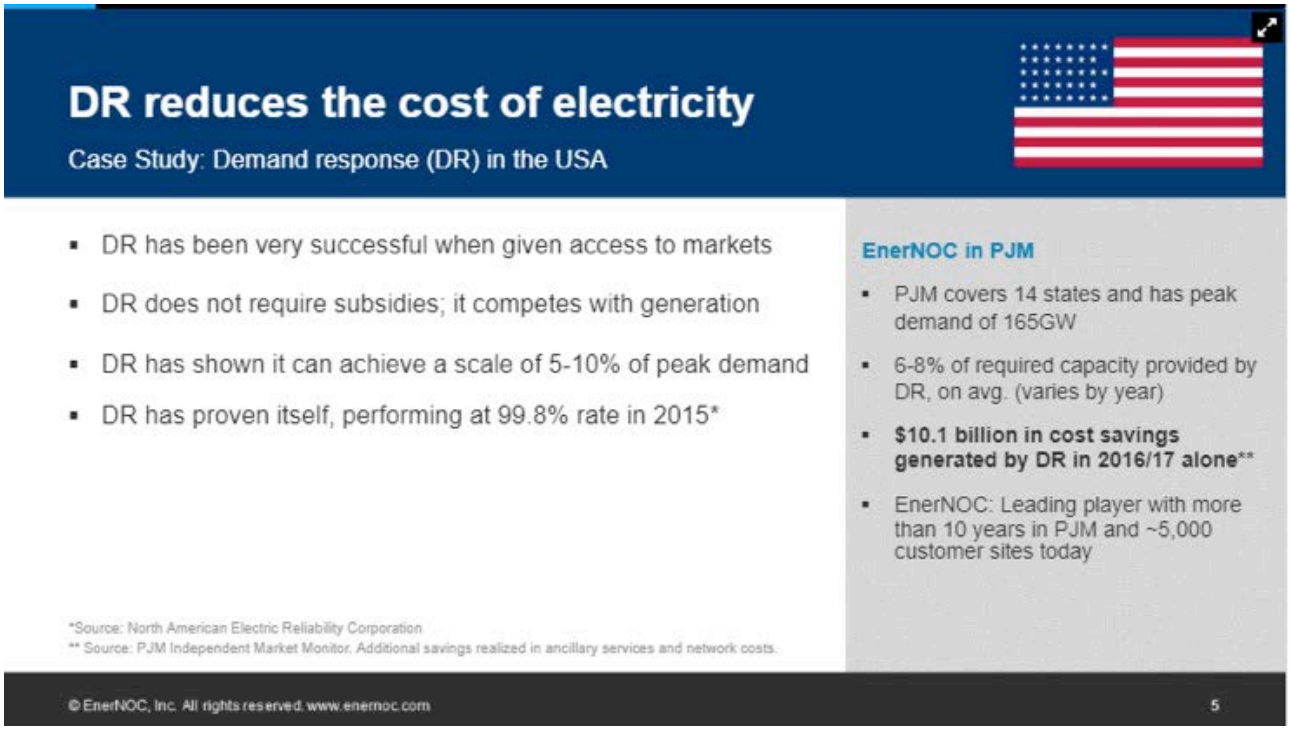
Demand Response Programs

The U.S. Department of Energy adequately defines Demand Response (DR) as follows:

"Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives. Demand response programs are being used by some electric system planners and operators as resource options for balancing supply and demand. Such programs can lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates. Methods of engaging customers in demand response efforts include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing, and critical peak rebates. It also includes direct load control programs which provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills."

As a result, DR programs have proven to reduce energy demand and energy costs across the U.S. and the globe.

Figure 10(a) – EnerNoc Case Study – DR reduces the cost of electricity



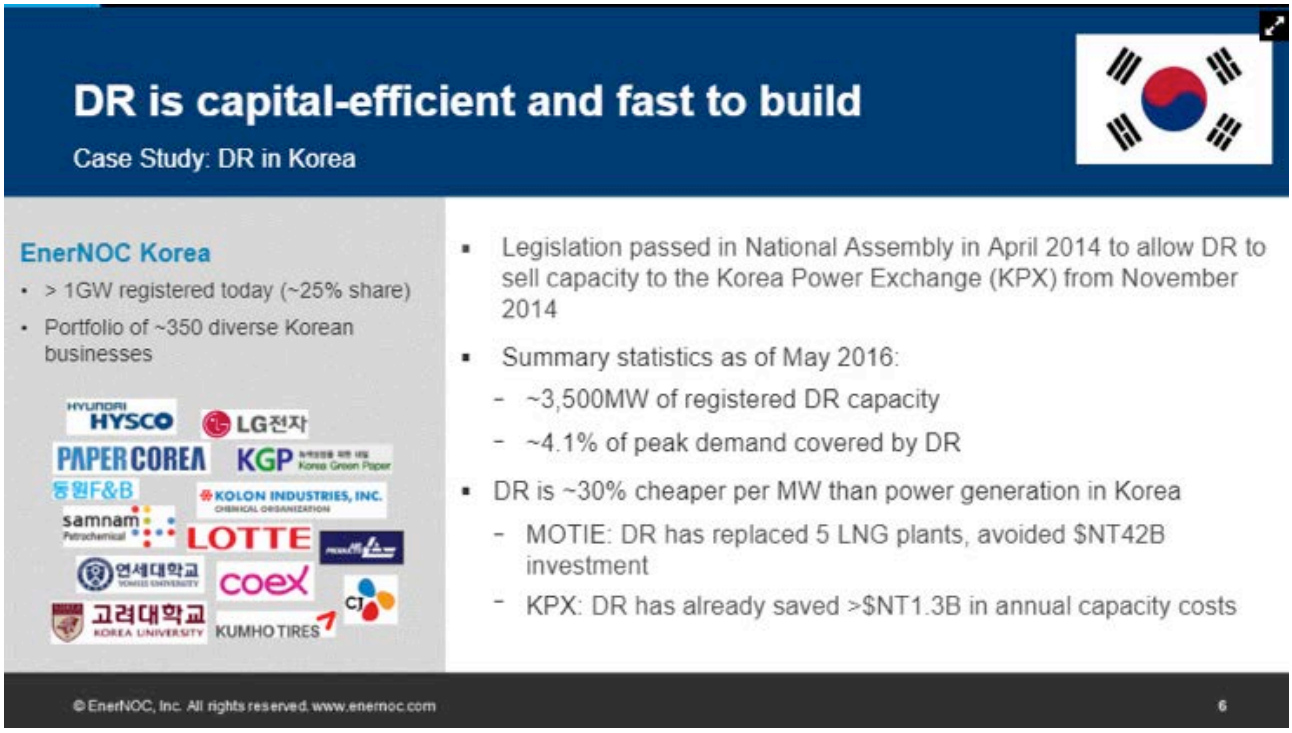


Figure 10(b) – EnerNoc Case Study – DR reduces the cost of electricity

We believe DR should be a part of the National IRP to better manage demand requirements and resulting higher costs. BELCO have historically dismissed DR except when it served their interests. In the early to mid-2000s, prior to BELCO upgrading their system; they reached out to local businesses for their assistance during the summer peak months. BELCO essentially paid some of their customers to run their backup generators to take pressure off the system because they could not meet the demand.

Programs like this could be offered under normal circumstances to offset/defer the need to increase capacity or to delay the need for replacements. Time-of-use and/or dynamic pricing can also be deployed to achieve the same objectives. BELCO has historically suggested that we do not have the "industry" to justify time-of-use tariffs but to my knowledge they have never asked their customers whether they would alter their respective operations for a lower tariff alternative. Furthermore; if they are so keen to introduce "Smart Metering" and the benefits of real-time information one would expect that they should want their customers to benefit from this new information access.

If our recommendations for energy monitoring above are accepted, commercial customers will be significantly more informed of when they are consuming and what is consuming energy in their facilities. This would better position them to consider and take advantage of DR programs. Pursuing initiatives like these are the only way we can achieve the energy aspirations highlighted in the Bermuda National Energy Policy aspirational Energy mix. BELCO's IRP submission clearly suggested that we will not get there through their efforts.

Floating Energy Ship Proposal

The floating energy solution can provide a unique and innovative opportunity for Bermuda and allow for an energy mix that best fits the National Energy Policy goals and objectives. In addition; it clearly addresses 4 of the problems previously highlighted with BELCO's IRP submission. These include:

I. IPP Participation: – The fact that we have raised this several times already in this response to the BELCO IRP submission is evidence that we believe it is critical to the future of energy in Bermuda and the goals and objectives of the National Energy Policy that; the 56MW approval for BELCO must be "disapproved". Figure 11 assumes BELCO's 56MW is installed by the TD&R Licensee by 2020. It also clearly illustrates the fact that with this 56MW installation, BELCO is in a surplus capacity position until 2026 and does not require any significant additions to the grid until 2031.

Figure 11 - BELCO Integrated Resource Planning Proposal – Capacity Gap Analysis

Table 1
Capacity Gap Analysis
(Base Load Forecast with Reserves)

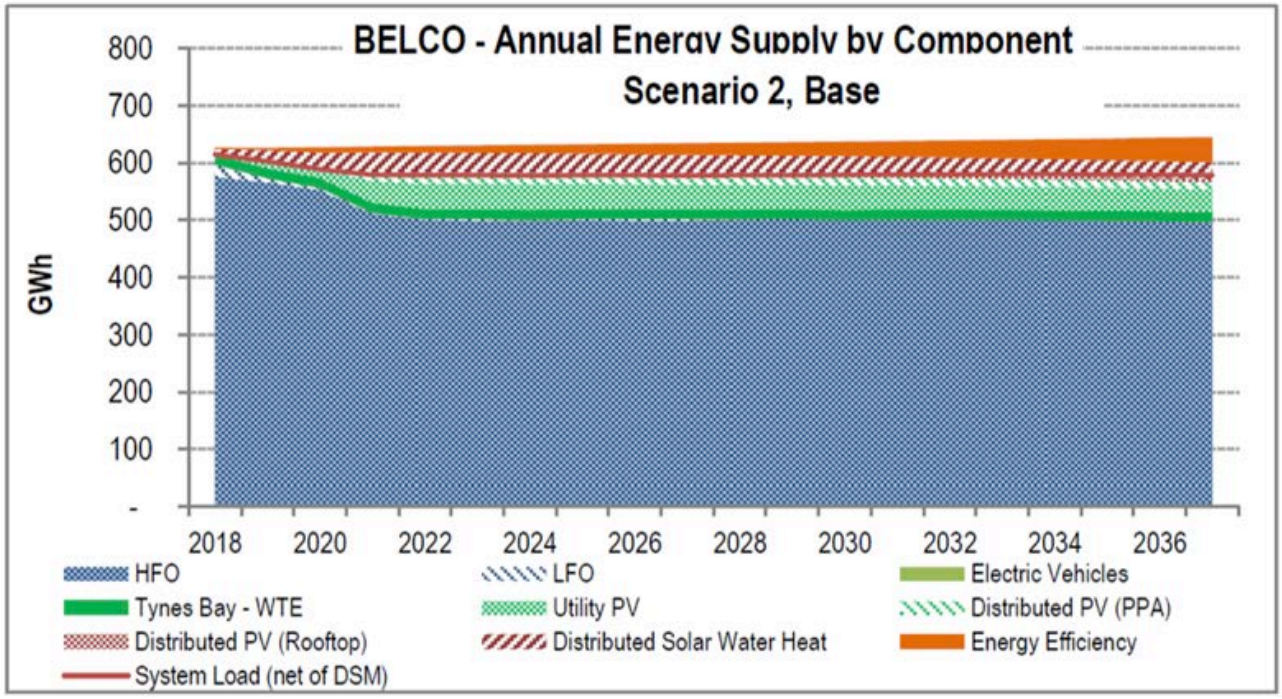
Year	Capacity Gap (MW)	Year	Capacity Gap (MW)
2018	27.8	**2028**	(5.3)
2019	17.2	**2029**	(5.2)
2020	6.8	**2030**	(5.1)
2021	6.9	**2031**	(33.5)
2022	6.9	**2032**	(33.3)
2023	7.0	**2033**	(33.0)
2024	7.1	**2034**	(32.8)
2025	7.2	**2035**	(32.5)
2026	(5.6)	**2036**	(60.7)
2027	(5.5)	**2037**	(60.3)

Given the opportunity, a floating energy solution would provide a resilient, affordable, but flexible alternative to BELCO's IRP submission.

II. Natural Gas Penetration: - BELCO's IRP submissions highlights Scenario 3 as their preferred energy solution for Bermuda. This involves the conversion of the Central Plant to LNG. However; there is no LNG available on the island currently and their 56MW plant upgrade approval provides for "Dual-Fuel" engines but does not include funding or plans for the importation, regasification, and storage of LNG for use in their new

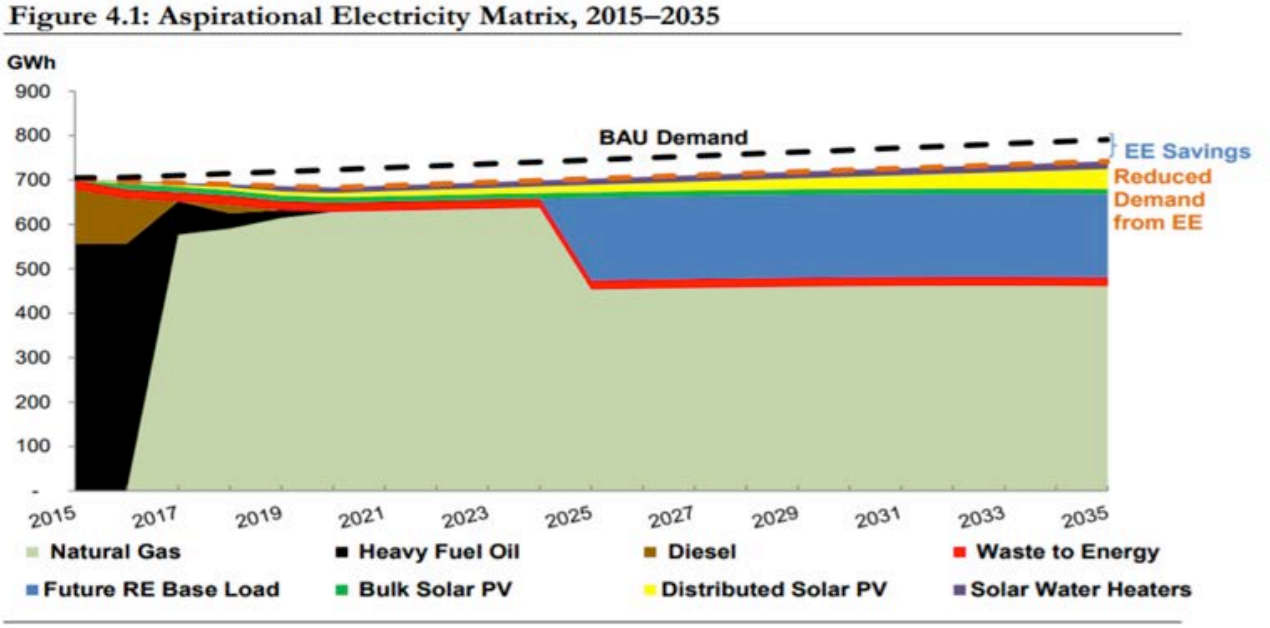
plant. So, despite their public declarations about LNG over the past few years they will not actually be bringing LNG to the island. Hence; their actual contribution to the future energy mix in Bermuda is better reflected by Figure 12 below.

Figure 12 - BELCO Integrated Resource Planning Proposal – Scenario 2



Scenario 2 in Figure 12 is clearly a "business as usual" scenario. On the other hand, a floating energy solution would provide the infrastructure required to transform the island to an LNG environment and produce a energy mix more closely aligned with the Bermuda National Energy Policy displayed in Figure 13.

Figure 13 - Bermuda National Energy Policy – Aspirational Electricity Matrix



A floating energy solution could provide the 56MW capacity on PPA terms over a period of 10, 15, or 20 years. This gives us the security of having a reliable supply for as long as we want but allows the penetration of other technologies without the risk of "stranded assets". In other words, we would not need to invest in the capital infrastructure required to bring LNG to the island which means we won't be stuck with the asset for 20-30 years if new cleaner or renewable alternatives come to fruition. This would truly enable LNG to be a transition fuel for Bermuda as illustrated in Figure 13.

Floating energy solutions have been deployed across the globe for decades, including places such as; Bangladesh, Papua New Guinea, Dominican Republic, and Jamaica. Given the goals and objects of the National Energy Policy, Figure 13 shows why this solution makes sense for Bermuda. The Floating Energy Solutions checks several boxes for Bermuda and offers these additional benefits:

- Allows us to obtain the LNG infrastructure required to take advantage of LNG on the island without the required capital or footprint of a land-based solution. The vessel can have a regasification unit onboard to use LNG as fuel, and to deliver gas to shore if required to supply BELCO engines or for other uses on island.
- Can utilize a multi-fuel system including LNG, LPG, and Diesel, making them the cleanest mobile power solution in the market and provides the fuel security we need to protect against supply fuel shortages or spikes in fuel cost during the transition to renewables.
- The vessel can either be moored along a jetty, or it can be placed offshore with 8-12 mooring solutions. Both solutions are compatible with ship to ship transfer of fuel and in both cases the ship can be moved in the case of hurricanes or other situations which may occur over the life of the contract.
- Can be sized from 30-450MW and store up to 50 days of fuel. A minimum 10-year PPA is required but can be extended beyond 10 years as required to allow for future IRP submissions and/or new technology integration.
- Can be delivered in 12-30 months.

7. Conclusion

The Bermuda Government should be applauded for the work it has done over the last decade in the local energy space. We reflect on the efforts in this regard starting from the Energy Green Paper culminating into this very process. We believe this was all done in keeping with the island's best interests and positive direction. Nonetheless; the timing is such that if we allow BELCO to build their proposed 56MW plant, all the work done over the last decade will have been in vain, for the net result will be "business as usual".

The Bermuda Better Energy Plan, Floating Energy Solution and the addition of Demand and Commercial Customer Energy Efficiency Programs should be the energy mix for Bermuda. These solutions will:

i. provide a clean, affordable, and reliable alternative that will allow us to more quickly transition away from fossil fuels and traditionally large "brown-fill" footprints for energy production.

ii. avoid or delay the inevitable rate increases associated with the BELCO IRP submission.

iii. enable the country to better manage our energy usage through awareness, conservation, and energy efficiency.

We thank you for the opportunity to participate in this public consultation and we look forward to seeing a National IRP that includes our ideas, reflects the intent of the Energy Act 2016 and delivers the goals and objectives of the National Energy Policy.

Regulatory Authority of Bermuda

Response to Consultation Document 2018 10 02

(Alternative Integrated Resource Plan Proposals Consultation)

30th November, 2018

Dear Sirs,

In opening our response, we would like to refer you to a recent report on global renewable energy trends published by Deloitte at :- https://www2.deloitte.com/insights/us/en/industry/power-and-utilities/global-renewable-energy-trends.html

This report states that renewable energy (RE), has only recently become "mainstream" energy sources, but is now rapidly becoming a preferred one. It also shows that RE is actually helping grid infrastructure by adding stability etc. in contrast to the utility scaremongering about high levels of RE on the grid. It also shows that globally the increased adoption of wind and solar PV is helping to lower the cost of electricity in many of the example locations provided. Further it shows that in Australia and Europe, distributed rooftop solar capacity exceeds utility scale capacity, setting an example that makes huge sense for Bermuda, given the amount of roof space that we have compared to land suitable for more solar farms. We strongly recommend that the RAB reads this report as it contains so much valuable information pertinent to how we plan our energy future in Bermuda.

In light of this September Deloitte report, the recent report on climate change published by over a dozen US Federal agencies and volumes of other information, it amazes us that out of the nine IRP proposals, including BELCO's, four of them are based on 100% fossil fueled solutions, while BELCO's is more than 80% fossil fueled. Of the four renewable technology proposals, two of them do not satisfy the commercial operation history requirement of the IRP mandatory requirements. This is truly a sad reflection on how this IRP process has occurred so far, but at least we can take consolation in the fact that at least one proposal displays the vision of an energy future for Bermuda that we, our children and grandchildren all deserve.

Before answering your four questions pertaining to this consultation, we wish to first state why in our opinion the Bermuda Better Energy Plan submitted by Etude and BE Solar (BES) is the best IRP for Bermuda. In reaching this conclusion, we refer to our consultation response to BELCO's IRP that we previously submitted. We developed our response independently from BE Solar and Etude, although we did exchange some data to verify the level of adoption of solar in Bermuda to date. Yet we have come to many conclusions and recommendations that are the

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same or very similar. For ease of reference, we have enclosed that previous response as an appendix to this response. Please note the following:

1. Both Etude/BES and BAE pointed out that BELCO's IRP does not meet the Renewable Energy (RE) targets set in the National Electricity Sector Policy (NESP) or the Energy White Paper both of which advocate the wider adoption of RE.
2. Both of us showed that the Levelized Cost of Electricity (LCOE) for Utility Scale Solar PV ($0.103/kWh for the Airport Finger project) and Distributed Solar PV (Commercial & Residential) were far lower than shown in BELCO's IRP, resulting in these renewables being made to look less attractive in the BELCO plan than in real practice.
3. Both of us showed that the annual degradation of tier 1 and tier 2 solar modules is approximately half of what Liedos/BELCO used in their IRP, again falsely portraying that Solar PV has a higher LCOE than in reality.
4. Both of us showed that Solar thermal is a poor investment compared to solar PV and heat pump water heaters, with the market for new solar thermal sales having dried up completely. Yet Liedos/BELCO show solar thermal growing to 34 GWH annually by 2021. This far exceeds their IRP forecasts of 5 GWH of Distributed Rooftop Solar PV and 15 GWH of Distributed (larger scale) Solar PV on Power Purchase Agreements (PPA). We therefore strongly recommend that the RAB examine Liedos/BELCO's reasoning for advocating a technology that has essentially become economically obsolete here and recommend that the BELCO IRP allocation for solar thermal should be reassigned to rooftop solar PV and heat pump water heaters. Consider also that BELCO/Ascendant closed down their renewable energy company, Pure Energy, after huge recurring losses. So they are perhaps ill equipped to ascertain the direction that Bermuda's RE/EE industry should be heading.
5. Both firms see that the adoption of electric vehicles in Bermuda will be faster than Liedos/BELCO have modeled.
6. BAE recommended looking at an offshore wind farm as the logical substitute for the large scale renewable to be introduced in 2023 under the NESP. Etude/BEsolar went further by including 60MW of offshore wind in their alternative IRP.
7. While BAE criticized Liedos/BELCO for using a lower percentage of energy reduction from energy efficiency, Etude/BEsolar's alternative IRP proposes even more energy efficiency gains, and we believe the overall efficiency gains that they proposed are economically attainable.
8. Both firms confirmed that the maintenance cost for Solar PV are far lower than the numbers used by Liedos/BELCO, thus the real LCOE of utility scale, commercial and residential solar PV is lower than asserted by Liedos/BELCO

In conclusion, Etude, BE Solar and BAE have all shown that the LCOE of solar PV is substantially lower than Liedos/BELCO have stated in their IRP proposal. Etude/BE Solar went further showing the LCOE of offshore wind is far below the fossil fueled technologies that BELCO is

advocating. These two renewable technologies at the utility scale offer low and stable long-term electricity costs unlike BELCO's fossil fuel generation system. Consider that Liedos/BELCO used a forecasted natural gas commodity price of $2.86/mmBTU for 2019, followed by $2.83 and $2.85 in 2020 and 2021 respectively. Yet as of the 28th November 2018, Henry Hub futures bulk prices have risen by more than 50%, reaching a high of $4.785/mmBTU on that date. This recent price is 68% higher than the average price for those three years forecasted by Liedos/BELCO. We recognize that a 68% increase will not translate to that magnitude of an increase in the price of LNG delivered to Bermuda, but the increase would in all likelihood result in LNG having the highest LCOE rather than the lowest as predicted by Liedos/BELCO.

By contrast, in the same month, crude oil priced have dropped by approximately 30%. Combined, this adequately demonstrates the volatility of fossil fuels for electricity generation and how BELCO's and other fossil fueled based alternative generation proposals may be far too low on the LCOE for LNG based generation and possibly too high for oil based generation. In contrast, the LCOE for all three size ranges of solar PV and for utility scale wind are far more certain because they have free energy sources.

Please note our following answers to the four Consultation questions

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

   We don't recall any except that the Sorenson proposal does not include any energy input cost factor for the production of the Hydrogen fuel source. Conventional wisdom dictates that to obtain hydrogen from sea water you must spend energy, either from a renewable source or a more conventional source and this fact seems to have been ignored in the Sorenson proposal.

2. *Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?*
   Firstly, please note that there are no Ministerial directions published on your web site in the Electricity Sector page for such documents. The fact that you refer to them would lead us to suspect that the RAB has been given one or more Ministerial directions, in which case your failure to publish them only inhibits the consultation process. As for Ministerial Statements, the Minister did make one in the House of Assembly on 8th December 2017 that we recall. In that statement he said "**it is plain that energy conservation and efficiency must play a far more prominent role in the IRP process**". The Etude/BE Solar alternative proposal is the only one of the eight that addresses this statement and it does so far more aggressively than BELCO's draft IRP. Rather than quoting further sections of that Ministerial Statement, we have attached the whole statement in Appendix 1 and highlighted certain sections on renewables adoption etc. Again the statement calls for the

wider adoption of renewables more in line with the targets previously set in the Energy White Paper that was published when he was previously the Minister responsible for Energy. The white paper targets for energy efficiency and renewable energy were considerably more aggressive than the NESP targets. Based on that Ministerial Statement, in our opinion, the Alternative Proposal submitted by Etude/BE Solar is by far the most consistent with both this Ministerial Statement, the six purposes of the EA and section 40 of the EA compared to the other IRP proposals.

With regard to the other alternative proposals, please note that we have grouped them as follows:

I. **Fossil Fueled Alternatives, otherwise referred to as Twentieth Century technologies**: These includes Offshore Utilities, Sol, BEESGC & BCM-Bouygues. Ideally these proposals should have been submitted as possible alternatives to the BELCO North Power Station (NPS), prior to the RAB approving the NPS. Now that the NPS has been approved, adding any one of these technologies/proposals will likely result in stranded assets which may actually increase the cost of electricity. This is not a criticism of the NPS approval, as we accept that this was necessary to continue to have a reliable power supply after 2019. For this to have been avoided, the Electricity Act would have had to be introduced at least two years earlier than it was.

   In our opinion, these proposals rank the lowest in relation to the ability to satisfy the purposes of the EA contained in Sections 6 (c) and (f) and the Ministerial Statement.

II. **Unproven Renewables**: This includes the proposals by BGA and Sorenson. As much as we recognize the huge potential of wave power and its more consistent power output, unfortunately the BGA proposal does not yet meet the commercial operation in another jurisdiction mandatory requirement. Hopefully this or another wave power technology will have achieved commercial utility scale deployment a few years before the next IRP process occurs in less than five year's time. The Sorenson proposal also fails the same mandatory hurdle, and in our opinion is missing too many details.

III. **Proven Renewables**: Other than Etude/BE Solar Proposal covered above, the only other proven renewable energy technology proposal was submitted by Enviva and Albioma (E&A). Whilst we prefer renewable technologies with zero emissions or very low emissions, if other jurisdictions are endorsing the use of Biomass as a more sustainable source of electricity than fossil fueled solutions, perhaps Bermuda should give this some consideration as well. The ability to produce electricity 24X7 using a renewable source is this proposal's biggest asset and its apparent stable fuel cost would be second. However, their projected LCOE of $165.2/MWh is

considerably higher than the approved airport solar farm but it is also far lower than the LCOE for Biomass contained in the Appendices of BELCO's IRP. It is fractionally lower than BELCO's LCOE for Reciprocating Internal Combustion Engines (RICE) contained in their IRP Appendix II.D1 The RAB's publishing of BELCO's Fuel Adjustment Rate applications for the past two years on 29th of November 2018 is too late for us to analyze how this BELCO LCOE projection may have changed since the IRP was written. We also note that E&A are carrying no debt service for T&D in their spreadsheets. To us this implies they are expecting BELCO to provide the T&D infrastructure and therefore there will possibly be further costs added to the LCOE for this biomass renewable. As such, the RAB has provided insufficient information for us to ascertain whether this E&A proposal represents a least cost opportunity for "renewable" energy.

This leaves Bermuda with the Etude/BE Solar alternate proposal as the only logical choice for a better IRP than that proposed by Liedos/BELCO.

3. *Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?*

   We have basically answered the commercial operation question in answer 2 above.

4. *Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?*

   We believe that the LCOE assumptions and methodology in the Etude/BES Alternative Proposal are far more realistic than those provided in the BELCO IRP. We did not see where Etude/BES factored in the high cost of running BELCO's gas turbines as opposed to their eight main reciprocating internal combustion generators. Considering that Solar PV is better suited to offsetting the use of these gas turbines between April and November than wind power, more detailed modeling and analysis with the recently release FAR application fuel costs may later show that the ideal mix of solar PV and wind power will be slightly more Solar PV and slightly less wind.

   We would like to thank Mr. Nick Hutchings for identifying in his BELCO IRP consultation response the potential for rooftop solar in Bermuda by obtaining the total building foot print area from the Government's GIS Department. The data obtained shows that the total footprint of buildings here is approximately 1,227 acres, which dwarfs the vacant land owned by Government that is readily available for solar farm development. Nick used an assumed 20% of the building footprint as being available for rooftop solar installations, or 245 acres. Our calculations show that just half of this (or 10% of buildings' foot print) could accommodate approximately 97MW DC of high efficiency solar modules which would

produce approximately 26% of BELCO's current annual energy sales. This shows the huge potential for rooftop solar PV here and the even bigger potential is battery storage is widely adopted in future rooftop solar installations. Given this huge resource, the scarcity of land suitable for more solar farms, the Ministerial Statement and the insight provided in the Deloitte report, the RAB needs to completely change tacks on their approach to rooftop solar and embrace at least the higher rooftop solar adoption rate contained in the Etude/BE Solar proposal.

With regard to the large energy savings from energy efficiency (EE) and energy conservation (EC) contained in the Etude/BES alternative proposal, we maintain that this is really the low hanging fruit when it comes to reducing Bermuda's CO_2 emissions and high cost of foreign fuel purchases. We further believe that the projected savings from EE & EC in the Etude/BES alternative IRP are achievable with the necessary changes in Government policy. Other jurisdictions have incentivized EE and EC with good success and we will need incentives here to achieve the predicted savings. Examples of how this could be done include:

- Lowering customs duties on more efficient equipment, materials and products
- Possibly increasing the duty on less efficient items
- Banning the importation of the least efficient items such as general purpose incandescent lamps
- Providing grants to low income homes for more efficient lighting, water heating, space heating etc. or alternatively having BELCO provide these through a subsidy program
- Introducing mandatory energy audits for buildings on BELCO's commercial demand rates, possibly with mandatory display of the efficiency rating
- Introducing mandatory efficiency surveys and reporting prior to the sale or rental of any residential property

In conclusion we reiterate our support for the Etude/BE Solar Alternative IRP plan for the reasons given above. It is the plan that provides the least cost of electricity and best sustainability over the next twenty years and beyond.

Yours Sincerely,

C. E. Nash, P. Eng.

Engineering Manager

CEN/nec

Cc Nick Duffy

APPENDIX 1

Ministerial Statement, 8th December, 2017

HIT Photovoltaic Module
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MINISTRY OF
TRANSPORT & REGULATORY AFFAIRS

MINISTERIAL STATEMENT

SUBJECT: **Energy Summit and Integrated Resource Planning**

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8 December 2017

Mr. Speaker, I take this opportunity to state with clarity and certainty that this Government supports clean energy, diversification in generation, more competition where appropriate. We desire a more open discussion, which the Integrated Resource Planning process will provide, with sensitivity and understanding for the legacy issues of aging plant. Noting BELCO's challenges, we also want to assure BELCO that their role is neither underestimated nor unappreciated as we move forward with the transformation of the energy sector.

Mr. Speaker, the Integrated Resource Plan, or IRP, is a transparent regulatory process, run by the Regulatory Authority, or RA, which places the ownership for Bermuda's energy future in the hands of the public. The process is interactive and will involve several drafts, and though we cannot know the exact time by which it will be complete, we can note some statutory time frames. The RA is tasked with triggering the process with a request to BELCO, the Transmission, Distribution and Retail licensee, to submit a draft of the IRP within 90 days of that request. After the RA has reviewed that draft and it has verified that the draft meets their requirements and complies with set Government policy, the public then has at least 60 days to review and provide response and challenge if desired to that IRP. At that point there may be several iterations of revision and consultation. In recognition that the RA was keen to commence the IRP process after having issued licenses on October 28th of this year, the Department of Energy made that the focal point of the 2017 Energy Summit. The Department's goal through hosting this event was to provide key industry participants and prospective market entrants with the tools they will need to participate in the public consultation that is required around that IRP process.

Mr. Speaker, I am pleased to inform this Honourable House of the success of the Bermuda Energy Summit of 2017, held on November 16th at the Hamilton Princess Hotel. There were over 150 attendees, both local and from overseas. Keynote speaker, Dr. Devon Gardner, Programme Manager for Energy at the CARICOM Secretariat, started the day with a passionate and inspiring address imploring the community to be more active and engaged in the future of energy in Bermuda. He brought awareness to the resiliency needed in response to the increasing frequency of natural disasters as our climate changes.

Mr. Speaker, on that note, hurricane season is now officially over, but our preparations cannot cease. As a side note, the Department of Energy also participated in the BELCO Incident Command System Desktop Exercise that was conducted on Wednesday, November 29th, as my colleague, Minister Wayne Caines, discussed last week in his statement to this House. We remain committed to ensuring that Bermuda's energy supply remains secure.

Mr. Speaker, continuing on with a synopsis of the Energy Summit, the first presentation of the day was given by BELCO, on the state of affairs at the plant. Their presentation highlighted the challenges we all face with an aging plant and infrastructure. **Mr. Speaker**, the morning moved on with a discussion about IRPs and how they are conducted in other jurisdictions, with speakers from the Clinton Institute's Small Islands Energy Programme, Worldwatch International, and the Brattle Group. Rounding out the morning, was a panel discussion about the regulatory environment and role of the regulator in the electricity sector. It examined

examples of more progressive rate making in other jurisdictions, with a focus on performance-based regulation.

Mr. Speaker, the Energy Summit also included a panel on energy efficiency, specifically as it relates to the hospitality sector, with some outstanding local examples from Rosedon and Rosewood Resorts. The Regional Manager of the Caribbean Hotel Energy Efficiency Action gave some insight to how small and mid-size guest houses and hotels were able to make small improvements that amounted to substantial savings in energy costs. Mr. Speaker, it is plain that energy conservation and efficiency must play a far more prominent role in the IRP process. After all, the lower the overall energy demand, the fewer the resources needed to meet demand. Simply put, we can no longer afford to be less competitive as a jurisdiction in which to do business due to high energy costs. We can, should, and will do better.

Mr. Speaker, the Summit continued with a panel discussion on those things that were within Bermuda's reach, namely storage technologies and electric vehicles, which are no longer concept cars and bleeding-edge batteries. These are now a combination of energy management systems, utility-scale batteries, and even commercial vehicles that might well transform the transportation sector as we know it. It concluded with a panel tying together all the points of discussion.

The main take-away from this year's Energy Summit was that we, as citizens, need to be involved, engaged, and a part of every step of the IRP process. This plan will be owned not by the utility nor the regulator, but by the people of Bermuda. **Mr. Speaker**, it is worth noting that shortly after the Summit, as a matter of fact the day after, on November 17th, the RA issued a notice requesting an Integrated Resource Plan draft from BELCO in accordance with Section 40 of the Electricity Act 2016. BELCO has up to ninety (90) days to submit the IRP proposal to the RA. This means that the RA should expect to see that draft no later than mid-February. All things running smoothly, and in recognition of the iterations and revisions of an interactive process, we may see a final IRP by the end of August 2018.

Mr. Speaker, the Government is acutely aware of the need for reliable energy. As such, we understand BELCO's challenges, which are in essence, Bermuda's challenges. We believe in an equitable way forward, where we recognise that fossil fuel generation still has a prominent role to play. What must happen, though, and what our regulator is empowered to allow, is for the regulatory compact to be honored with the utility, where used and useful assets are approved to be purchased by the utility which, in turn, is allowed to recover the costs and make a reasonable profit. What this means is that any licensed entity in the electricity sector is effectively in the public service, and it has to purchase equipment and pay for personnel to operate that equipment or manage the grid. There would be no reason for any utility to ensure that its equipment was modern, efficient, safe, and reliable if it could not make a reasonable profit from it. This is the essence of the regulatory compact. The regulator examines the costs of providing service to the public, and determines what the utility may expect to be

compensated for. This concept underpins all of regulation in Bermuda. There is a duty to be fair to the rate payer, but also fair to those providing energy to the grid- both large and small energy producers, and to those providing the infrastructure to get that energy to the customers. This noted, we must simultaneously make certain that Bermudians have their say and have their preferences honored, while ensuring there is healthy and sensible competition.

Mr. Speaker, a great deal of consultation goes into every policy we create. At this point, we simply need to move forward with those policies in the foreground, guiding all that we do. We will base our actions on the firm foundation of the 2011 Energy White Paper. Its broad principles still stand, though we do need to adjust some of the sub-goals. The broad principles of achieving more energy independence through indigenous renewable resources frame what we have done and will continue to do. As we re-examine the Energy White Paper, we will ensure that those broad goals are reinforced, and that they underpin policy and practice moving forward.

With that in mind, **Mr. Speaker**, the Government expects to finalise the National Fuels later this month to be published within the first six weeks of the New Year, if not sooner. The Department of Energy published the Fuels Policy discussion paper in June 2017, after which the public's comments were reviewed and responses provided and published in August 2017. The government has taken this thoughtful input into consideration and is making final adjustments to the Policy now. The purpose of the policy is to direct the island's fuel sector towards a future that is affordable, sustainable, safe and secure, helping inform the IRP and Bermudians' involvement with the IRP process. All sectors of our economy are dependent on imported fuels, and Bermudians' concerns over the monetary cost, as well as the environmental and health costs, point to a need to chart a more sustainable course for the energy sector. This involves making a key distinction between conventional fossil fuels and low-carbon fuels, and endorsing actions that shift our use from the first to the second. (However, I should point out we have not lost sight of the significance of displacing fuels – whether low carbon or conventional fossil fuels – with clean renewable sources of energy.)

Mr. Speaker, as we progress to a 'greener' energy economy, we look forward to job creation and sustainable, sensible competition in the electricity sector. We look forward, also, to seeing the public have more interaction with the Regulatory Authority.

Mr. Speaker, this Government is committed to the transformation of the regulatory environment to one that is nimble and responsive. The RA is in the process of building capacity, ensuring that it is fit for purpose, streamlined and efficient, with the expertise it needs to be an effective and responsive multi-sector regulator. We will require a management review of the RA to ensure that this capacity gets built up in a responsible and affordable way, ensuring that the needs of the utility sectors are met. **Mr. Speaker,** the regulator is only as good as its legislation. Toward this end, we will be examining the Regulatory Authority Act 2011, along

with the Electricity Act 2016, in order to ensure the legislation allows for the agility that a dynamic energy sector requires, and that it promotes the goals of cleaner, sustainable electricity with price stability. The RA must implement policy through prudent regulation that considers the public's needs, listens and responds to all affected stakeholders, and uses progressive rate making principles to ensure that decisions made are efficient, timely, and prudent.

Mr. Speaker, we look forward to a regulator that renders decisions that implement policy, for a properly regulated and vibrant energy industry. We will also examine accountability measures, and how they are framed in legislation, to ensure that the regulator is held to the high standard of operation and decision-making that Bermuda deserves.

Mr. Speaker, one may ask why we feel green energy is so important. One could go so far as to say that Bermuda did not create the challenges of climate change, and so we should not make ourselves responsible for attempts to halt that change over time. However, we know that a greener economy has more than moral imperative behind it.

Mr. Speaker, the benefits of keeping more currency in Bermuda, circulating in our economy, as opposed to purchasing foreign oil, are numerous and cannot be ignored. Greener energy will contribute to the health and well-being of all of Bermuda, not just for those who directly participate in the energy sector. Air quality improves, just a little both locally and globally, with every solar panel on a roof. A little extra money stays in the local economy with every conservation measure. There is a job for an installer with every PV system purchased. The renewable energy sector will provide jobs for electricians, technicians, computer and software specialists, repair and maintenance specialists, salespersons, marketers, engineers, and design professionals. It all adds up, and these benefits should no longer be considered as vague externalities because there are real and tangible benefits for Bermuda. We look forward to a regulatory environment where these benefits are considered with every decision.

Mr Speaker, we will all be participants in Bermuda's energy future, whether as active investors or thought leaders or as more passive consumers. Whatever your role, this energy future is yours. Our position going forward is simple and clear: Bermuda's energy future must be owned by Bermuda, for the benefit of Bermuda- for the benefit of our economy, our environment, and our people.

Thank you, **Mr. Speaker**.

APPENDIX 2

BAE's Response to BELCO's IRP Consultation 17th August, 2018

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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

Our Ref: B-R104

POSTED ON WWW.RAB.BM

30 November 2018

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

Attention: Monique Lister, Senior Legal Advisor

Dear Sirs,

Re: Response to the Integrated Resource Plan (IRP) Alternative Proposals Consultation

This letter provides the response of Bermuda Electric Light Company Limited ("BELCO") to the Integrated Resource Plan Alternative Proposals Consultation dated 2 October 2018 (the "Second Round Consultation Document"). It represents BELCO's second set of comments in the public consultation process relating to the integrated resource plan ("IRP") proposal (the "Consultation"). The Second Round Consultation Document sought comment on the eight proposals submitted further to the publication of BELCO's IRP proposal filed with the Regulatory Authority on 15 February 2018 (the "IRP Proposal") (the "Proposals").

This letter does not comprehensively address any matters with which BELCO takes issue in the Second Round Consultation Document, and any failure to refer to particular aspects of the Second Round Consultation Document may not be construed as a waiver by BELCO of any rights or remedies available to it. In fact, 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 matter contained herein (including Appendix A), and/or otherwise to modify and amend its position as set out herein (including Appendix A).

Taking each of the Proposals in turn, in Appendix A, BELCO addresses the four questions asked in the Second Round Consultation Document. Any definition used in Appendix A but not defined therein shall carry the meaning set out in this letter.

BELCO looks forward to participating in the next phase of the IRP approval process in due course.

Yours faithfully,

Dennis Pimentel
President

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Appendix A

BCM McAlpine and Bouygues Energies and Services Proposal

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

    i. The proposal from BCM McAlpine and Bouygues Energies and Services (the "BCM Proposal") should be modified to meet the full requirements of the Electricity Act 2016 (the "EA") and the Bulk Generation Proposal Guidelines issued by the Authority (the "Authority") (the "Guidelines") by providing:

    - Information to demonstrate how its inclusion in the IRP Proposal would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial Directions ("Directions");
    - Data on capital, operating, and fuel cost of future generation;
    - Technical operating characteristics and expected retirement dates of existing generation;
    - Assumptions on future macroeconomic performance (e.g. growth of economic indices) and government policy;
    - Technical operating characteristics and availability of future generation;
    - Price for input fuels and other related commodities and import infrastructure;
    - Costs related to any required network infrastructure upgrades;
    - Sensitivity analyses of possible "high" and "low" cases along with base case scenarios for each source of uncertainty. These scenarios would be expected to be targeted at the assumptions that have the greatest impact on overall system costs. The uncertainties can include but are not limited to:
        - Production uncertainty;
        - Fuel price; and
        - Alternative capital and operating cost assumptions.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. The resource technologies and fuel types proposed for evaluation in the BCM Proposal are already included as candidate resources in the IRP Proposal but simply at a different site. The BCM Proposal provides no substantiated data or information that supports a conclusion that including any of the resource technologies operating at the Marginal Wharf site would result in an electricity supply that is more consistent with the purposes of the EA and Directions (e.g. least cost provision of electricity).

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. The technologies proposed for consideration in the BCM Proposal are in widespread use for commercial electric power generation worldwide.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. The BCM Proposal provides a high-level, qualitative assessment of the three fuel types that it proposes to evaluate: fuel oil including heavy fuel oil ("HFO")

and light fuel oil ("LFO"); gas fuel including liquefied natural gas ("LNG") and liquefied petroleum gas ("LPG"); and biomass in the form of wood pellets. Each fuel type was scored across five criteria: power plant capital expenditure; fuel-supply infrastructure capital expenditure; operational expenditure; security of supply; and environmental impact. The results show LNG and LPG to be the most attractive fuel types. This conclusion is consistent with the selection of LNG as the preferred future primary fuel type in the preferred plan set out in the IRP Proposal (the "Preferred Plan").

ii. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Bermuda Engineering Company Limited Proposal

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

i. BELCO considered wind technology in its IRP Proposal, but such technology was disqualified as a candidate resource based on LCOE screening and the need for a feasibility study inclusive of site specific ambient data to determine feasibility in Bermuda. As such, prior to including offshore wind technology, feasibility studies should be performed to determine factors such as: (i) the most suitable unit size and location; (ii) the most suitable points of interconnection to the electric grid; (iii) potential impacts on grid operation and any required solutions needed to mitigate such impacts; (iv) defined environmental impacts (including aesthetics, noise and bird kill); (v) community and stakeholder input; and (vi) comprehensive cost estimate. Prior to installing a wind farm, it would be prudent to obtain at least 24 months of onsite meteorological data collected from the appropriate height and location correlated with a reliable long-term reference. After the abovementioned studies are conducted and the data collected, the BE Solar Proposal ought to be appropriately modified.

ii. The Bermuda Engineering Company Limited (BE Solar) (the "BE Solar Proposal") provides for the use of multiple potential sites for bulk solar installation. A feasibility study should be performed to confirm the availability of these sites for such use, as typically 2.5 to 3 acres of land are required per megawatt of installed capacity and the question is whether suitable land is available in Bermuda. Similarly, a feasibility study should be performed to confirm the potential for distributed solar installations and develop a feasible implementation plan. Thereafter, the BE Solar Proposal ought to be appropriately modified.

iii. The BE Solar Proposal presents an approach to load forecasting that appears to have ignored weather normalization. This approach is not industry best practice and the BE Solar Proposal ought to be appropriately modified.

iv. There is an assumption on page 13 of the BE Solar Proposal that most solar PV in Bermuda is maintenance free. This assumption should be justified.

v. The BE Solar Proposal recommends that the plans for the utilization of LNG be abandoned and replaced with an assessment of LPG. A switch to LPG as primary fuel will require replacement of existing and under construction reciprocating units with new units designed for LPG operation, resulting in significant stranded assets costs that will negatively impact customer rates.

vi. Figure 13 on page 34 of the BE Solar Proposal depicts the graph of levelized energy costs per MWh ("LCOE") which shows an erroneous scale. It appears that the y-axis (Cost per MWh) of this graph should be scaled by a multiple of ten (x10). For instance, based on the graph of Figure 13, the LCOE of offshore wind translates to $0.017/kWh which does not appear to be a realistic figure.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. The assumptions around the offshore wind (including costs, resource availability, and performance) should be clarified and refined. Similarly, the assumptions around the increased capacity of solar PV (utility scale and distributed) should be clarified and vetted with respect to the available physical space and true land costs for additional installations). The projected impacts of energy efficiency measures ("EE") from the commercial and residential sectors should be clarified (e.g., the assumptions around adoption rates and the exact EE mechanisms). The above clarifications are required in order determine whether the BE Solar Proposal would result an electricity supply that is more consistent with the purposes of the EA and Directions.

    ii. Certain assumptions should be further clarified, including:

    - Wind resource at specific sites (including meteorological data at the relevant site and height);
    - Capital cost of solar and offshore wind;
    - Operating cost of solar and offshore wind;
    - Maintenance costs;
    - LNG infrastructure costs; and
    - Electrical interconnection costs.

    iii. With the contemplated significant shift in the generation mix, there is a complex interaction with all aspects of the system that needs to be understood to determine whether a proposal is more consistent with the purposes of the EA and Directions.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. Much of the technology proposed is evaluated or included in the IRP Proposal.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. The BE Solar Proposal makes the following assumption around the weighted average cost of capital ("WACC") for offshore wind: "While higher rates could be expected in Bermuda due to additional risks, it was assumed the Government would be motivated to reduce these through non-subsidy measures to reduce the cost of electricity."

    ii. BELCO is unsure what is meant by non-subsidy measures, but it appears as though the proponent is assuming the Government would provide loan guarantees or other support to reduce the financial risk to project developers. Providing one proponent with an advantage that others do not have appears to be contrary to a principal function of the Authority (namely, to promote competition). The WACC used should represent what project developers would need to earn to finance their projects on a stand-alone basis.

    iii. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

iv. Further clarification regarding the basis of the projection of adoption of 4,000 EV should be provided, as the explanation in the BE Solar Proposal is not clear.

v. Energy Efficiency

- Was an end-use study/survey conducted to support the assumptions for EE gains/implementation?
- It is acknowledged that replacing residential cooling systems is likely to require an incentive. Was the cost of this incentive represented in the results? Is it assumed that the Government will bear the cost of this incentive?
- The EE assumptions and impacts with respect to refrigeration are unclear. Is it assumed that an incentive would be required to achieve the higher tiered SEER rated equipment adoption?
- The appliance EE reduction of 20% appears arbitrary. How was this load reduction impact estimated?
- What cost was estimated to support BELCO's transmission loss improvements and what projects were assumed to accomplish these improvements?
- The assumptions for demand reduction (not energy) are not discussed or substantiated. Clarification around appliance/equipment coincident use with system peak and the assumed demand efficiency should be delineated.

vi. The BE Solar Proposal reports that the fossil fuel generation fleet capacity factor would be reduced to less than 25% which is low by industry standards. The capacity factor is calculated as the ratio of energy generated divided by the total possible energy generation of a resource and is a representation of the utilization of that resource. Achieving such a capacity factor will impact the dispatch, operation, and maintenance of the fossil fuel generation units which could increase the cost to operate and maintain those units. The BE Solar Proposal should provide the operating profile details of the fossil fuel generation including the number of starts, ramping rates, and operating load-levels (full load vs part load operation) as well as assumed impacts to the estimated useful life and operating and major maintenance costs as a result.

vii. Utility Scale Solar PV

- Is the capital cost of the utility scale solar of $1,300 strictly construction cost or is it to include owner (e.g., development costs and fees; land; insurance; laydown leases; easements; and other miscellaneous costs) ("Owner Costs") and other costs (e.g., legal, financing fees, commitment fees, and interest during construction) ("Other Costs")? It is on the lower end of construction cost. Is this cost on a DC or AC basis?
- An annual degradation assumption of 0.4% per year is aggressive.
- A capacity factor of 18% is reasonable.
- What is the assumed DC-AC ratio of the capacity?
- It appears that 60MW (it is unclear whether that is AC or DC) has been assumed for utility scale. Where will this be located? What assumptions

were made with respect to land availability, land cost and suitability, given that 2.5 to 3 acres of land are typically required per installed megawatt?

viii. Offshore Wind

- Is the capital cost the construction cost only, or is it inclusive of the Owner Costs and Other Costs?
- The analysis of the Bermuda wind resource should be further clarified as should the analysis in the Bren wind study.
- How close to shore are the turbines? How long is the distance of the subsea transmission interconnection cable?
- Wind resource risk is a key determinant in the cost of capital. Proponents should clarify the wind resource assumptions they are using and what evidence they have that such assumptions are consistent with financing assumptions.

ix. Battery Storage

- Is the capital cost the construction cost only or is it inclusive of the Owner Costs and Other Costs?
- What about costs for operation and maintenance, major maintenance, and renewals and replacements?
- The storage capacity of the battery energy storage system is not clearly described. Clear definition of the capacity of the battery energy storage system and the electric vehicle energy storage assumptions should be provided in terms of capacity per time (e.g., 100MW @ 1hr = 100MWh).

x. Capacity Gap analysis

- This appears to be based on a load forecast inclusive of the assumptions around EE impacts. There have been assumptions made involving governmental incentives to accomplish these EE impact estimates. This approach imbeds the risk of underestimating the capacity gap if the external incentives are not realized to achieve the estimated EE impacts.

xi. "The government works with the solar industry to minimize the soft costs of small solar systems."

- The BE Solar Proposal has made several assumptions about the Government of Bermuda intervening to provide incentives or legislation to drive the assumptions used in the analysis. This approach imbeds the risk of overestimating adoption rates of certain technologies, underestimating the true cost of certain technologies, and underestimating the capacity gap if the external incentives are not realized to achieve the estimated EE impacts. The outcomes as a result of government intervention (through subsidies, incentives, or other) should be viewed as a sensitivity rather than a base case.

Bermuda Environment Energy Solutions Group Proposal

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

   i. The Bermuda Environment Energy Solutions Group (BEESG) proposal (the "BEESG Proposal") suggests that BELCO has not commenced building its new generation plant and that its proposal should therefore be preferred. The statement is inaccurate, as BELCO has commenced construction of the North Power Station to urgently replace aging generation assets that are slated to be decommissioned. The BEESG Proposal ought to be modified to remove any inaccuracies.

   ii. The heat rate is reported on a lower heating value ("LHV") basis in the BEESG Proposal, which is in contrast with the heat rates reported on a higher heating value ("HHV") basis in the IRP Proposal. In order to make a fair and accurate comparison, the BEESG Proposal should use heat rates and fuel heat content on an HHV basis.

   iii. No estimate of cost or schedule was included with respect to electrical interconnection. Such information ought to be included.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

   i. The assumptions relating to costs, particularly power plant and interconnection costs, should be carefully reviewed to ensure that they include all costs at levels that are appropriate for development and operation of the power plant at the proposed site. The accuracy and completeness of these assumptions are key factors in determining whether the BEESG Proposal is more consistent with the purposes of the EA and Directions in terms of least-cost provision of reliable electricity.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

   i. The IRP Proposal includes the type of technology proposed in the BEESG Proposal.

   ii. The technology proposed for consideration in the BEESG Proposal is in widespread use for commercial electric power generation worldwide

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

   i. The BEESG Proposal inaccurately states that the IRP Proposal did not consider independent power producer ("IPP") generation as resource options. The IRP Proposal does consider IPP power supply alternatives.

   ii. The project cost does not appear to include Owner Costs and Other Costs.

   iii. The project cost provided does not appear to include interconnection costs.

iv. The response in connection with question 1 relating to the heat rate is repeated here. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Bermuda General Agency Proposal

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

    i. While two small scale wave energy pilot projects utilizing the offered technology are identified in Bermuda General Agency Proposal (the "BGA Proposal"), there is no indication that a full scale facility of the size proposed for Bermuda has been or is being developed anywhere. In addition to failing to meet the EA requirement that the BGA Proposal explain how it uses technology in commercial operation elsewhere, the BGA Proposal also fails to address certain items as required in the Guidelines and should be modified to provide the following information to enable evaluation:

    - Demonstration with supporting data inputs and assumptions of how the inclusion of this project would result in an electricity supply that is more consistent with the purposes of the EA and Directions;
    - Demonstration of how it uses technology that is in commercial operation in another jurisdiction;
    - Data on capital and operating costs;
    - Technical operating characteristics and plant availability;
    - Assumptions on future macroeconomic performance and government policy;
    - Costs related to network infrastructure upgrades as necessary;
    - Sensitivity analysis of possible "high" and "low" cases along with base case scenarios for each source of uncertainty, including:
        - Production uncertainty;
        - Alternative capital and operating cost assumptions for the proposed resource.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. The information requested in BELCO's response to question 1 above is required in order to evaluate whether including the BGA Proposal in the IRP Proposal would result in an electricity supply that is more consistent with the purposes of the EA and Directions.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. As noted above, the BGA Proposal does not provide information to demonstrate whether a project of similar size utilizing the technology proposed for Bermuda is in commercial operation elsewhere in the world.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. The BGA Proposal provides an estimated capacity factor of 30 – 35 percent and an estimated production cost in the range of USD 0.08 – 0.14 per kwh; it does not provide any details on the capital and operating costs and the plant reliability that support the estimates. Additional information as requested in the response to question 1 above is required in order adequately respond to this question.

ii. The BGA Proposal presents a unique technology that is fixed to the seabed and completely submerged. It is important to provide a complete discussion and information regarding the safety measures to be put in place to protect recreational and commercial vessels and the submerged equipment. It is also important to provide a full understanding of the proposed maintenance methodology including required equipment, staff, training, certifications, and safety programs and procedures. Is the operation and maintenance of the technology of a level of sophistication that local Bermuda resources can be utilized to provide maintenance services?

iii. The BGA Proposal does not discuss or provide support for the analysis/assumption of the wave energy resource. As with other naturally occurring ambient renewable energy resources (e.g., wind and solar), it is important to understand the basis for the assumption of the available resource for generating energy.

iv. Information regarding the success of prior demonstration projects and the history and current status of the build-out for commercial scale off the west coast of Africa (Ghana) should be provided to describe such things as manufacturing capacity, equipment delivery and installation success (including schedule and performance), historical defect rates, and actual performance as compared to projected performance.

v. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Brad Sorensen and Arpheion Inc. Proposal

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

    i. The proposal submitted by Brad Sorensen and Arpheion Inc. (the "Sorensen Proposal") fails to adequately address certain items as required in the EA and the Guidelines and should be modified to provide the following information:

    - Demonstration with supporting data inputs and assumptions of how the inclusion of this project would result in an electricity supply that is more consistent with the purposes of the EA and Directions;
    - Demonstration of how the Sorensen Proposal uses technology that is in commercial operation in another jurisdiction;
    - Data on capital and operating costs;
    - Technical operating characteristics and plant availability;
    - Assumptions on future macroeconomic performance and government policy;
    - Costs related to network infrastructure upgrades as necessary;
    - Sensitivity analysis of possible "high" and "low" cases along with base case scenarios for each source of uncertainty, including:
        - Production uncertainty; and
        - Alternative capital and operating cost assumptions for the proposed resource.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. The information requested in the response to question 1 above is required in order to evaluate whether including the Sorensen Proposal in the IRP Proposal would result in an electricity supply that is more consistent with the purposes of the EA and Directions.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. The Sorensen Proposal does not adequately describe the technology upon which it is based, nor does it provide information to demonstrate whether a project of similar size utilizing the proposed technology is in commercial operation elsewhere in the world.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

    ii. The following statements made in the Sorensen Proposal are in direct opposition to a key requirement of the EA which stipulates that the proposal must demonstrate how the proposed technology is in commercial operation in another jurisdiction:

    - "….is completely new technology"
    - "Bermuda is a good place to start this new technology…"

- “…..has no history, because it is new”

Enviva and Albioma Proposal

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

    i. The Enviva Proposal appears to calculate a cost savings with respect to CO2 emissions which is treated as a sensitivity in the IRP Proposal. To make a direct comparison between results, the analysis of the Enviva Proposal should exclude CO2 costs from the base case analysis.

    ii. The Enviva Proposal is not clear with respect to the debt service calculation which appears to increase over time. This should be clarified.

    iii. There is no discussion of major maintenance costs and it appears that these costs are omitted from the Enviva Proposal. Such a discussion ought to be added.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. The assumptions relating to costs, particularly power plant and interconnection and fuel costs, should be reviewed carefully to ensure that they include all applicable costs at levels that are appropriate for development and operation of the power plant at the proposed site. The credibility and completeness of these assumptions are key factors in determining whether the Enviva Proposal is more consistent with the purposes of the EA and Ministerial directions in terms of least-cost provision of reliable electricity.

    ii. The Enviva Proposal appears to be proposing a negotiated power purchase agreement ("PPA") between BELCO and Enviva-Albioma for the biomass fuel supply and biomass power plant, eliminating the competitive procurement approach outlined in the IRP Proposal.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. The technologies and the unit size proposed in the Enviva Proposal are in wide spread use in the electric utility industry worldwide.

    ii. The source and supply chain and transportation logistics of the biomass fuel should be further clarified. In particular, clarification is required around the assumptions regarding local landing, storage (including space and humidity control requirements), and handling in Bermuda and the permitting process anticipated regarding the mass import of vegetation.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. Under "Land Costs" on page 5 of the Enviva Proposal it is indicated the IRP Proposal did not include land costs. However, for generation planned to be added by BELCO, in its capacity as a bulk generation licensee, there are no incremental land costs, as such costs are already included in BELCO's asset base. The IRP Proposal included IPP sensitivities which assumed a land cost of $5,000 per acre per annum.

ii. A potential site for the biomass facility does not appear to be identified in the Enviva Proposal.

iii. Under "Interconnection costs" on page 5 of the Enviva Proposal it is indicated that the IRP Proposal did not include transmission interconnection costs. However, the IRP Proposal does include interconnection costs which were based on estimates prepared by BELCO.

iv. Under "Inflation" on page 6 of the Enviva Proposal it is indicated that the assumption of flat gross domestic product ("GDP") is unreasonable. No support for this claim is provided.

v. On page 7 of the Enviva Proposal it is indicated that the discount rate used by BELCO for LCOE calculation is not clearly defined. The LCOE discount rate assumed to be (8%) is confirmed to be the rate used in the IRP Proposal LCOE analysis.

vi. It was explained that scenario B added costs which were not included in scenario A, yet scenario B LCOE is less than scenario A. This does not immediately make sense but could be a result of the lower rate of inflation assumed in scenario B. The difference in inputs between the two scenarios of the Enviva Proposal should be clarified.

vii. It is not clear how the grid interconnection, land development, and permit costs are allocated in scenario B. Details around how these costs are assigned in the Enviva Proposal should be provided.

viii. The Enviva Proposal recommends that an independent assessment of the GDP forecast be commissioned.

ix. The performance characteristics presented should be carefully evaluated and confirmed for:

- Heat rate;
- Fixed operation and maintenance ("O&M") costs (also confirm what this covers);
- Variable O&M costs (also confirm what this covers); and
- Biomass fuel cost and heat content.

x. The capital costs presented in the Enviva Proposal should be carefully evaluated. The proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Offshore Utilities, LLC Proposal

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

    i. While the technology proposed in the proposal submitted by Offshore Utilities, LLC (the "Offshore Utilities Proposal") is in commercial operation in other jurisdictions, the Offshore Utilities Proposal fails to adequately address certain items as required in the EA and the Guidelines and should be modified to provide the following:

    - Demonstration with supporting data inputs and assumptions of how the inclusion of this proposal would result in an electricity supply that is more consistent with the purposes of the EA and Directions;
    - Data on capital and operating costs;
    - Technical operating characteristics and plant availability;
    - Assumptions on future macroeconomic performance and government policy;
    - Costs related to network infrastructure upgrades as necessary;
    - Sensitivity analysis of possible "high" and "low" cases along with base case scenarios for each source of uncertainty, including:
        - Production uncertainty;
        - Alternative capital and operating cost assumptions for the proposed resource.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

    i. As is proposed in the IRP Proposal, the Offshore Utilities Proposal similarly offers LNG as the primary fuel with power generating equipment supplied by GE Power Systems. The main difference between the two proposals is the location of the Offshore Utilities Proposal LNG storage and regasification facilities on-board a permanently moored ship located offshore compared to the land-based location contemplated in the IRP Proposal. We anticipate that the offshore location will introduce adverse weather related risks that are likely to restrict the operation of the facility during certain weather conditions.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

    i. The Offshore Utilities Proposal does not adequately describe the technology upon which the proposal is based, nor does it provide information to demonstrate whether a project of similar size utilizing the proposed technology is in commercial operation elsewhere in the world.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

    i. The Offshore Utilities Proposal does not provide capital and operating cost assumptions to support the estimated price range provided therein for power and omits certain key technical information such as power generation technology, size of generating units, plant efficiency and plant reliability.

    ii. The Offshore Utilities Proposal indicates the offshore power plant has fewer permitting issues. This assertion should be substantiated.

iii. The Offshore Utilities Proposal indicates the proposed offshore power plant will comply with all benchmarked environmental regulations. This assertion should be substantiated.

iv. The Offshore Utilities Proposal indicates that the proposed offshore power plant does not impose additional burden on existing electric infrastructure. This assertion should be substantiated.

v. Based on the design and capacity of the existing electric network at the proposed point of connection to the grid, BELCO anticipates there would be need for network upgrades and reinforcement in order to integrate 100 MW of generation. A transmission and interconnection study should be considered to determine the impact and requirements of this capacity connected at this location.

vi. The Offshore Utilities Proposal puts forth 100 MW of generation which is close to the total Bermuda system peak demand. There is no discussion of early retirement of the existing fleet or the economic impact analysis of stranded generation asset costs that will negatively impact customer rates. There is also no discussion regarding the risk and requirements of keeping such a large portion of the generation fleet floating offshore.

vii. The Offshore Utilities Proposal lacks discussion regarding the safety programs and procedures required to operate an offshore floating power plant. Additional information regarding how major oceanic storms impact the system or their potential to cause a disruption in power delivery should be provided.

viii. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Sol Proposal

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

   i. The proposal submitted by Sol (the "Sol Proposal") should be modified to incorporate a competitive procurement approach utilizing best industry practices for IPPs' contracts for fuel and power generation services. The Sol Proposal is drafted as an engineering, procurement and construction proposal for a negotiated contract.

2. ***Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?***

   i. The recommended fuel supply and generating resources (LNG) and reciprocating engine generators that comprise the Sol Proposal are congruent with fuel supply and resources that are included as a part of the Preferred Plan.

   ii. The Sol Proposal is proposing early retirement of selected existing generating resources and replacement by new generating resources rather than conversion of existing resources to dual fuel operation. To determine whether the Sol Proposal is more consistent with the purposes of the EA and Directions, it is necessary to conduct an assessment of the costs of the Sol Proposal vis-à-vis conversion of BELCO's plant and the negative impact of stranded asset costs on rates.

   iii. The Sol Proposal appears to be proposing a negotiated PPA for the LNG and power plant infrastructure, eliminating the competitive procurement approach outlined in the IRP Proposal.

3. ***Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?***

   i. While the Sol Proposal does not specify the major generating equipment manufacturer, the technology options are stated as reciprocating internal combustion engine generators and combined cycle combustion turbine generators. These technologies in the unit size proposed within the Sol Proposal are in widespread use in the electric utility industry worldwide.

4. ***Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?***

   i. The source of modeling assumptions should be identified and tied to a particular identified generating unit.

   ii. The cost of any electric system upgrade necessary to facilitate the electric interconnection should be identified and broken out separately.

   iii. The Sol Proposal states that in connection with the proposed LNG Terminal at Ferry Reach: "Recovery of Sol's investment would be over the life of the FR LNG Terminal and would not be recovered over one year as shown in BELCO's IRP". The underlined portion of the statement is untrue as the production cost modeling results as shown in the appendices of the IRP Proposal show debt service for the LNG infrastructure extending through the study period. The

spike in the all-in $/MWh natural gas curve provided in Figure 2.2 in the IRP Proposal occurs as a result of the cost to convert certain existing generating units from fuel oil to dual fuel operation treated as a cash outlay, adding debt service of new generation, and adding debt service of the LNG infrastructure in 2022.

iv. The Sol Proposal should clarify the delivery point for the gas pricing provided in Figure 1 to be either (i) the proposed Ferry Reach Power Plant or (ii) the existing BELCO central plant site.

v. The Sol Proposal should provide fuel pricing for delivery to the site for which pricing is missing from Figure 1, including a breakout of the pipeline delivery cost from the proposed Ferry Reach LNG terminal to BELCO's central plant site.

vi. The Sol Proposal does not provide any production cost or LCOE analysis to demonstrate the economic performance of its proposal compared to the IRP Proposal.

vii. The Sol Proposal does not indicate the assumptions around capacity factor and or the approximate fuel storage capacity in terms of operational supply (i.e., 20,000m3 is a quantity sufficient for X days/weeks at a capacity factor of X).

viii. The Sol Proposal should clarify the target cost of electricity to allow for proper comparison and inclusion in the IRP Proposal.

ix. To the extent relevant, the proponent ought to address its cost of capital and provide evidence that such cost of capital is achievable in the market place.

Chris Worboys
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TR7 1TY
United Kingdom

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

30 November 2018

Subject: Response to Consultation Document: Comments on IRP Bulk Generation Proposals

Dear Ms Lister,

I am writing to submit a response to the Regulatory Authority of Bermuda's consultation on Bermuda's IRP Bulk Generation Proposals. This response considers, for each Alternative Proposal, the questions issued by the Regulatory Authority of Bermuda (RAB) in their consultation document:

1. Are there any provisions that should be modified?
2. Would including the Alternative Proposal in the IRP provide an electricity supply more consistent with the purposes of the Electricity Act and ministerial directions for the least-cost provision of reliable electricity?
3. Do you have comments on the proposed technologies? Are they in commercial use in other jurisdictions?
4. Do you have views on the assumptions, methodologies and conclusions?

As you are no doubt aware, I worked as part of the team at Etude Consulting Ltd. to create the alternative proposal submitted by Bermuda Engineering Company Ltd. (BE Solar), which has become known as the Bermuda Better Energy Plan (BBEP). I submit this response in an effort to further explain and support our work, and to provide objective feedback on all of the alternative proposals.

This is based on the knowledge we have accumulated over several months of reviewing BELCO's IRP and developing the BBEP IRP, and also on past work in Bermuda's energy sector going back a decade, including several years as a Policy Analyst for the Department of Energy.

Thank you for your time in reviewing my response, I look forward to learning of the final outcome of the IRP consultation process.

Yours sincerely,

Chris Worboys

1.0 General Considerations Applicable to all Alternative Proposals

1.1 Cost of Electricity

The cost of electricity is one of the most important criteria for evaluating IRPs and proposals for bulk generation, however cost calculations are very easily manipulated. It is therefore vital that any IRP or alternative proposal clearly demonstrates the assumptions that have been used to calculate electricity costs.

After reviewing BELCO's IRP, we realised it had either marginalised or completely ruled out some of Bermuda's most attractive generation technologies based on a levelized cost of energy analysis that we felt used questionable assumptions. We therefore performed our own detailed levelized cost of energy analyses, developed specifically for Bermuda. The results of these calculations are shown in Figure 1. We are happy to explain these calculations in more detail and to adjust them if this would be of use to the RAB.

These calculations are both robust and conservative. They indicate clearly that solar photovoltaic and offshore wind technologies are the least-cost sources of electricity available to Bermuda. The accuracy of these calculations is confirmed by the airport solar project, which is contracted to sell power for 10.3¢/kWh, a price that is almost identical to our calculations for 2018.

Fuel oil and LNG represent the most expensive sources of electricity, based on conservative US Energy Information Administration projections for fuel prices over the IRP study period. Our opinion is that actual future costs are likely to be higher. The cost of electricity generated from LNG could be lower relative to fuel oil, however this would depend on the approach to shipping, regasification and storage of the LNG, in addition to future fuel cost trends. Historically, the costs of both fuel oil and LNG have been very volatile.

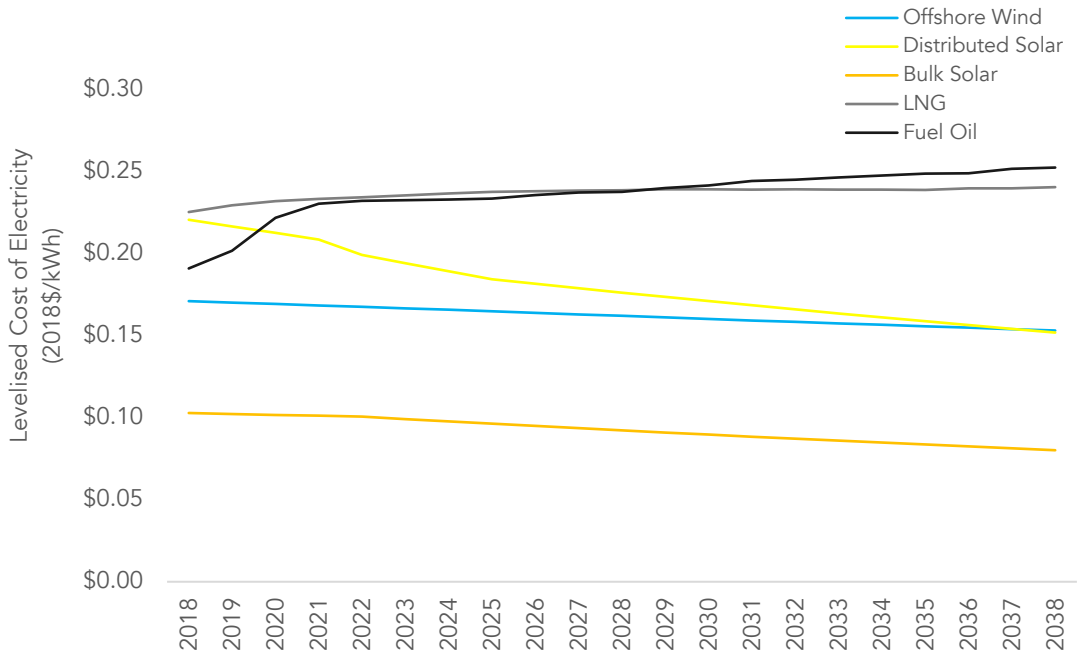


Figure 1 – Levelised energy cost calculations for Bermuda

To determine the average wholesale cost of electricity from an electricity supply that included large components of intermittent renewable energy it was necessary to include the costs of

both energy storage and backup fossil fuel generation. We achieved this through hourly dispatch modelling using Bermuda's wind and solar resource data. This modelling accounted for the costs of battery storage and fossil fuel plant operating at reduced capacity factors[1].

The BBEP is very conservative in how the costs of fossil fuel backup are calculated, for example we assumed that capital costs are being repaid for all backup fossil fuel generation equipment throughout the duration of the plan. In reality, a significant quantity of BELCO's generators are likely to have been fully depreciated and can provide cheaper backup power than we have assumed.

Another way we have been conservative is in assessing the lifetime of fossil fuel generators and how this affects the cost of power. The lifetime of the new MAN 51/60 generators that will be deployed in the North Power Station is 200,000 hours. These are likely to run for around 6,000-7,000 hours a year in BELCO's IRP. Based on this, they may be expected to have a lifetime of around 30 years. In the optimum renewables scenario of the BBEP, they are required for less than 2,000 hours a year by 2038 so their lifetime could almost treble, providing many decades of service where the capital costs had been completely paid off.

The results of the cost modelling show that in 2022, the first year that the LNG plant or offshore wind farm is forecast to be operational, the average cost of electricity in the optimum renewables scenario of the BBEP, including all these backup costs, using conservative assumptions, was almost identical to an LNG dominated generation mix based on BELCO's IRP.

The clear advantage of the generation mix proposed in the BBEP is the reduction in exposure to fossil fuel price increases and volatility, and the reduction in Bermuda's trade deficit. In the optimum renewables scenario of the BBEP, fossil fuel use has reduced 80% by 2038. The $85 million sent out of Bermuda's economy to purchase fuel by BELCO in 2017 would have been only $17 million under the generation mix proposed in the BBEP.

While investment in renewable energy technologies inevitably sends some money offshore, our recent analysis while in Bermuda revealed 70% of the retail cost of solar photovoltaic systems stays in Bermuda, mainly covering labour costs associated with sales, installation and permitting. The net flow of money offshore in the BBEP IRP would be greatly reduced.

1.2 Carbon Dioxide Emissions

BELCO's original IRP used qualitative analyses of the environmental impact of different generation technologies. We felt it was important to use quantitative analyses to provide a clearer measure of environmental performance. Figure 2 shows the results of our analysis, and provides international context. It shows the emissions that would arise under BELCO's IRP and the BBEP IRP using the United Kingdom for comparison as an example of a country that has committed to decarbonising its electricity supply.

It is clear from this comparison, that BELCO's IRP would take Bermuda from a level of emissions not seen in the UK since the 1980's to a mid-1990's level. By international standards, Bermuda would be over 40 years behind. The BBEP IRP would enable Bermuda to achieve a level of emissions equivalent to the UK's in 2016 by 2038, still 20 years behind but well on track to long-term decarbonisation.

[1] As the cost of fossil fuel generation is dominated by fuel costs, capital costs account for just 24% (fuel oil) - 33% (LNG) even at a 24% capacity factor.

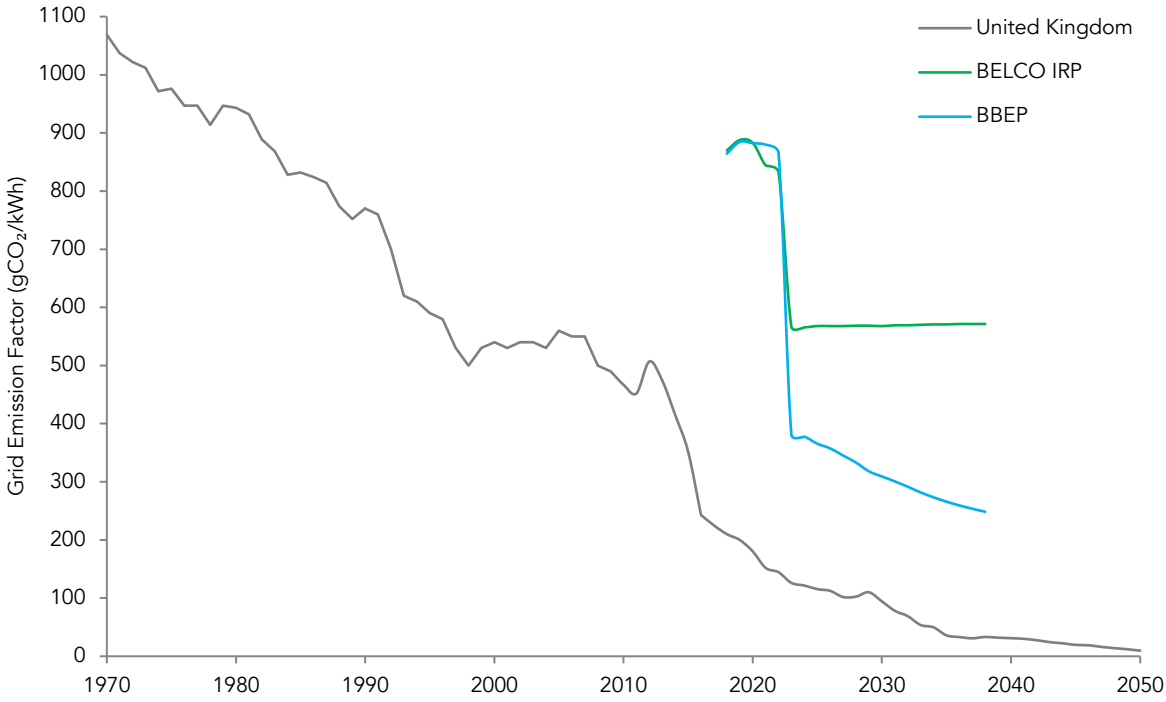


Figure 2 – Carbon dioxide emissions of electricity in BELCO's IRP and the BBEP compared to the United Kingdom

It is worth mentioning that carbon dioxide and other emissions produced from biomass combustion are high. It should not be considered as a zero or even low carbon fuel without detailed analyses of the supply chain, and suitable fuel supply contracts that guarantee the source is sustainable. It should also be considered that while combustion of biomass can in some circumstances be almost carbon-neutral, unburnt woody biomass acts as a store of carbon, and is therefore carbon negative. This is a better net carbon position than even carbon neutrality, if it can be achieved.

The enthusiastic endorsement of biomass for electricity generation by several governments occurred some time ago and more recent research is calling into question whether this is the most appropriate use. Respected bodies such as Chatham House[2] and the UK Committee on Climate Change[3] are increasingly of the opinion that the best use for woody biomass in tackling climate change is to lock up atmospheric carbon by using it as a construction material in buildings or other forms of carbon capture, rather than combustion, which re-releases carbon to the atmosphere. Many sustainability professionals expect only limited use of biomass for power generation in the future.

1.3 Security of Supply

There are many aspects to security of supply, varying from day to day mechanical reliability, storm survivability of generation plant, storm interference with fossil fuel supplies and geopolitical events. Historically, groups opposed to renewable energy have mistakenly attempted to claim that wind and solar technologies represent a risk to supply due to their intermittency. There is clearly no technical basis for these concerns as any electricity generation mix with a component of intermittent energy is designed to cater for this through

[2] Chatham House (2017) *Woody Biomass for Power and Heat*
[3] Committee on Climate Change (2018) *Biomass in a low-carbon Economy*

demand response, energy storage and fossil fuel generation. Leading economies all over the world rely daily on substantial proportions of their electricity being provided by intermittent renewable energy and small islands are already using wind and solar with excellent results.

There has also been much focus on the risk of storms to offshore wind turbines. Evaluation of risk to electricity generation plant should be evidence based. This can be done through using forecast models of wind, wave and rainfall exposure to assess the probability of certain conditions occurring during the operational lifetime of a generator. This analysis informs engineering and insurance decisions, and the balance of cost between the two. In the case of offshore wind and large scale solar, there is a natural incentive for such work to take place before a project would receive financing. This would normally be done by a project developer with experience in the relevant technology, rather than at an IRP stage.

Our justification for including offshore wind in the BBEP IRP is that existing turbines are rated for up to 156 mph, which is stronger than any wind speed ever recorded in Bermuda. Turbines shut down in high wind speeds and pitch their blades into the wind to prevent damage. The top three manufacturers either already offer or are developing T-Class turbines designed to withstand typhoons, which have been described by their manufacturers as being suitable for hurricane prone areas. We have spoken with a UK based offshore wind expert who is involved in a 3GW offshore wind project in Taiwan where T-Class turbines are being used. She has specifically advised us that *'with careful planning, site assessment and turbine selection risks from extreme weather are unlikely to be large'*.

Based on the above we feel that offshore wind is a suitable candidate technology for inclusion in the BBEP IRP at this stage. We assume that detailed studies into storm survivability would be carried out by project developers prior to wind being deployed. In the BBEP, sufficient fossil fuel generation capacity would be maintained to meet the output of almost the entire wind farm in any case (all costs of this have been accounted for), so in the event a turbine was damaged, Bermuda would just have to go back to using more expensive fossil fuel based generation until it was repaired.

1.4 Flexibility of Supply

The energy industry has become one of the fastest changing industrial sectors in recent times. Over the past two decades, many countries have changed their energy policy positions multiple times as the technical and economic viability of different technologies has developed. Not just in Bermuda, but globally, it has been a very uncertain time and a difficult environment in which to perform generation mix planning. Just five years ago, a supply provided predominantly by LNG as proposed by BELCO may have made financial sense, yet today there is clear evidence this is no longer the case.

Perhaps the clearest message that can be taken from recent history is the need to base present decisions on the future and not on the past. Modern generation mix planning must consider likely cost and technological development pathways that are expected to occur throughout the study period. While fuel costs may be volatile and difficult to predict, cost reduction curves for technologies such as solar photovoltaics, offshore wind turbines and battery storage are not. They are predictable and their costs are forecast to continue to reduce while their efficiency is forecast to improve.

This is not a reason to wait to deploy these technologies; they are already cheaper today so there is a significant cost every year we delay and the improvements in efficiency are gradual. We should however plan to take full advantage of these cost reductions by building in

flexibility in our future supply options. LNG infrastructure designed to supply 12mmcfd looks very different to infrastructure designed to supply the 4mmcfd demand forecast in the BBEP IRP. We need to identify a low-regrets generation mix pathway that allows Bermuda to take full advantage of the latest technological developments without the risk of stranding assets.

The action plan outlined in the BBEP IRP represents such an option. It uses the workhorses of modern renewable energy technology, solar and wind, to provide 64% of Bermuda's electricity by 2038, while working with fuel oil, LNG or LPG as fossil fuel backup. The BBEP IRP could be integrated with elements from two or even three of the other alternative proposals to create a diverse generation mix that can be adapted to provide flexibility over time. This is why I believe it is the best option for Bermuda.

1.5 Electricity Grid

The electricity grid is a fundamental enabling technology for all electricity generation technologies, yet very little focus has been placed on its development in the IRP process. BELCO are currently proposing a $120 million round of upgrades to the grid, yet clearly Bermuda has not yet decided what the generation mix will look like or where key generation technologies will be located.

How can funds be efficiently allocated to grid upgrades when we don't know where the electricity will be flowing from? The marginal costs of performing these upgrades in a manner that accommodates a significant proportion of clean affordable renewable electricity may actually be quite modest, however this is less likely if these upgrades take place based on a centralised generation model. This could result in excess capacity in some parts of the network, and insufficient capacity in others. The end result would be higher costs for the consumer.

1.6 Moving forward

Based on what we have learned during our work on the BBEP IRP, I respectfully submit the following suggestions for further work that appears to be critical to progressing Bermuda's generation mix planning and deployment. Some fall outside of the RAB's jurisdiction:

- Modifying the IRP process in the Electricity Act to better serve the public interest and account for the imbalance in financial and human resources between BELCO and other stakeholders.
- Commissioning an independent study on the ability of the electricity grid to accommodate large proportions of renewable energy, and costs of upgrade options.
- Updating cost modelling to account for lower backup costs of fully depreciated fossil fuel generators, and reduced balancing costs from demand response.
- Detailed technical feasibility study into the potential for offshore wind energy, resulting in allocation of seabed that can be used for offshore wind development, providing environmental impact and other criteria are met.
- Confirming the real-world cost and viability of offshore wind energy through an initial competitive bidding process.
- Gathering investment grade offshore wind resource data as soon as possible, which could be sold to potential wind developers.
- Reducing permitting costs for distributed solar by consolidating and streamlining planning and interconnection processes.
- A programme to aggressively deploy distributed solar systems across public buildings, which could achieve significant economies of scale.

2.0 Views on the Alternative Proposals

2.1 BCM McAlpine & Bouygues Energies & Services

This is a proposal for a new power plant on a site consisting of grass, scrub and woodland at Marginal Wharf. It is proposed that the power plant could operate using fuel oil, natural gas or biomass. Fuel oil and LNG could be provided by a pipeline from the oil docks, while biomass could be delivered from the adjacent wharf. A comparison of the technologies is provided using a scale of one to five. No explanation is provided as to how the scores are calculated, therefore this method does not permit meaningful comparison.

The chosen location appears to have some logistical advantages for fuel delivery over the central plant location proposed in BELCO's IRP. It would also be further away from populated areas reducing the impact of noise and airborne pollution on local residents. It is difficult however to support the use of what appears to be a greenfield site when a large brownfield site is available nearby.

The elevation of the site is also a concern, with the Bermuda National Trust's report[4] on the effect of sea level rise in Bermuda forecasting this area will be one of the first to be inundated. While a two-metre increase in sea levels represents the higher end of forecasts over the next eighty years, the relative level of risk for this site from more modest sea level rise in combination with storm surge appears to be a more valid concern.

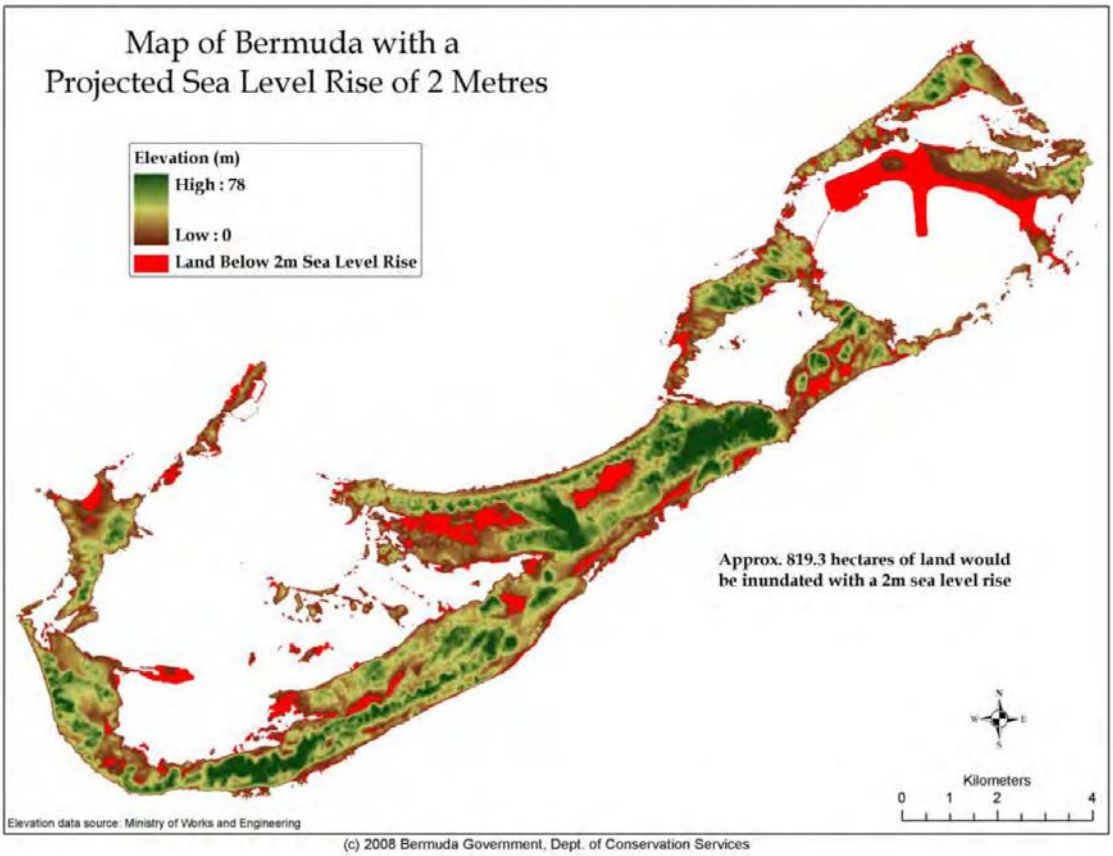


Figure 3 – Areas impacted by sea level rise (©BNT 2010)

[4] Bermuda National Trust (2010) *The Impact of Climate Change on Bermuda*

This proposal could in principle satisfy one requirement of the Electricity Act, in providing a reliable source of electricity, however its degree of compliance with other criteria would depend on the specific fuel choice and measures to mitigate risk from projected sea level rise. As discussed in Section 1, fuel oil and LNG do not offer least-cost options and their costs are volatile. They also do not put Bermuda on track to achieve meaningful long-term reductions in carbon dioxide emissions. While the costs of biomass may be more stable, it should not be automatically regarded as a low carbon fuel. Based on these considerations, this proposal is not considered an optimal solution in its current form.

2.2 Bermuda Engineering Company Limited (BE Solar)

Our team felt that BELCO's original IRP was not as compliant with the Electricity Act as should be possible given current generation technologies and Bermuda's energy resources. As a result we felt it was necessary to create a complete alternative IRP, the BBEP. It was developed from the outset to provide Bermuda with an IRP that was compliant with the Electricity Act. We feel this objective has been achieved, as outlined in the comparison below.

Purpose of the Electricity Act	How the Bermuda Better Energy Plan delivers:
1. Ensure the adequacy, safety, sustainability and reliability of electricity supply in Bermuda	✓ Solar and wind energy combined with energy storage and LPG offer a safe, sustainable and reliable solution
2. Encourage electricity conservation and the efficient use of electricity	✓ Includes robust estimates of the potential for energy conservation and efficiency. ✓ Electricity use reduces by 30%
3. Promote the use of cleaner energy sources and technologies	✓ Proposes 64% of electricity being provided by renewable energy from the sun and wind by 2038
4. Provide non-discriminatory interconnection to transmission and distribution systems	✓ Proposes ending discriminatory charges for solar systems connected to the grid
5. Protect the interests of end-users with respect to prices and affordability, and the adequacy, reliability and quality of electricity	✓ Uses the least-cost sources of energy: solar and wind ✓ Determines that small solar systems offer lower cost electricity than buying from the grid ✓ Recognises the cost of electricity from solar and wind is low, is stable and can be set by Bermuda ✓ Acknowledges that the cost of wind and solar is forecast to reduce
6. Promote economic efficiency and sustainability in the generation, transmission, distribution and sale of electricity	✓ Recognises that Bermuda has excellent solar and wind resources. Using them could keep millions of dollars a year in the local economy

This proposal also supports Ministerial directives for least-cost provision of energy, with solar and offshore wind not only offering the least-cost solutions today, but offering long-term price stability for decades.

The proposal uses solar photovoltaic, offshore wind, battery storage and conventional fossil fuel technologies to create a balanced, modern electricity generation system. These are all mature technologies. Not only are they commercially available in other jurisdictions, wind and solar now account for the vast majority of investment in global renewable electricity

generation equipment, which was $265 billion in 2017, compared to just $103 billion investment in fossil fuels.

Detailed assumptions for this proposal are presented in Appendix C of the BBEP IRP, with many being taken directly from BELCO's IRP. High cost and low-cost scenarios were used to test sensitivities for each generation technology, providing confidence in the results. Calculations are described in detail, including their sensitivity to various key assumptions. The overall methodology follows best practices in IRP development.

Limitations of the methodology include the need to include the cost of grid integration. This was not assessed in detail as it would have formed a significant additional body of work, and much of the data is held by BELCO. The sensitivity of electricity costs to capital investments in grid upgrades was explored and the impact found to be low due to the long lifetime and low operational costs of grid infrastructure. If we are provided with cost estimates, we could easily integrate these into our modelling. Other limitations include excessively conservative assumptions that were made regarding the cost of providing fossil fuel backup, which did not account for the lower costs incurred by providing backup from fully depreciated generation plant, and conservative assumptions regarding the cost of energy storage, which did not include the lowest cost option of using demand response.

Based on these considerations, this proposal is the most compliant with the Electricity Act. It provides Bermuda with a flexible forward-thinking IRP that is complementary to several of the other proposals. A small-scale LNG generation plant could be developed at St. Davids or the FR facility to provide backup generation for intermittent renewables. A wave energy farm could be deployed to work with offshore wind and solar technologies.

A key insight from the modelling is that going half way between BELCO's IRP and this proposal is nonsensical – renewables are cheaper and their costs are falling, so it makes sense to plan to incorporate as much renewable energy as possible into Bermuda's future electricity generation mix, and to assume that it will be desirable to continue to do so. We expect the amounts of renewable energy proposed in the BBEP IRP will seem conservative within another few years.

2.3 Bermuda Environment Energy Solutions Group Consortium

This is a similar proposal to that submitted by BCM McAlpine & Bouygues Energies & Services. It proposes construction of a 56MW dual fuel LNG/fuel oil generation plant at the same location. Advantages are similar for both proposals, in that generation would be further from populated areas than at BELCO's Pembroke site and LNG produces fewer emissions than fuel oil.

An interesting and valuable aspect of this proposal is for a smaller scale LNG receiving terminal at Ship's Wharf, or the use of LPG. Either option could reduce infrastructure costs and financial commitment to LNG as a fuel option offering a lower regrets option relative to the $120 million capital investment proposed in BELCO's original IRP to receive and transport LNG to BELCO's Pembroke site.

Compliance with the Electricity Act is similar to the other proposal, in that this proposal could provide reliable electricity, however this would be at a financial and environmental cost premium to the use of renewable energy technologies. The reduced capital investment in LNG infrastructure is an attractive proposition as this provides greater flexibility in Bermuda's future electricity generation mix. Based on these considerations, this proposal is considered

more desirable than the BCM McAlpine & Bouygues Energies & Services proposal based on the assumption that either LNG is delivered to the Ship's Wharf site at smaller volumes or LPG is used instead.

2.4 Bermuda General Agency Ltd.

This proposal is for a 20MW wave energy system using Seabased wave energy generators that could provide around 9% of Bermuda's electricity at a proposed cost of 8-142¢ /kWh. A recent journal article[5] confirms that Seabased's commercial progress is in line with experienced wave energy companies such as CETO and Pelamis. The technology appears to offer compliance with several of the requirements of the Electricity Act in that it could provide clean sustainable energy at competitive prices.

Seabased's technology appears to be promising enough to merit further investigation and consideration in future IRP's. Its inclusion in the present IRP would need to be determined based on more careful investigation of the current status of commercial trials, as the technology appears to be in late stages of pilot projects and possibly early stages of the first commercial deployment, so may not yet meet the RAB's requirement for commercial operation in other jurisdictions. The assumptions and methodology used for the levelised energy cost calculations should also be independently validated.

Based on these considerations, this proposal offers a valuable contribution to the IRP consultation as it demonstrates the risks to Bermuda from over-committing to fossil fuel-based infrastructure in an environment of rapidly falling renewable energy costs and technological development. This technology could easily form part of a portfolio of renewable energy generation technologies in a more progressive IRP such as that proposed in the BBEP IRP.

2.5 Brad Sorenson and Arpheion Inc.

This proposal appears to be for electricity and water generation through the combustion of hydrogen gas. The source of the hydrogen gas is not clearly identified, however large quantities would need to either be shipped to Bermuda or created locally through electrolysis and then stored. Both transport and storage of hydrogen can present logistical issues that would need to be investigated.

The majority of hydrogen is currently produced using fossil fuels through steam reformation, which is a carbon intensive process. To achieve a net environmental advantage the hydrogen would need to be produced from clean energy sources using electrolysis. Significant losses in primary energy would arise from this process, and from the subsequent storage and transport of the hydrogen. This would likely lead to a relatively high cost of electricity. The Waterrocket technology appears to be at a prototype stage, and therefore may not meet the RAB's requirement for use of technology in commercial use in other jurisdictions.

Based on these considerations, this proposal does not appear to warrant inclusion in the IRP.

2.6 Enviva and Albioma

This proposal is for three 17MW biomass fuelled generators operated by Albioma, with one month's supply of biomass fuel, provided by Enviva, stored on site. The proposal suggests electricity could be generated for a cost of 14-22¢/kWh. It is not clear if this includes any duty

[5] Rusu E & Onea F (2018) *A review of the technologies for wave energy extraction.* Clean Energy Vol 2, No 1, 10-19

on the imported biomass fuel. The technology appears to offer compliance with at least two of the requirements of the Electricity Act in that it could provide reliable energy at a competitive price.

Key concerns with this proposal are fuel handling logistics, reliability of future fuel cost projections and the environmental sustainability of using biomass as a fuel, as discussed in Section 1. A further concern is that the use of biomass is not necessarily compatible with an electricity grid with high penetrations of intermittent renewable energy, which could ultimately provide more stable electricity costs and greater reductions in emissions of both carbon dioxide and pollutants that are harmful to human health.

Based on these considerations, the generation of electricity from biomass may offer a cost competitive alternative to fossil fuel generation, but should not be assumed to be an environmentally sustainable solution. It may not be as well suited to longer-term goals to adopt zero emission technologies such as solar PV, offshore wind or potentially wave farms. Smaller distributed biomass generators operating on a combined heat and power principle using locally sourced biomass may offer a solution more compliant with the Electricity Act.

2.7 Offshore Utilities

This proposal is for a floating LNG regasification, storage and electricity generation plant at a claimed cost of 9-13¢/kWh. As with the other proposals for LNG powered generation, this could offer a modest reduction in carbon dioxide emissions and a significant improvement in air quality. The proposed cost of electricity is very low, however as no detailed calculations or assumptions are provided it is not possible to verify the accuracy of these estimates.

The proposal is somewhat compliant with the Electricity Act in that it suggests electricity could be provided at a very competitive cost, however the electricity would not be clean or sustainable. Reliability in terms of storm survivability and signing off the majority of Bermuda's electricity production to a different provider are key concerns, as are the ability of BELCO to adjust to a role of grid operator only. The visual and environmental impact of a permanently moored industrial ship are also important considerations.

2.8 Sol

This proposal is for a 20-55MW LNG/HFO duel fuel generation plant at the FR facility. It provides a third land-based option for generating electricity in a less densely populated area, without the need to install a new LNG pipeline to BELCO's central plant. As levelized energy cost calculations were not provided, it is assumed that the cost of electricity will be similar to that of the other LNG based proposals. The landed fuel costs do not appear to include $5.37/mmBTU of normalised customs duty, which was accounted for in BELCO's original IRP and the BBEP IRP.

Compliance with the Electricity Act is similar to the other proposals for LNG/fuel oil generation, in that this proposal could provide reliable electricity, however this would be at a financial and environmental cost premium to the use of renewable energy technologies. It also appears to represent a larger commitment to LNG than the Bermuda Environment Energy Solutions Group Consortium (BEESG) Proposal.

Based on these considerations, this proposal is considered more desirable than the BCM McAlpine & Bouygues Energies & Services proposal due to the location, however less desirable than the smaller scale BEESG proposal that is better suited to integration of renewable energy.

Submission by Dr David E Chapman
Wednesday, 28 November 2018

On the face of it, regarding the energy generation mix, the two proposals are actually quite similar with the main differences being the addition of offshore wind by the Bermuda Better Energy Plan. While the addition of the offshore wind resource will reduce the island's consumption of fossil fuels in theory, the Bermuda Better Energy Plan has not quantified the cost to the island in regards to potential environmental, social and economical impacts from the proposed installation of a large bank of off-shore wind turbines. This cannot be discounted or just assumed to be beneficial over the long term.

There is also little emphasis by the Bermuda Better Energy Plan put towards distributed solar residential generation despite a massive potential to generate over a 100 MW according to their own figures. In this light, the Bermuda Better Energy Plan seems primed towards encouraging a more attractive business climate for entry into Bermuda by suppliers of bulk renewable energy generation such as wind and bulk solar when in reality an energy mix coming from an emphasis on energy efficiency combined with making the climate more attractive for domestic solar photovoltaic integration may prove to be more in line with the principles of sustainable development, provide an additional income source for residents as well as cutting vastly the dependency by the island on fossil fuels. This is particularly important in regards to the perceived increase over time in electric vehicles which will add an additional demand for electricity over time, and not fossil fuels, as well as when the social, environmental and economic impacts of off-shore wind turbines are compared to that of an island saturated with residential solar.

Nevertheless, in regards to the overall suitability of the two energy plans, any plan that puts greater emphasis on the integration of renewable energy has to be seen as a better long-term option than one that continues to peg Bermuda's energy supply to fossil fuels. My submission is intentionally short as much of the commentary that I could make on this issue has already been written about in great detail in my 2014 PhD thesis, which can be found here: https://pure.royalholloway.ac.uk/portal/files/22958109/2014chapmandphd.pdf.

RUBiS
Energy Bermuda

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

November 30, 2018

Response to Consultation Document on IRP Bulk Generation

Dear Ms. Lister,

RUBiS Energie, the parent company of RUBiS Energy Bermuda Ltd., is a specialist in the storage, distribution and marketing of petroleum products, boasting leading market positions in over 30 countries.

Within this global context, we have seen, and been part of, an Energy Transition in Western Europe, the Caribbean, and Africa, where many changing regulations are focusing on the critically important growth of renewable energy production. Based on our considerable experience and expertise in handling and marketing fuels and liquid inflammable gases such as LPG and LNG, we would like to respectfully submit a concise summary of our observations of the current IRP for Bulk Generation and offer a suggestion for alternative consideration:

- Heavy Fuel Oil (HFO) is being replaced rapidly as the core fuel for power production baseload and ship bunkering because of its significant GHG (CO2) and pollutants (Sulfur and nitrogen oxides) emissions;
- Ambitious renewable energy (electric and heat) developments are currently ongoing and /or planned but there is a significant time lag for these to come on-line in many jurisdictions; and
- In these developed and developing countries, Natural Gas and LPG are being considered as a viable alternative during a transition period to clean energy production, while other complementary energy drivers are being developed or put to scale, as solar and wind have been for the past 15-20 years.

The reasons behind such a trend being largely adopted, or at least planned, include the following:

- Electricity production prices based on sun (photovoltaic) have decreased by 10 times since 2007;
- Waste to energy (from agriculture, dump etc...) processes have been developed through methanisation and pyro gasification. Some have proved to be efficient and should become affordable, whilst others are showing solid potential;

- Supply from renewable energies, such as solar and wind based, for electricity generation is intermittent. The need to have a continuous balance between electricity production and electricity demand is particularly critical. Thus, at the very least, a "baseload" installed generation capacity must be oversized so as to be able to compensate immediately for any weather-based variation. Additionally, the distribution network would also require some adaptation to such "smart" production logistics;
- The loss in terms of CO2 emission from Natural Gas or LPG is approximately -30% compared to HFO, and it pollutants emissions are close to zero, again compared with HFO;
- In terms of the availability and abundance of Natural Gas and LPG, it is recognised that the supply will be continuous for the coming 2-3 decades at least; and
- The main difference between LPG and LNG is the cost of the infrastructure and logistics. LNG, being cryogenic, requires more expensive assets and therefore larger volumes to be competitive.

It is our opinion that the RA should consider that LNG is the appropriate choice for a generation capacity of approximately 100 MW and LPG should be considered for complementary baseload generation (between 5 and 30 MW). Such LPG complementary generation would also ease the electricity distribution if located at the eastern or western extremities of the island.

Most importantly, the critical infra-structure for LPG importation, storage and distribution is already in place in Bermuda so LPG based generation and LPG fueled public transport and fleet options can be brought online quickly, and on a cost-effective basis.

LPG is considered by many to be a natural bridging fuel to LNG for a sustainable low carbon energy system. Benefits include:

- The reduction of our carbon footprint through the displacement of fuel oil-based generation;
- LPG to power will diversify the national energy mix supply and relieve the load of grid distribution;
- LPG consumption in larger volumes will help reduce the price for domestic and commercial customers, allowing for greater adoption and thereby reducing base load requirements; and
- LPG performs very favourably with respect to capital cost, scalability, geographic reach, and social and environmental benefits.

There is an abundant and long-term supply of LPG at competitive prices as:

- LPG is produced along with natural gas (it is a by-product of the gas E&P chain);
- US gas production has seen a significant production increase, which is expected to continue for years to come. The US domestic market cannot absorb this quantity resulting in a strong increase in exports and the resulting over-supplied market will ensure ongoing and long-term price competitiveness;
- The existing US export market is 25 Mmt per year;
- Price transparency: LPG indices have developed for several regions:

- *US – Mont Belvieu*
- *Arab Gulf – Saudi CP*
- *Europe – CIF ARA*
- *Asia – Far East Index*

- Direct indexation: LPG Prices are derived directly from LPG indices instead of via other oil / gas indices.

LPG is an easily transportable fuel:

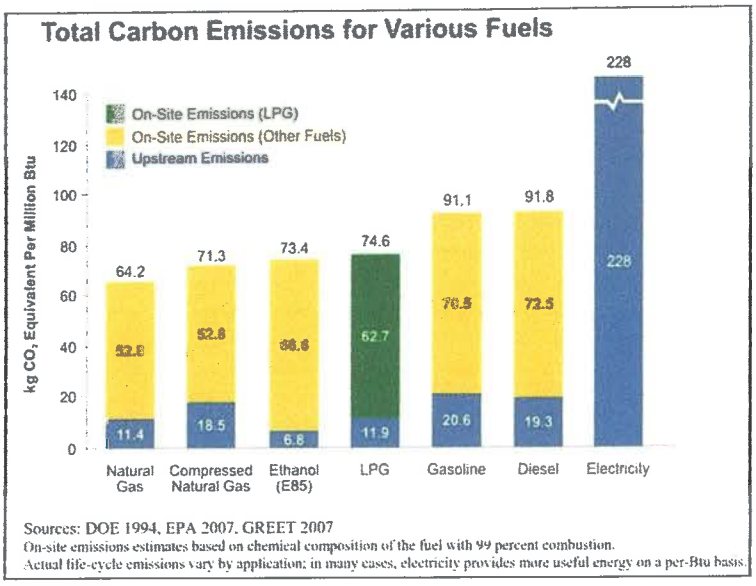
- Propane is transported in a liquid state when subject to modest pressure/cooling;
- This property specificity makes it simple to transport on sea *(vessels)* or land *(cylinders, pipes, trucks)*; and
- A large and stable shipping industry has been developed around LPG to ship the product across the world, to remote locations and for any volumes necessary.

LPG has an efficient and limited infrastructure requirement:

- Infrastructure capex for LPG to power projects is relatively low;
- The main requirement is standard port infrastructure + storage tanks which are already in place in Bermuda, so there is the ability to leverage and further reduce costs; and
- No regasification units are required.

LPG is a Proven & Clean Technology

- All the predominant manufacturers have proven track-records with propane fired engines / turbines;
- There is the ability to consider multi-fuel, converted HFO generation with a switch to natural gas if required; and
- LPG is a low emission fuel which allows for carbon footprint reduction.



LPG is a proven & safe technology with a solid track record and has been adopted in many Island nations and has been successfully implemented for small power generation projects of 5-30MW.

- There are over 30 power plants running on LPG worldwide *(Source UDI - World Electric Power Data Base, 2014);*
- Most existing plants have the ability to run on several fuels;
- Major manufacturers are able to provide efficient turbines or engines running on LPG with solid operational track-record *(Hitachi-Mitsubishi, General Electric, Turbomach, Wartsilä and Siemens);*
- The typical plant size was historically 5-50MW but recent projects have been developed for larger outputs *(200 MW in Virgin Islands, 400 MW in Ghana); amd*
- The best LPG turbines can deliver over 55% combined cycle efficiency, with strong reliability, reduced emissions and very limited maintenance.

We appreciate the opportunity to be allowed to provide our comments and of course, any of our qualified and experienced staff are available to provide any additional information.

Sincerely,

Graham Redford
Managing Director
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www.rubis-bermuda.com

BERMUDA SOLAR ENERGY ASSOCIATION

27 November 2018

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

Attention: Monique Lister

Reference: Response to Consultation Document: Comments on IRP Bulk Generation Proposals

Dear Ms. Lister,

The Bermuda Solar Energy Association is putting all its support behind the Etude - Bermuda Better Energy Plan, commissioned by Bermuda Engineering Company Limited (BE Solar) and endorsed by Greenrock, BEST, BUEI as well as numerous other corporate entities and private individuals.

It is the only Alternative Proposal that would result in an electricity supply that is more consistent with the purposes of the Electricity Act (2016) and Ministerial directions (e.g. least-cost provision of reliable electricity). As such it is the only Alternative Proposal that fulfills the Regulatory Authority Bermuda's assessment methodology (as used by its consultant Ricardo Energy & Environment), including the proposed modifications to the assessment methodology proposed in the answer to Question 4 below.

The Bermuda Solar Energy Association is a growing association of more than 145 solar photovoltaic system owners, solar system installers and other interested parties.

We have a vision of every house and business in Bermuda having a renewal energy system just like every house and business in Bermuda has a water tank to collect its fresh water from rain. This would be supplemented by bulk solar systems, maximizing the use of renewable energy and minimizing the emission of greenhouse gases for Bermuda.

From a more practical view point, our vision is that all participants in the Bermuda energy market work in tandem to achieve and even exceed, with a high probability of success, the goals of the National Electricity Sector Policy ("NESP") energy targets. The latter being that renewal sources will provide 35% of the energy consumed in Bermuda by 2025.

Planet Earth will be so grateful if we can all reduce our energy consumption and exceed the goals of the NESP energy targets.

BERMUDA SOLAR ENERGY ASSOCIATION

Best regards,

On behalf of the
Bermuda Solar Energy Association
and its Executive Committee

BERMUDA SOLAR ENERGY ASSOCIATION

Response to Consultation Questions

Abbreviations

BELCO	Bermuda Electric Light Company
EA	Electricity Act (2016)
FAR	Fuel Adjustment Rate
FIT	Feed-in-Tariffs
IRP	Integrated Resource Plan
NESP	National Electricity Sector Policy
PV	Photovoltaic
RAB	Regulatory Authority of Bermuda
SEA	Bermuda Solar Energy Association

Definitions

Conservation	As per BELCO's IRP: A premeditated behavioral adjustment associated with a conscious decision to adjust an end-user's utility or comfort in order to reduce energy consumption; examples include adjusting the thermostat at the expense of temperature comfort, and turning off lights when not in the room;
Energy Efficiency	As per BELCO's IRP: deriving the same utility from a given end-use using a less energy-intensive device that does not require a change in user behaviour or intervention to conserve energy, and/or programs and incentives that encourage end-use switch-outs to more efficient units;

Consultation Questions

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

Pro-active approach toward conservation and energy efficiency

While this consultation is about the various Alternative Integrated Resource Plans, the starting point for everyone should be conservation and energy efficiency i.e. how can we avoid building all those very expensive energy producing assets in the first place?

In addition, Section 6(b) of the EA states "to encourage electricity conservation and the efficient use of electricity" thus the Alternative Proposals and BELCO's IRP must encourage conservation and energy efficiency in order to be compliant with the EA. The SEA is of the opinion that predicting a lower demand curve is not enough for the final IRP to be compliant with the EA.

As an initial step, the SEA propose that all Alternative Proposals and the BELCO's IRP include a budget for publicity campaigns and incentive(s) to help consumers conserve and implement

energy efficient solutions that will result in lower energy consumption. We further suggest that this incentive programme be weighted towards low income households.

The SEA is proposing that BELCO spend 0.5% of its revenue, per year for the next 10 years, on incentive(s) to help consumers implement energy efficient solutions that will result in lower energy consumption. It is worth noting that this amount is in addition to the amounts BELCO is currently spending on publicity campaigns to sway consumers toward energy conservation.

Pro-active approach toward Distributed Solar PV

As stated in the response to Question 3 below, Solar PV, particularly distributed solar, is the single most important renewable energy technology available in Bermuda today that can accomplish the six purposes of the EA, the four objectives and vision of the NESP and the four principal functions of the RAB.

The installation of solar PV is a cash flow business: invest now and save later. BELCO, via its billing system, is already operating in the middle of those cash flows. As a result the SEA propose that BELCO acts as facilitator for the installation of residential solar PV systems just like the communication industry helps consumer purchase cellular phones.

It is important to note that this is not a subsidy. We expect BELCO to earn fees for providing this service.

The SEA is proposing that BELCO should plan to facilitate 1 MW of new solar residential PV power per year.

2. Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?

The Bermuda Better Energy Plan, is the only Alternative Proposal that would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity). As such it is the only Alternative Proposal that fulfils the RAB's assessment methodology (as used by its consultant Ricardo Energy & Environment), including the proposed modifications to the assessment methodology proposed in the answer to Question 4 below.

The purposes of this Act include the following, namely, to seek:-

(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; and

(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.

In Bermuda, the risk of fuel price volatility is borne entirely by the consumers through the monthly FAR. Price volatility particularly affects the less well-off and the retirees, a growing segment of the Bermuda population. The SEA believes that in order to be compliant with the EA the objectives of "prices and affordability" and "reliability and quality", mentioned in paragraph (e) above, must be read to include the objective of reducing the risk of consumer price volatility.

BELCO's IRP does not result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity) as it does not fulfil all of the criteria of the RAB's assessment methodology, including the proposed modifications to the assessment methodology listed in the answer to Question 4 below. The BELCO's IRP does not meet the renewable targets of the NESP, the proposed renewable solutions have a low probability of success (see answer to Question 3 below) and it unnecessarily exposes consumers to the risk of fuel price fluctuations. As an example, BELCO's IRP models the price of natural gas falling to $2.86/MMBTU in 2019, yet in November 2018 alone it has jumped more than 50% reaching as high as $4.71/MMBTU.

3. Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?

Distributed Solar PV

Solar PV, particularly distributed solar, is the single most important renewable energy technology available in Bermuda today that can accomplish the six purposes of the EA, the four objectives and vision of the NESP and the four principal functions of the RAB[1]. Our vision is thus that distributed solar PV rooftop will exceed the NESP vision.

In support of our vision, the data shows that distributed solar PV is the only renewable technology that has made a meaningful contribution to the Energy White Paper's targets for 2020. Rooftop solar PV is the only true renewable energy technology that has achieved any significant growth since 2011, with approximately 4 MW of rooftop solar PV capacity now installed on both residential and commercial buildings.

The Tyne's Bay "Waste-to-Energy" Plant is the only other alternative technology to fossil fuel generation that has had meaningful impact, but it now has very limited growth potential and significant emissions, whereas solar PV still has huge growth potential and zero emissions.

All other renewable/alternative energy technologies for electricity generation mentioned in the White Paper and/or NESP have not achieved any, or at least any significant installed capacity.

[1] Bermuda Alternate Energy Limited (« BAE »), Response to Question 2 of Consultation Document 17-0316, C.E. Nash, P. Eng, May 12, 2017

In addition, distributed Solar PV is the only renewable energy technology to offer the following benefits over other the renewables technologies[2]:-

(a) Reduce the summer FAR for all customers by offsetting the high energy cost of producing electricity using inefficient gas turbine 'peaking engines' during the day with lower energy cost during the night;

(b) Reduce similarly, but to a lesser extent, the FAR for all customers in the fall, winter and spring;

(c) Reduce the most carbon intense emissions of BELCO;

(d) Reduce grid losses with the neighborhood distribution model;

(e) Reduce expense by BELCO upgrading the grid to take multi-megawatt in-feeds such as at the airport;

(f) Produce a climatically more resilient source of energy than large scale solar farms as it is distributed over the entire 21 square miles of the island, rather than being concentrated in one or two locations that are susceptible to localised weather events such as cloud cover and unexpected storm surge or wind gust. This argument would be amplified if all the sites are concentrated in a few parishes (St George and St David);

(g) Avoid further development of un-used land as it can mostly be deployed on existing roof tops. Preliminary analysis of available roof space suggests that with 20% coverage, distributed rooftop solar could generate approximately 50% of BELCO's current annual production total; and

(h) Offer solar customers the option of silent back up power rather than using noisy and fuel burning generators during power outages.

Bulk Scale Solar PV

We are hoping that the goals for Bulk Scale Solar PV & Distributed Solar PV from the BELCO's IRP can be achieved. However the projection 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[3]. As a result we believe that BELCO's goal is at best optimistic.

Solar water heaters

The goal in the NESP for Solar water heaters is 2.0%, BELCO's IRP goal is over 5.0%. Both are very optimistic goals because adoption of this technology in recent years has almost

[2] Bermuda Alternate Energy Limited (« BAE »), Response to Question 2 of Consultation Document 17-0316, C.E. Nash, P. Eng, May 12, 2017

[3] Bermuda Alternate Energy Limited (« BAE »), Response to Consultation Document 2018 05 02 (Integrated Resource Plan Consultation), C.E. Nash, P. Eng, August 17, 2018

completely ceased as a result of its high cost in typical Bermuda homes and relatively poor return on investment compared to solar PV and heat pump water heaters[4].

The major barriers are:-

(a) Many Bermuda homes will have a number of small water heaters rather than one large one;

(b) The minimum required water storage capacity to generate a worthwhile return is 80 gallons because in smaller capacity systems the water is fully heated very early in the day, thus not utilizing the available solar energy for most of the day; and

(c) High cost of retrofitting.

BELCO's IRP is describing a solar water heater system as "solar thermal water heater system paired with a 1,060 watt PV panel". While this system has been available in Bermuda for a number of years, the only known installations have been on a few BELCO properties. As a result we believe that the goal listed in BELCO's IRP has a low probability of success.

Liquefied Natural Gas ("LNG")

The SEA does not support the introduction LNG technology in Bermuda for the following reasons:-

(a) The life-cycle greenhouse gas emissions (includes extraction, liquefaction and transportation on the mainland) of LNG, while better than Waste to Energy and Oil, remains a poor choice when compared to renewable energies like Solar PV and Offshore Wind.

Technology	gCO2eq/kWh
Waste to Energy	1000
Oil	900
LNG	600
Solar	35
Offshore Wind	8

Reference: Page 11, 12 of the Bermuda Better Energy Plan

(b) The high capital cost and the risk that the assets become stranded because of the rapid developments of alternative forms of energy production that are better suited to Bermuda.

Per BELCO, LNG would require (1) "Necessary offloading, storage and regasification infrastructure *[which]* would be constructed at a location in St. Georges, Bermuda in the vicinity of the existing Fuel Oil storage depots" and (2) "A new NG pipeline *[which]*

[4] Bermuda Alternate Energy Limited (« BAE »), Response to Consultation Document 2018 05 02 (Integrated Resource Plan Consultation), C.E. Nash, P. Eng, August 17, 2018

would be constructed along the route of the existing Fuel Oil pipeline to the Central Plant for use in baseload and peaking generating units.";

(c) The security zone required around the assets listed in (b) above and risk of deflagration resulting from those same assets;

It is completely unrealistic to think that the Bermuda population would allow the construction of "a new NG pipeline *[which]* would be constructed along the route of the existing Fuel Oil pipeline".

(d) This technology unnecessarily exposes consumers to the risk of fuel price fluctuations;

Offshore Wind

Offshore wind has the lowest life-cycle greenhouse gas emissions of any of the renewable energies suitable for Bermuda and as such should be included in the final IRP.

Rather than ignoring Offshore Wind, the RAB should initiate a Request for Proposal to settle the difference in opinion about the viability of Offshore Wind between the BELCO's IRP and the Alternative Proposals.

4. Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?

It is worth stating the obvious that the SEA believes that the Alternative Proposals and the BELCO's IRP should be evaluated using the same model, set of assumptions and assessment methodology.

(a) The RAB assessment methodology should include a simple Yes/No question on whether the Alternative Proposals and the BELCO's IRP are meeting the Government's goal for renewable energy as stated in the NESP.

Section 6(c) of the EA states "to promote the use of cleaner energy sources and technologies, including alternative energy sources and renewable energy sources". The SEA is of the opinion that the Alternative Proposals and BELCO's IRP must propose technologies that will meet, with a high probability of success, the NESP targets in order to be compliant with the EA.

(b) The RAB assessment methodology should include an assessment whether the renewable energy technologies proposed in the Alternative Proposals and BELCO's IRP are appropriate for Bermuda.

Appropriate for Bermuda means that the selected renewable energy technologies should have a high probability of success in Bermuda. Our answer to Question 3 above is summarized here:-

Technology	Appropriateness
Distributed Solar PV	Single most important renewable energy technology available in Bermuda today that can accomplish the six purposes of the EA, the four objectives and vision of the NESP and the four principal functions of the RAB;
Bulk Scale Solar PV	Bermuda lacks many big areas of relatively low cost land on which solar farms can be installed compared to most jurisdictions;
Solar Water Heaters	High cost in typical Bermuda homes and relatively poor return on investment compared to solar PV and heat pump water heaters;
LNG	Not suited for a small island like Bermuda; better solutions exist; unnecessarily exposes consumers to the risk of fuel price fluctuations;
Offshore Wind	Subject to a successful RFP;

(c) The RAB assessment methodology should be using a single model and underlying set of assumptions against which the BELCO's IRP and the Alternative Proposals should be reviewed.

The underlying set of assumptions should include assumptions about the continuous upward trend in fuel price and the continuous downward trend in the costs of implementing renewable energy solutions.

Further, the SEA recommends that once completed, the models and underlying assumptions should be subject to public consultation.

(d) The RAB assessment methodology as regards Section 6(e) of the EA must consider the full range fuel price uncertainty. As mentioned in paragraph (c) above, the SEA is of the opinion that the RAB must select and publish the assumptions that should be used by the Alternative Proposals and the BELCO's IRP to perform their sensitivity analysis.

Full disclosure is particularly important here. The RAB must publish, in addition of the expected results, the median results as well as the result at the 60^{th}, 70^{th}, 80^{th}, 90^{th}, 95^{th} and 99^{th} percentiles.

(e) The RAB assessment methodology as regards Section 6(a) of the EA must consider realistic disaster scenarios. As mentioned in paragraph (c) above, the SEA is of the

opinion that the RAB must select and publish the scenarios that should be used by the Alternative Proposals and the BELCO's IRP to test the adequacy, safety, sustainability and reliability of their respective plan.

The realistic disaster scenarios should include, but not be limited to:-

- Strong category 4/5 hurricane at high tide;
- Flooding from a storm, of any strength, that stall over Bermuda for an extended period of time;
- Fire or explosion at, or along the supply line to, the critical energy producing assets.

30th November 2018

Regulatory Authority
1st Floor, Craig Appin House
8 Wesly Street
Hamilton, Bermuda

Attention: Monique Lister

Reference: "Response to Consultation Document: Comments on IRP Bulk Generation Proposals"

Dear Ms. Lister,

I hope this letter finds you all well. As many of those at the Regulatory Authority know, I have been working on my Master's Thesis on Distributed Solar PV Policy in the Caribbean. As a result, I have unfortunately been unable to take the time to develop the in-depth response to the IRP consultation that I feel it clearly deserves.

However, due to the importance of this consultation to the future on energy in Bermuda I feel I must voice my support for the Bermuda Better Energy Plan (BBEP). Also, I would like to share some of the results of my thesis research concerning potential deficiencies and discrimination that may be caused by Bermuda's distributed solar PV remuneration policy and tariff structure.

Finally, I would like to draw your attention to the overwhelming support from BUEI, Greenrock, BEST, Sir John Swan and other important public figures in Bermuda, along with the sheer number of responses you must be receiving supporting renewable generation. It is important to listen to the voice of the public during these consultation periods and implement the plans which they support, while also recognising the limitations these plans may present.

From my experience working in the industry, I recognise the importance of answering the physical consultation questions rather than making an outright declaration of support for one path or another. Therefore, I shall frame my response accordingly.

Consultation Questions:

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

   Levelized Cost of Electricity (LCOE)

   It is important to point out the drastic difference between the LCOE's calculated within BELCO's IRP submission and the BBEP. Furthermore, the LCOE's within BELCO's previous 2016 IRP, available on their website, are vastly different than those included within their 2018 submission.[i]

   My concern with this is that if the Regulatory Authority is to base their decisions on the provisions within these two proposals, how do they determine which of them are working off of correct cost assumptions?

   Since cost is such an important parameter and has explicitly been noted by the Minister as being his primary concern, it is vital that the Regulatory Authority determine the exact cost of each generation source and thus which proposal uses the correct assumptions. The Regulatory Authority has access to information concerning costs of technologies currently implemented, or being implemented, within Bermuda, such as utility scale and distributed solar PV. For example, the 6MW Saturn Solar project bid has agreed to accept 0.103 $/kWh

for their electricity. [ii] This suggests that BELCO's numbers within the IRP proposal of 0.197 – 0.289 $/kWh for the LCOE of utlity scale PV are either far too high or Saturn has not guaranteed the returns required to remain viable according to BELCO's WAAC of 10%. Both of these results are concerning for Bermuda's energy future.

Therefore, before the provisions within any of the proposals can be considered, I believe it is vital for the Regulatory Authority to determine what information is being used to determine the costs of each technology. If the BBEP's values are incorrect, we cannot rely on their assumption that increasing renewables, such as offshore wind generation, will result in a decrease in electricity costs. Likewise, if BELCO's cost estimations for solar PV are incorrect, we may fail to implement the full potential of renewable resources that could help to reduce the cost of electricity and minimise our vulnerability to fluctuations in the price of fuel. As a result, I would urge the Regulatory Authority to investigate further into how the costs within each of these proposals have been determined and decide which are the most reliable.

2. Do you have any comments on whether including the Alternative Proposals in the IRP would result in an electricity supply that is more consistent with the purposes of the EA and Ministerial directions (e.g. least-cost provision of reliable electricity)?

Bermuda Better Energy Plan (BBEP)

I believe that there are many aspects of the BBEP that should be included within BELCO's final IRP in order for it to be better aligned with both the purposes of the EA and Ministerial directions. I have broken my response to this question down into the three most important aspects within the BBEP that I feel should be included within BELCO's final IRP to provide a more reliable, sustainable and least cost provision of electricity within Bermuda:

- *Offshore Wind*

  According to the BBEP, offshore wind generation has the potential to supply our energy needs at a much lower cost than conventional fossil fuel generation. Although I am sceptical of the potential for wind generation to reach the levels prescribed within the BBEP, I do support its increased adoption in Bermuda. BELCO's current IRP proposal suggests that it can include up to 25 MW of wind generation. However, it does not explicitly state in its procurement plans when or how much wind generating capacity is to be implemented. I believe that this aspect of the BBEP can therefore be adopted alongside BELCO's current IRP proposal by simply limiting wind to 25 MW capacity and encouraging BELCO to explicitly include it within their procurement schedule.

  By installing wind generation, Bermuda can help diversify its electricity mix and thus reduce its susceptibility to fluctuations in fuel prices (mentioned in the answer to question 3 regarding LNG). Also, due to the iterative nature of the IRP, once the true potential of wind generation is realised, adjustments can be made in the next IRP in five years. Therefore, Bermuda should definitely consider this aspect of the BBEP, however a full commitment to wind generation should only take place once its impact on the islands grid dynamics and energy supply is fully understood, which is why I support incremental increases in wind generation.

  Finally, in order for the Regulatory Authority to better understand the impact high levels of wind generation can have on the electricity sector of small island jurisdictions I believe it is important to use the analysis generated by other similar jurisdictions. For example, lessons can be learned from Aruba, where 30 MW of wind generation supplies almost 15% of their yearly electricity generation.

- *Utility Scale PV*

BELCO's IRP proposal explicitly states that 24 MW of wind generation should be installed by 2021. However, the BBEP points out that these levels of utility scale solar PV penetration may be difficult to achieve in Bermuda do to the lack of available land and suitable installation sites. The BBEP explicitly states a number of locations that could support certain sizes of utility scale PV and I believe these should be pursued. Furthermore, the Bermuda Land development Company (BLDC) controls many unused or undeveloped properties that have the potential to be used for utility scale PV. These options along with other potential sites should be explored by the Regulatory Authority and the actual potential for utility scale PV determined. If the 6MW Saturn Solar Project mentioned in my response to question 1 is successfully able to provide electricity to BELCO at such inexpensive rates, it ultimately demonstrates the potential of utility scale solar PV to satisfy the purposes of both the EA and Ministerial directions.

It is clear that the main obstacle to utility scale PV (assuming the success of the Saturn Project) in Bermuda is the available land. Therefore, I agree with the with the BBEP that the majority of Bermuda's efforts should be directed towards smaller scale, independently owned, distributed solar PV generation. However, in order to successfully encourage the adoption of this promising generation technology, significant changes need to be made to both BELCO's IRP and the solar remuneration policy within Bermuda.

- *Distributed Solar PV*

Despite the Tynes Bay Waste to Energy (WTE) facility, the only other renewable energy generation that has been implemented with any reasonable success to date has been distributed solar PV. However, the majority of this generation has typically been implemented by wealthier households under BELCO's net metering program. To demonstrate this, I have included a graph from the research contained within my thesis that illustrates the yearly uptake of distributed solar PV according to the submissions on the Department of Planning's website since 2014. [iii] Please note that the data for the current year (2018) only includes submissions up to September. Therefore, the total rate of uptake in 2018 has been adjusted, assuming the rate of uptake in the final 3 months is equal to the average monthly uptake throughout the year.

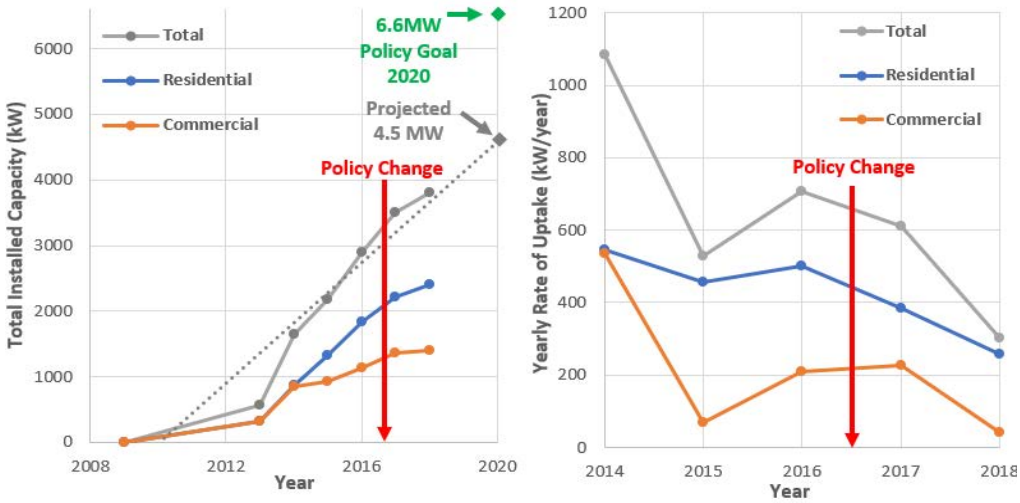

Figure 1: Total Distributed Solar PV Capacity, Rate of Uptake & Projections [iii]

The transition from net metering to an avoided cost-based FIT applied to all excess energy in real time, has clearly discouraged investment and thus should be addressed. However, the main reason for the lack of investment from lower income households existed long before the policy change.

The BBEP pointed out that the lack of investment from smaller households is actually due to the tiering of facilities charge and the fixed nature of solar PV facilities charges. Although it is briefly mentioned within the BBEP's submission, I feel it is important to demonstrate the impact that this oversight has had and will continue to have on potential investment in distributed solar PV from low income households. When an individual installs solar PV in Bermuda they automatically transition to the fixed solar facilities charge of $39.95 per month. However, depending on the individual's usage prior to the transition, this shift can either have a positive or negative effect on their monthly bill. The table below illustrates how this policy can impact different types of consumer in Bermuda

Table 1: Impact of Facilities Charge

Original Tier (kWh/month) *	Facilities Charge	Solar Charge	Additional Monthly Fee or Savings **	Lifetime Fee or Savings **
0-300	$ 20.00	$ 39.95	$ 19.95	$ 5,985.00
300-450	$ 30.00	$ 39.95	$ 9.95	$ 2,985.00
450-750	$ 39.95	$ 39.95	-	-
750-1500	$ 62.50	$ 39.95	- $ 22.55	- $3,47.20
1500+	$ 95.00	$ 39.95	- $ 55.05	- $16,515.00

* Original listing is in kWh/day. Tiers above assume 30 days per month.
** Negative Values indicate Savings and Positive values indicated Fees. Lifetimes set to 25 years.

Households with lower consumption may be required to pay nearly $6,000 in excess fees over the 25-year operational lifetime of their solar PV system to cover the monthly facilities charge increase from simply switching to the fixed solar charge. On the other hand, households with a larger consumption can save up to 55 USD$ per month, resulting in more than $16,500 in savings over the lifetime of the system. Due to the fact that electricity use is often correlated with household income, hence the purpose of tiered rate structures, this facility charge structure creates serious inadvertent discrimination against low income households wishing to install distributed solar PV.

The resulting inequity in net compensation received discourages investment from low income households and clearly flies in the face of recent efforts made by the current government to encourage investment from low income households. For example, the newly implemented rebate system for households with low ARV's of up to $8,000 may simply go to offsetting these increased monthly fees realised by these individuals by simply installing solar PV.

As a result, it appears that the Regulatory Authority could provide a similar investment incentive if it simply removed the fixed solar charge and kept facilities charges constant. Furthermore, the new fees paid by higher tier consumers could be directly used to fund the rebate program, reducing the need for excessive government expenditure.

It is important to note that even without the impact of facilities charges, low level consumers, especially those who are unable to self-consume their electricity in real time, are still heavily disadvantaged by Bermuda's avoided cost-based

policy. In order to illustrate the potential for vastly different returns based on consumer type, I have included the full set of modelling results developed within my thesis, based off of average regional prices obtained from distributed solar PV installers within Bermuda. These results are shown with and without tiered facilities charges for varying consumption levels and degrees of self-consumption. The results can be found in the Appendix attached to my response.

Although I understand that these models are my own and are based off the assumptions I have made, I believe it is the Regulatory Authority's responsibility to develop their own models in order to understand how their policies impact different types of consumers. This way, significant discrimination, such as that which has clearly resulted from tiered facilities charges, can be avoided in the future. Ultimately, I wish to support the BBEP's suggestion that amendments be made to the current system in order to encourage investment from the entire population, not just wealthier individuals with higher consumption levels.

Finally, I would like to point out the inconsistencies present within BELCO's IRP proposal concerning distributed solar PV. In BELCO's previous IRP in 2016, they explicitly outline the amount of distributed solar PV to be included within their procurement plan at 1MW installed per year.[i] However, in BELCO's most recent proposal, distributed solar PV has been grouped within the EE/EV/PV section and thus it is unclear as to what exactly their aspirations are regarding this important technology. Furthermore, their aspirations for EE have actually gone down from those included within Case 4 (1st choice case) of the 2016 IRP, despite now including distributed PV. I am confused to how this is the case, as their LCOE for this technology has decreased since 2016 and yet they aspire to include less within their energy mix. As a result, I believe that in order to accept BELCO's IRP the Regulatory Authority should require them to explicitly state how much energy they expect to be obtained from this important distributed renewable resource.

3. Do you have any comments on the technology proposed in the Alternative Proposals, including whether such technology is in commercial operation in another jurisdiction?

Offshore Wind

Again, as mentioned above, I believe The Regulatory Authority should pursue the 25 MW of wind generation outlined in BELCO's IRP before a larger commitment is made. Rather than ignoring the potential for offshore wind, I agree with the Solar Energy Association's submission, that the Regulatory Authority should initiate a Request for Proposals in order to determine the potential for wind generation. Furthermore, Bermuda should look to other similar jurisdiction's, such as Aruba, in order to gauge the impact large scale implementation of wind generation can have on the grid and electricity prices.

Utility Scale PV

I believe BELCO's aspiration of 24 MW of utility sale PV by 2021 should be pursued. Again, this technology has been proven on many small island jurisdictions throughout the world and the impact of its implementation on a large scale should be drawn from these examples. However, in order to supplement this form of generation, efforts should be made to increase distributed solar PV capacity. Bermuda, like many other small island jurisdictions lack large plots of available land needed to implement massive amounts of utility scale solar PV. Therefore, if the amount of available land is found insufficient the Regulatory Authority must look towards distributed solar PV to achieve the 24 MW outlined within BELCO's IRP.

Distributed Solar PV

As mentioned in my response to question number 2. Distributed Solar PV is the only renewable electricity generation technology that has shown any promise so far within Bermuda. Therefore, I believe an effort should be made to design a more effective policy that encourages investment from the entire population, in order to avoid discrimination towards low income households. This technology has clearly shown promise both in Bermuda and overseas and should be utilised to meet the goals of the EA. Therefore, I believe it is important for BELCO to explicitly state the expected capacity of distributed solar PV within its final IRP.

Liquid Natural Gas (LNG)

According to BELCO's proposal, LNG has massive potential to both reduce Bermuda's cost of electricity and reduce our carbon footprint at its current price. I must agree that transitioning to a low carbon fuel may have the greatest potential to reduce GHG emissions in the short term. However, relying solely on a single conventional generation source for over 85% of Bermuda's energy needs by 2037 leaves the island extremely vulnerable to price fluctuations and does not meet the needs outlined in the EA for a sustainable and reliable source of electricity generation.

Ironically, the price of natural gas over the past month may actually serve as a warning to small island jurisdictions, such as Bermuda, who aspire to transition to this fuel source. According to the NASDAQ, the price of natural gas in the US (NYMEX) has risen from under 3.25 $/MMBTU to above 4.50 $/MMBTU over the course of November.[iv] This increase of nearly 40% in under a month would be extremely damaging to Bermuda's economy and thus should be taken into consideration by the Regulatory Authority when determining if BELCO's proposal will be able to meet the purposes of the EA and the Ministerial directions. As a result, I would ask the Regulatory Authority to approve such a transition with caution.

4. Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the Alternative Proposals?

In conclusion I would like to apologise for the haste in which my response above have been presented. However, I have taken the time to write what I can in order to urge the Regulatory Authority to listen to the submissions that have been made within this consultation. Like me, many of the individuals who submit responses are very busy and have taken the time to research and write what they can. Even those responses which may clearly be developed from templates, still represent a Bermudian who has taken the time to voice their opinion concerning the future of energy on their beloved island. I have personally witnessed many individuals of my generation who care very little for this industry submit responses because they recognise the importance of sustainable electricity generation and the responsibility, we all have to do our part to fight climate change.

The technical feasibility of certain Alternative Proposals may be questioned, and rightly so. I believe the ambitions contained within the BBEP may be just that, ambitious. However, I support the initiatives made to encourage renewable generation in Bermuda and increase the diversification of our energy mix. Therefore, I believe this is what should be taken from the BBEP's proposal and the support it has undoubtably received from public submissions. The public clearly recognise the need for alternative, sustainable sources of energy, and it is up to the Regulatory Authority to discern what that mix might look like.

We must find a balance between BELCO's LNG centric proposal and the BBEP's heavy reliance on untested offshore wind generation. This may include encouraging utility scale PV

generation, or amending the current policy towards distributed solar PV. However, regardless of the direction taken, the most important aspect of any IRP is to explore the options available and to listen to the input of those individuals impacted most by its decisions. I hope the Regulatory Authority will do all within its power to investigate and determine, based on their own research, what Bermuda's energy future will look like.

Finally, I would love to further share the findings and research contained within my thesis concerning Bermuda's distributed solar remuneration policy with those at the Regulatory Authority if they wish. I believe it would go a long way for the Regulatory Authority to develop its own models in order to understand the significant discrimination that has been created by Bermuda's current policy as outlined within the EA.

Thank you again for undertaking this important and difficult task. I wish you all the best in your decision and hope to work with you in the future to make Bermuda's electricity sector a more fair and sustainable environment for all Bermudians.

Kinds regards,

Simon Clinton

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[i] BELCO. (2016). *BELCO 2016 IRP.* Bermuda Electric Light Company. Retrieved 30th November 2018 from https://www.belco.bm/images/stories/pdf/2016BELCOIRPFinalReport063016.pdf

[ii] Bell, J. (2018). *Solar power plant deal signed.* The Royal Gazette. Retrieved 30th November 2018 from http://www.royalgazette.com/environment/article/20180605/solar-power-plant-deal-signed

[iii] Department of Planning Bermuda. (2018). *Planning and Building Applications*. Ministry of Environment & Planning Bermuda, Bermuda Government. Retrieved 1st October 2018 from http://www.planning.gov.bm/applications.aspx

[iv] NASDAQ. (2018). *U.S. National Average Natural Gas Price: End of day Commodity Futures Price Quotes for Natural Gas (NYMEX).* Retrieved 1st October 2018 from https://www.nasdaq.com/markets/natural-gas.aspx

APPENDIX

Bermuda Results

Abbreviations & Definitions:

PP – Payback Period

NPV – Net Present Value of Investment

IRR – Internal Rate of Return

Self-Consumption (%) – Amount of electricity produced in real time that is not exported by a distributed generator but used to satisfy their own load at the time. Levels from 0% up to 100% are modelled in 25% increments in order to get a range of potential degrees of self-consumption (do not illustrate real values)

Consumption (kWh/m) – Total electricity consumed in kilowatt hours per month. Average Consumption taken to be 725 kWh/m and levels of 33.33%, 66.66%, 100%, 200% and 300% are modelled

Net Import (kWh/m) – Total monthly electricity consumption subtract total monthly electricity generation

2kW with Tiered Facilities Charge

	System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
2kW – With Facilities Charges	(33.33%) 241.7 kWh/m	0%	241.7	5.1	45.1	-$8,159	-4.16%
		25%	241.7	5.1	32.8	-$7,299	-2.02%
		50%	241.7	5.1	25.6	-$6,439	-0.20%
		75%	241.7	5.1	21.0	-$5,579	1.43%
		100%	241.7	5.1	N/A	N/A	N/A
	(66.66%) 483.3 kWh/m	0%	483.3	231.7	21.7	-$5,777	1.16%
		25%	483.3	231.7	16.6	-$4,320	3.64%
		50%	483.3	231.7	13.5	-$2,863	5.91%
		75%	483.3	231.7	11.3	-$1,407	8.05%
		100%	483.3	231.7	9.8	-$30	10.01%
	(100%) 725 kWh/m	0%	725.0	473.3	21.7	-$5,777	1.16%
		25%	725.0	473.3	15.9	-$4,052	4.08%
		50%	725.0	473.3	13.0	-$2,595	6.31%
		75%	725.0	473.3	11.0	-$1,138	8.44%
		100%	725.0	473.3	9.5	$319	10.50%
	(200%) 1450 kWh/m	0%	1450.0	1198.3	13.9	-$3,084	5.61%
		25%	1450.0	1198.3	10.7	-$932	8.74%
		50%	1450.0	1198.3	8.8	$1,221	11.75%
		75%	1450.0	1198.3	7.4	$3,374	14.74%
		100%	1450.0	1198.3	6.4	$5,526	17.76%
	(300%) 2175 kWh/m	0%	2175.0	1923.3	9.2	$797	11.15%
		25%	2175.0	1923.3	7.6	$2,949	8.74%
		50%	2175.0	1923.3	6.6	$5,102	11.75%
		75%	2175.0	1923.3	5.8	$7,255	14.74%
		100%	2175.0	1923.3	5.2	$9,407	23.33%

2kW No Facilities Charge

	System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
2kW – No Facilities Charge	(33.33%) 241.7 kWh/m	0%	241.7	5.1	21.7	-$5,777	1.16%
		25%	241.7	5.1	18.4	-$4,917	2.66%
		50%	241.7	5.1	15.9	-$4,057	4.06%
		75%	241.7	5.1	14.1	-$3,197	5.40%
		100%	241.7	5.1	N/A	N/A	N/A
	(66.66%) 483.3 kWh/m	0%	483.3	231.7	21.7	-$5,777	1.16%
		25%	483.3	231.7	16.6	-$4,320	3.64%
		50%	483.3	231.7	13.5	-$2,863	5.91%
		75%	483.3	231.7	11.3	-$1,407	8.05%
		100%	483.3	231.7	9.8	-$30	10.01%
	(100%) 725 kWh/m	0%	725.0	473.3	21.7	-$5,777	1.16%
		25%	725.0	473.3	15.9	-$4,052	4.08%
		50%	725.0	473.3	13.0	-$2,595	6.31%
		75%	725.0	473.3	11.0	-$1,138	8.44%
		100%	725.0	473.3	9.5	$319	10.50%
	(200%) 1450 kWh/m	0%	1450.0	1198.3	21.7	-$5,777	1.16%
		25%	1450.0	1198.3	14.9	-$3,624	4.74%
		50%	1450.0	1198.3	11.4	-$1,472	7.95%
		75%	1450.0	1198.3	9.2	$681	11.01%
		100%	1450.0	1198.3	7.7	$2,834	14.01%
	(300%) 2175 kWh/m	0%	2175.0	1923.3	21.7	-$5,777	1.16%
		25%	2175.0	1923.3	14.9	-$3,624	4.74%
		50%	2175.0	1923.3	11.4	-$1,472	7.95%
		75%	2175.0	1923.3	9.2	$681	11.01%
		100%	2175.0	1923.3	7.7	$2,834	14.01%

5kW with Facilities Charge

5kW – With Facilities Charges

System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
(33.33%) 241.7 kWh/m	*0%*	*241.7*	*-349.8*	*24.7*	*-$14,325*	*0.11%*
	25%	*241.7*	*-349.8*	*20.0*	*-$12,175*	*1.85%*
	50%	*241.7*	*-349.8*	*N/A*	*N/A*	*6.93%*
	75%	*241.7*	*-349.8*	*N/A*	*N/A*	*8.06%*
	100%	*241.7*	*-349.8*	*N/A*	*N/A*	*N/A*
(66.66%) 483.3 kWh/m	*0%*	*483.3*	*-108.1*	*19.6*	*-$11,943*	*2.07%*
	25%	*483.3*	*-108.1*	*15.0*	*-$8,301*	*4.69%*
	50%	*483.3*	*-108.1*	*12.6*	*-$5,325*	*6.93%*
	75%	*483.3*	*-108.1*	*11.3*	*-$3,175*	*8.06%*
	100%	*483.3*	*-108.1*	*N/A*	*N/A*	*N/A*
(100%) 725 kWh/m	0%	725.0	133.6	19.6	-$11,943	2.07%
	25%	725.0	133.6	14.8	-$8,032	4.87%
	50%	725.0	133.6	12.0	-$4,390	7.58%
	75%	725.0	133.6	10.1	-$748	9.58%
	100%	725.0	133.6	9.2	$1,625	11.05%
(200%) 1450 kWh/m	0%	1450.0	820.8	16.0	-$9,396	3.81%
	25%	1450.0	820.8	11.7	-$3,978	7.52%
	50%	1450.0	820.8	9.2	$1,440	11.22%
	75%	1450.0	820.8	7.6	$6,859	14.27%
	100%	1450.0	820.8	6.5	$12,277	17.62%
(300%) 2175 kWh/m	0%	2175.0	1545.8	12.7	-$4,651	7.36%
	25%	2175.0	1545.8	9.8	$768	7.52%
	50%	2175.0	1545.8	8.0	$6,186	11.22%
	75%	2175.0	1545.8	6.8	$11,604	14.27%
	100%	2175.0	1545.8	5.9	$17,023	20.16%

5kW No Facilities Charge

	System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
5kW – No Facilities Charge	(33.33%) 241.7 kWh/m	*0%*	*241.7*	*-349.8*	*19.6*	*-$11,943*	*2.07%*
		25%	*241.7*	*-349.8*	*15.6*	*-$9,792*	*3.65%*
		50%	241.7	N/A	N/A	N/A	N/A
		75%	241.7	N/A	N/A	N/A	N/A
		100%	241.7	N/A	N/A	N/A	N/A
	(66.66%) 483.3 kWh/m	*0%*	*483.3*	*-108.1*	*19.6*	*-$11,943*	*2.07%*
		25%	*483.3*	*-108.1*	*15.0*	*-$8,301*	*4.69%*
		50%	*483.3*	*-108.1*	*12.6*	*-$5,325*	*6.93%*
		75%	*483.3*	*-108.1*	*11.3*	*-$3,175*	*8.06%*
		100%	483.3	N/A	N/A	N/A	N/A
	(100%) 725 kWh/m	0%	725.0	133.6	19.6	-$11,943	2.07%
		25%	725.0	133.6	14.8	-$8,032	4.87%
		50%	725.0	133.6	12.0	-$4,390	7.58%
		75%	725.0	133.6	10.1	-$748	9.58%
		100%	725.0	133.6	9.2	$1,625	11.05%
	(200%) 1450 kWh/m	0%	1450.0	820.8	19.6	-$12,089	1.71%
		25%	1450.0	820.8	13.5	-$6,671	5.73%
		50%	1450.0	820.8	10.3	-$1,252	9.60%
		75%	1450.0	820.8	8.3	$4,166	12.63%
		100%	1450.0	820.8	7.0	$9,584	15.96%
	(300%) 2175 kWh/m	0%	2175.0	1545.8	19.6	-$12,089	1.71%
		25%	2175.0	1545.8	13.5	-$6,671	5.73%
		50%	2175.0	1545.8	10.3	-$1,252	9.60%
		75%	2175.0	1545.8	8.3	$4,166	12.63%
		100%	2175.0	1545.8	7.0	$9,584	15.96%

10kW with Facilities Charge

10kW – with Facilities Charge

System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
(33.33%) 241.7 kWh/m	*0%*	*241.7*	*-941.2*	*18.5*	*-$19,267*	*2.58%*
	25%	241.7	N/A	N/A	N/A	*N/A*
	50%	*241.7*	*N/A*	*N/A*	*N/A*	*N/A*
	75%	*241.7*	*N/A*	*N/A*	*N/A*	*N/A*
	100%	*241.7*	*N/A*	*N/A*	*N/A*	*N/A*
(66.66%) 483.3 kWh/m	*0%*	*483.3*	*-699.5*	*16.7*	*-$16,885*	*3.61%*
	25%	*483.3*	*-699.5*	*13.1*	*-$10,267*	*6.25%*
	50%	483.3	*N/A*	N/A	N/A	N/A
	75%	483.3	*N/A*	N/A	N/A	N/A
	100%	483.3	*N/A*	N/A	N/A	N/A
(100%) 725 kWh/m	*0%*	*725.0*	*-457.8*	*16.7*	*-$16,885*	*3.61%*
	25%	*725.0*	*-457.8*	*12.7*	*-$9,333*	*6.60%*
	50%	*725.0*	*-457.8*	*10.7*	*-$3,318*	*8.85%*
	75%	725.0	N/A	N/A	N/A	N/A
	100%	725.0	N/A	N/A	N/A	N/A
(200%) 1450 kWh/m	0%	1450.0	267.2	15.0	-$14,192	4.72%
	25%	1450.0	267.2	10.7	-$3,429	8.80%
	50%	1450.0	267.2	8.3	$7,335	12.68%
	75%	1450.0	267.2	7.0	$16,257	15.86%
	100%	1450.0	267.2	6.3	$23,320	18.40%
(300%) 2175 kWh/m	0%	2175.0	916.7	13.1	-$10,312	6.24%
	25%	2175.0	916.7	9.7	$452	8.80%
	50%	2175.0	916.7	7.7	$11,215	12.68%
	75%	2175.0	916.7	6.4	$21,979	15.86%
	100%	2175.0	916.7	5.5	$32,742	21.98%

10kW No Facilities Charge

	System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
5kW – No Facilities Charge	(33.33%) 241.7 kWh/m	*0%*	*241.7*	*-941.2*	*16.7*	*-$16,885*	*3.61%*
		25%	241.7	N/A	N/A	N/A	N/A
		50%	241.7	N/A	N/A	N/A	N/A
		75%	241.7	N/A	N/A	N/A	N/A
		100%	241.7	N/A	N/A	N/A	N/A
	(66.66%) 483.3 kWh/m	**0%**	**483.3**	**-699.5**	**16.7**	**-$16,885**	**3.61%**
		25%	**483.3**	**-699.5**	**13.1**	**-$10,267**	**6.25%**
		50%	483.3	N/A	N/A	N/A	N/A
		75%	483.3	N/A	N/A	N/A	N/A
		100%	483.3	N/A	N/A	N/A	N/A
	(100%) 725 kWh/m	***0%***	***725.0***	***-457.8***	***16.7***	***-$16,885***	***3.61%***
		25%	***725.0***	***-457.8***	***12.7***	***-$9,333***	***6.60%***
		50%	***725.0***	***-457.8***	***10.7***	***-$3,318***	***8.85%***
		75%	725.0	N/A	N/A	N/A	N/A
		100%	725.0	N/A	N/A	N/A	N/A
	(200%) 1450 kWh/m	0%	1450.0	267.2	16.7	-$16,885	3.61%
		25%	1450.0	267.2	11.5	-$6,122	7.81%
		50%	1450.0	267.2	8.8	$4,642	11.72%
		75%	1450.0	267.2	7.4	$13,564	14.90%
		100%	1450.0	267.2	6.6	$20,628	17.43%
	(300%) 2175 kWh/m	0%	2175.0	916.7	16.6	-$16,766	3.66%
		25%	2175.0	916.7	11.5	-$6,002	7.85%
		50%	2175.0	916.7	8.8	$4,761	11.77%
		75%	2175.0	916.7	7.1	$15,525	15.63%
		100%	2175.0	916.7	6.0	$26,288	19.58%

50kW with Facilities Charge

	System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
50kW – with Facilities Charge	(33.33%) 241.7 kWh/m	*0%*	*2500.0*	*-3414.2*	*15.2*	*-$66,926*	*4.54%*
		25%	*2500.0*	*-3414.2*	*11.2*	*-$23,431*	*8.18%*
		50%	2500.0	N/A	N/A	N/A	N/A
		75%	2500.0	N/A	N/A	N/A	N/A
		100%	2500.0	N/A	N/A	N/A	N/A
	(66.66%) 483.3 kWh/m	***0%***	***5000.0***	***-914.2***	***15.2***	***-$66,926***	***4.54%***
		25%	***5000.0***	***-914.2***	***11.2***	***-$23,326***	***8.19%***
		50%	***5000.0***	***-914.2***	***8.8***	***$20,274***	***11.94%***
		75%	***5000.0***	***-914.2***	***7.4***	***$61,948***	***14.90%***
		100%	5000.0	N/A	N/A	N/A	N/A
	(100%) 725 kWh/m	0%	7500.0	1585.8	15.2	-$66,926	4.54%
		25%	7500.0	1585.8	10.7	-$15,098	8.85%
		50%	7500.0	1585.8	8.3	$33,857	13.02%
		75%	7500.0	1585.8	6.9	$77,457	16.12%
		100%	7500.0	1585.8	6.0	$121,058	19.61%
	(200%) 1450 kWh/m	0%	15000.0	9085.8	15.2	-$66,926	4.54%
		25%	15000.0	9085.8	10.7	-$15,098	8.85%
		50%	15000.0	9085.8	8.2	$36,731	13.26%
		75%	15000.0	9085.8	6.7	$88,559	17.01%
		100%	15000.0	9085.8	5.6	$140,387	21.21%
	(300%) 2175 kWh/m	0%	22500.0	16963.3	15.2	-$66,926	4.54%
		25%	22500.0	16963.3	10.7	-$15,098	8.85%
		50%	22500.0	16963.3	8.2	$36,731	13.26%
		75%	22500.0	16963.3	6.7	$88,559	17.01%
		100%	22500.0	16963.3	5.6	$140,387	21.21%

50kW No Facilities Charge

50kW – with Facilities Charge

System Size	% Self Consumption	Consumption (kWh/m)	Net Import (kWh/m) *	PP (years)	NPV ($)	IRR (%)
(33.33%) 241.7 kWh/m	*0%*	*2500.0*	*-3414.2*	*15.2*	*-$66,926*	*4.54%*
	25%	*2500.0*	*-3414.2*	*11.2*	*-$23,431*	*8.18%*
	50%	2500.0	N/A	N/A	N/A	N/A
	75%	2500.0	N/A	N/A	N/A	N/A
	100%	2500.0	N/A	N/A	N/A	N/A
(66.66%) 483.3 kWh/m	*0%*	*5000.0*	*-914.2*	*15.2*	*-$66,926*	*4.54%*
	25%	*5000.0*	*-914.2*	*11.2*	*-$23,326*	*8.19%*
	50%	*5000.0*	*-914.2*	*8.8*	*$20,274*	*11.94%*
	75%	*5000.0*	*-914.2*	*7.4*	*$61,948*	*14.90%*
	100%	5000.0	N/A	N/A	N/A	N/A
(100%) 725 kWh/m	0%	7500.0	1585.8	15.2	-$66,926	4.54%
	25%	7500.0	1585.8	10.7	-$15,098	8.85%
	50%	7500.0	1585.8	8.3	$33,857	13.02%
	75%	7500.0	1585.8	6.9	$77,457	16.12%
	100%	7500.0	1585.8	6.0	$121,058	19.61%
(200%) 1450 kWh/m	0%	15000.0	9085.8	15.2	-$66,926	4.54%
	25%	15000.0	9085.8	10.7	-$15,098	8.85%
	50%	15000.0	9085.8	8.2	$36,731	13.26%
	75%	15000.0	9085.8	6.7	$88,559	17.01%
	100%	15000.0	9085.8	5.6	$140,387	21.21%
(300%) 2175 kWh/m	0%	22500.0	16963.3	15.2	-$66,926	4.54%
	25%	22500.0	16963.3	10.7	-$15,098	8.85%
	50%	22500.0	16963.3	8.2	$36,731	13.26%
	75%	22500.0	16963.3	6.7	$88,559	17.01%
	100%	22500.0	16963.3	5.6	$140,387	21.21%

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November 28, 2018

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

Re: Integrated Resource Plan (IRP) Public Consultation

Dear Sir,

In accordance with the Integrated Resource Plan ("IRP") public consultation on Alternative Bulk Generation Proposals, Sol respectfully submits the following comments for the Authority's consideration:

1. **BCM McAlpine and Bouygues Energies & Services**
   - The site has been earmarked by BLDC for an energy project; as such, uncertain as to the developer's rights to use this site.
   - The suggested fuels would require pipeline construction through challenging terrain, without existing right of ways, if sourced from the Ferry Reach Terminal.
   - Fuel delivery by vessels, in particular, LNG vessels would be difficult in terms of access and egress impacts within St George's Harbour.
   - A power plant at this site would be environmentally challenging given its proximity to residents and other historic sites.
   - The proposal lists HFO or LFO products as possible fuel options which do not represent cleaner energy sources.
   - Seems to be lacking in detail to meet requirements for inclusion in the IRP.

2. **Bermuda Engineering Company Limited (BE Solar)**
   - An offshore wind farm would be an expensive solution ripe with environmental, transmission, dispatch and logistical issues.

- The intermittency of 60 MW from wind may be too large for the existing grid and would require battery storage, which would add further expense.
- Depending on the location, an offshore wind farm could be unsightly for the Bermudian seascape and could possibly compromise access for commercial and leisure sea crafts.
- We would suggest that proper evaluation of an offshore wind project proposal requires development of a Feasibility Study which would detail actual siting issues, impacts, expected energy capacity, estimated capital costs and O&M costs of the project.

3. **Bermuda Environment Energy Solutions Group Consortium (BEESG)**
   - The site has been earmarked by BLDC for an energy project; as such, uncertain as to the developer's rights to use this site.
   - Fuel delivery by vessels, in particular, LNG vessels would be difficult in terms of access and egress impacts within St George's Harbour.
   - A power plant and/or an LNG receiving terminal at this site would be environmentally challenging given its proximity to residents and other historic sites.
   - Fuel supply logistics would present challenges.

4. **Bermuda General Agency (BGA) Ltd.**
   - Proper evaluation of a wave energy project proposal requires development of a Feasibility Study which would detail actual siting issues, impacts, expected energy capacity, estimated capital costs and O&M costs of the project.
   - To our knowledge the technology is not currently commercially viable and could potentially result in Bermuda paying for an expensive experiment in wave energy.

5. **Brad Sorensen and Arpheion Inc.**
   - Proper evaluation of this technology requires development of a Feasibility Study which would detail actual siting issues, impacts, expected energy capacity, estimated capital costs and O&M costs of the project.
   - Potentially a very expensive solution exceeding what is required to meet the needs of Bermuda.
   - Effectively an experiment in an unproven technology paid for by Bermuda.

6. **Enviva and Albioma**
   - Wood pellets would need to be imported raising logistical concerns.
   - Utilization of Bermuda's waste for this Biomass technology would not provide any real environmental benefits i.e. minimal reduction in emissions.
   - Reliance would be placed on a limited market for wood pellets as opposed to the extensive LNG market.

7. **Offshore Utilities**

- An expensive LNG solution presenting environmental and logistical challenges requiring studies to assess vessel mooring, ship to ship transfers, and subsea natural gas pipeline.
- To our knowledge, there are no existing small-scale LNG offshore/ FSRU based projects. Small-scale LNG vessels (7,000m^3 -50,000m^3) are transportation vessels. Utilization of small-scale vessels or barges would require pier or trestle mooring at shoreline: offshore ship-to-ship LNG transfers are challenging for small-scale vessels.
- FSRUs are very large, the current fleet is sized between 138,000m^3 to 175,000m^3. FSRU project economics are based upon capacity utilization: markets below 350-400MW demand capacity are considered uneconomical. (Note – the design basis for Sol's onshore LNG tank is 20,000m^3).

At Sol, we continue to focus on Bermuda's energy needs with our ongoing participation in the IRP process. We trust our comments above will be duly considered and we look forward to working with the Authority to ensure Bermuda's energy future remains positive.

Kind Regards,
Sol Petroleum Bermuda Limited

Jonathan Brewin
General Manager

November 30, 2018

Dear Ms. Monique Lister:

Southport Midstream is pleased to provide for your review and consideration its response to the alternative proposals submitted in response to the Regulatory Authority of Bermuda's ("RA") Integrated Resource Plan (IRP). Our comment surround the merits of the proposals in the context of the previously submitted generation proposal submitted by BELCO as well as in the context of the RA's stated mission to "set out the strategy for procurement and retirement of generation assets as well as demand side resources that meets the needs of consumers in a cost-efficient manner that is also consistent with Bermuda's energy policy objectives". In particular, our response focuses on the RAs goal to promote the 'interests of end-users with respect to prices and affordability, adequacy, reliability and quality of electricity service' as set forth in section 14(1)e of the Electricity Act of 2016.

Introduction to Southport Midstream Partners:

Southport Midstream Partners, LLC ("SMP") is an independent infrastructure development company with a focus on niche, often overlooked terminal, storage and distribution solutions for refiners, petrochemical manufacturers, marketers, producers and end-users of natural gas, crude oil, condensate, NGLs, refined products and other bulk liquids. The team has decades of experience across various parts of the energy and finance industries with a specialized focus on wholesale natural gas commodities and associated infrastructure. SMP principals have unique expertise with commercial backgrounds having previously held positions within major wholesale natural gas marketers, traders, originators as commodity merchants throughout North America. In addition, SMP management has played an integral role in the development of many 'first-of-its-kind' infrastructure assets in North America with an emphasis on LNG and natural gas storage/gas pipeline including: Cameron LNG, Costa Azul LNG, Tres Palacios Gas Storage, Leaf River Energy Center, Bluewater Gas Storage, Pine Prairie Energy Center, among others.

SMP's response speaks only to what we believe, in our expert professional opinion, to be the best possible solution for the island of Bermuda and makes no reference to SMPs own project or particular interest in Bermuda as a prospective fuel supplier. To that end, we have reviewed and provide commentary on the eight proposals received thus far in the IRP with respect to generation and offer a recommended path forward. We also have shared for the Committee's review, our perspective on what the most feasible, economic, and viable option is for the island of Bermuda going forward to procure fuel to support the recommended generation programme. This includes identification of particular risks and concerns that were highlighted in some of the hybrid, generation/ supply chain solutions proposed in the IRP process.

A. Executive Summary:

At least four categories of generation types were proposed ranging from traditional dual-fuel bulk power plants to more unconventional and alternative types such as off-shore wind, wave, hydrogen and biomass. In our view, all of the proposed solutions have a range of significant **feasibility** challenges and are not suitable or realistic for the island of Bermuda. First and foremost, options that consider use of unproven technologies such as wave, hydrogen, and biomass fail to meet basic concerns and minimum threshold requirements in terms of reliability. Furthermore, all of these proposals, even more traditional approaches such as alternative dual-fuel bulk power solutions proposed are **uneconomic** relative to the currently proposed BELCO solution.

We strongly recommend Bermuda continue on the path that it is going in supporting the BELCO conversion of Pembroke Power Plant and its proposed dual-fuel design, without further delay, as the most viable, economic, practical and rational response to baseload power generation. Introduction of an IPP model on the island will not have the same success or provide the benefits on the island of Bermuda that it would have elsewhere in markets with the size to accommodate a diverse competitive market. Overall, we feel an IPP model in Bermuda, suggested by other parties, introduces second level and unintended risks to the bulk power system as well as unnecessary costs that are not properly accounted for in the aforementioned proposals.

To that end, we also recommend a specific supply procurement strategy that will ensure the least cost of supply to the new generation facility which will allow Bermuda to realize the lowest per mwh price for electricity going forward. This plan encompasses the following:

i) Procure fuel separate from infrastructure. Avoid offers that "roll-in" cost of fuel into cost of infrastructure.
ii) Procure LNG delivered by small-scale LNG vessel not to exceed 20K CBM in size.
iii) Pursue land-based storage terminal for LNG importation with not more than 20K CBM of storage.
iv) Pursue a natural gas pipeline as the mode of delivery to power plant, avoiding road-based delivery methods by truck.

B. Review of Proposed Generation:

Bermuda must consider and analyze these proposals relative to current generation mix and comparatively in terms of the "next best option". It must also consider the cost of the entire supply chain not just on the cost of the generation itself. Failure to do a comparison will not enable Bermuda to determine whether the alternative is in fact, superior, which is particularly acute with respect to reliability and economic viability.

Proposals are Not Reliable or Economic Relative to Existing Alternative:

Alternative generation solutions proposed include biomass (Enviva), wave energy (Bermuda General Agency Ltd), and hydrogen (Brad Sorensen and Arpheion Inc). While biomass has had some limited success in the United States, it is entirely unsuitable for the island of Bermuda in that is not an adequate baseload power source with a very limited track record of success. Other alternative renewable projects such as wave and hydrogen are even more problematic in that they are in very early stages of technological development and are unproven. Given this, it would be ill-advised for Bermuda to adopt this as a primary generation source, at this point in time. Not to mention, in comparative terms, all of

these proposals on a per Mwh basis are exceedingly more costly than traditional technologies (combined cycle) such as that under development by BELCO at Pembroke.

Furthermore, floating power plant alternatives such as that proposed by Offshore Utilities is ill suited for Bermuda. While there are a number of floating and fixed offshore facilities around the world, many of these facilities are often located in areas where there is a natural geographic barrier to protect the infrastructure or moored at an existing port at shore. These facilities cost more than land based solutions and as such are typically brought in as a temporary solution. In particular, relocating bulk power off-shore would introduce significant supply security concerns especially where the provider is a foreign owner. It seems implausible to relocate a critical asset generating baseload power off-shore, where the platform would be more susceptible to intended or unintended risks or even removal due to a possible dispute. Put simply, compared to land-based solutions, an offshore facility presents an unnecessary environmental and operational risks and undue commercial risk with a critical infrastructure asset that can literally be sailed away in a contract dispute or bankruptcy. In all, offshore solutions are not superior to land-based solutions in terms of economics or reliability. While Offshore Utilities promotes its solution as a solution for land constrained locales, there are already viable sites proposed that do not necessitate this type of a solution.

Similarly, off-shore wind proposals such as the 60MW proposal submitted by Bermuda Engineering Company Limited (BE Solar) are not a realistic solution for Bermuda in that the incremental cost to build adequate off-shore transmission is not suitable for a need the size of Bermuda especially where there are viable land-based alternatives and where the present transmission is adequate. Typically, subsea transmission connections are useful where a physical connection with a continental power system to leverage that location's economies of scale in energy production. Subsea transmission in spite of Bermuda's geographic isolation does not follow the typical rationale for adopting such a programme.

Competitive Power Models (IPP) Would Not Reduce Power Prices:

SOL and BEESG propose dual fuel bulk power stations at both Ship's Wharf (BEESG) and Ferry Reach (SOL) locations. While dual-fuel reciprocating internal combustion engine technology, as an asset class, is a proven, cost-effective technology, in this case, diversification of the supply mix will do very little, if anything, to reduce the per Mwh cost of generation. This is because the introduction of more entrants and multi-site generation will cause Bermuda to forfeit any economies of scale afforded to it by generating bulk power at one central station, with virtually no competitive benefits. In addition, new transmission lines will have to be added in order to serve the same load that has existing connection today which would place an additional and unnecessary burden on the rate payer. The island demand is simply too small for the IPP model to be effective in Bermuda.

In fact, studies have shown that countries with capacities below 1000 MW would not attract sufficient numbers of participants in generation and distribution to introduce sustained competition, a pre-requisite for achieving more efficient production.[i] As a consequence, competition in production and distribution would not deliver the desired economic benefits as often realized in larger developed countries.

Monopolistic conditions or quasi-monopolistic conditions in Bermuda are what have historically allowed it to achieve lower electricity costs by generating economies of scale derived from a centralized production infrastructure and a single transmission network. Aside from cost, the primary benefits to

this approach on the island have been expanded supply, improved operating efficiency, and guaranteeing and enhancing reliability and access in the most economic terms, by eliminating the need to coordinate these objectives or secure multiple financing arrangements. The original goal here was purely around the provision of electricity and energy services.

There could be other adverse consequences of decentralizing generation on island. For one, SOL and BEESG are inexperienced generation operators which raises the argument of necessity in the context of diversification. This may go without saying, but operation of a bulk liquid storage requires altogether a different operational as well as management competency. The qualifications of parties to develop and operate new generation in Bermuda should be integral to such a decision. Even in a scenario where another party generates power in Bermuda, given its size, BELCO would still serve the role as the RTO (Real Time Operator) and sole distributor of the electricity on island as one single market zone because it would be impractical to geographically divide parts of the service territory into multiple competitive 'market' regions. Bermuda would still operate a 'cost of service' generation market, but now with two rate-payer supported entities. For an IPP model to generate the savings necessary to compensate multiple generators, Bermuda would have to convert to an at-risk market-priced generation model, similar to what is seen larger markets in the U.S., Europe or even island markets with sufficient load, such as the Dominican Republic. Bermuda simply doesn't have the load to support a dozen or so generators competing in one market operated by a central RTO.

As well, foreign ownership could result in capital outflow on the island, which can weigh heavily on economies where the ratio of electricity consumption as a share of GDP is high. As company shares are likely to be held in foreign hands, dividends are received and spent abroad and cannot be reinvested in the local economy.[ii]

None of this is to suggest that Bermuda should have an unregulated, under-regulated, or mis-regulated power monopoly. It should not. Rather, one well-regulated power company that conducts bids and auctions properly and with regulatory oversight, will be the least cost option compared to that entity being compelled to purchasing power from an IPP. In Bermuda's case, power generation 'unbundling' may create additional costs and unintended consequences that outweigh any realized gains.

C. Recommended Approach: BELCO Expansion at Pembroke

The current proposed generation project by BELCO is the "best" and "least-cost" path that would result in the lowest possible power prices for the island, presuming BELCO pursues the currently contemplated plan to import LNG.

The many benefits of adopting natural gas as a primary generation fuel have been widely discussed and researched in Bermuda, by Leidos and others, ranging from reduced electricity costs, fuel security, fuel price stability, and environmental benefits from reduced emissions. As a result, we do not seek to revisit these in our commentary. Rather, with this path towards fuel conversion in mind, we recommend the following approach be taken by BELCO, with regard to fuel procurement and in so doing, the facilitation of on-island infrastructure development to support the importation of new fuels.

i) *BELCO should procure Bulk LNG delivered by small-scale vessel into a small land-based terminal not larger than 20,000 cbm of land-based LNG tank storage where LNG vaporized and delivered to the power-plant by pipeline.*

This being said, it is important for well-defined criterion be firmly established in any supply procurement process so that bids can be evaluated on an apples-to-apples basis. Otherwise, LNG fuel delivered on a 180,000 cubic meters (cbm) vessel may appear to be less expensive than LNG fuel delivered on a smaller vessel, however, the storage costs would be ignored, whereas a larger storage facility would be required at a greater cost in order to receive this supply. The cost savings from scale in the transportation of LNG by a bulk vessel would not outweigh the cost of constructing a single, dedicated, larger scale storage facility in Bermuda because those costs could not be spread (as they can be, for example, in the Dominican Republic where the electricity demand is roughly 20X the size of Bermuda's).

Because minimizing the 'delivered cost' of LNG fuel to the power plant is the goal, the other variable components in the supply chain must be standardized and fixed so as to be able to properly isolate and evaluate the cost of the supply feedstock itself.

ii) Fuel procurement process should be separate from the generation and any terminal procurement process, in order to ensure greatest transparency and least cost pricing

There are more market participants able to offer LNG supply-only products relative to the numbers of players able to offer a 'bundled solution'. Selection of the latter would limit the competitiveness of a process and likely lead to higher prices on the production of power from a MWh basis, where fuel, storage, and transportation costs are inputs

iii) The fuel delivery method of choice to distribute natural gas on the island should be by pipeline, not by ISO container or by truck. The same is true for the upstream supply chain. Be wary of truck-to-ship ("virtual pipeline") solutions that carry increased delivery risk, safety concerns, and logistical challenges.

Not only are virtual pipeline solutions proposed by Edge Gathering Virtual Pipeline solution (Nextera) fraught with logistical challenges and are highly questionable, these ISO or trucked options present too much upstream supply chain delivery risk that BELCO/Bermuda should not introduce into this process. Accident risk of trucks as well as liability risk for the upstream delivery party in the event of a catastrophe would jeopardize Bermuda's supply source. Not to mention, the route proposed by Edge Gathering Virtual Pipeline is located in one of the coldest geographies in the US, where LNG would be transported on icy roads and in poor conditions during the winter months. This is why many US utilities who rely on truck deliveries of LNG schedule them only seasonally and in the summer. No North American utility or critical infrastructure relies solely, or even substantially, on a trucked fuel solution, and neither should Bermuda. [we can note ISO New England's comments and concerns on trucked reliability for fuel oil to power plants – which represents a small percentage of New England's needs].

A traditional LNG liquefaction project, using piped natural gas as feedstock, where LNG is then piped directly into a vessel is the most reliable & proven method. Furthermore, the ability to <u>export</u> LNG from the US by container/truck without requiring federal authorization under Section 3 of the Natural Gas Act is very questionable as this method demonstrates an intent to circumvent.

Reliance on trucked LNG supply upstream would warrant the procurer in Bermuda to evaluate on-road delivery / upstream supply chain risk to its evaluation criteria. This would be an additional risk concern and burden that seems unnecessary relative to alternative methods. In particular this method:

1) ***Lacks transparency:*** This would introduce more possibility for upstream (US) supply disruption with limited oversight.

2) ***Is unprecedented***: LNG by truck plays a role as a short term off-peak or interruptible solution but not as a baseload method and certainly not as a long-term obligation (10+ years). No utility in North America relies 100%, nor even substantially, on trucked fuel for baseload requirements to critical infrastructure as a matter of practicality, so why should Bermuda?

3) ***Is unregulated***: Trucked LNG ("off-grid") is unregulated relative to traditional interstate pipeline method of deliveries in the United States that govern safety standards.

4) ***Is hazardous***: Introduces additional security & safety concerns given the number of trucks and containers required to successfully be transferred from port to power plant on already constrained Bermuda roads.

5) ***Is uneconomic***: Trucked LNG / virtual pipeline solutions are not economic relative to bulk alternatives, where bulk alternatives are feasible as is the case with Bermuda, especially over a long-term horizon. Any proposal that claims otherwise should be met with caution.

We applaud the RA's work to reform Bermuda's energy policy and support a course that leads to adoption of the most affordable and reliable energy infrastructure available. SMP's comments to the IRP responses, BELCO's proposal and its presumed path towards the adoption of a new fuel (LNG) are aimed to help the RA achieve that goal. Given the size and geographical location of the island, few, if any models exist elsewhere that suit Bermuda's unique circumstance. Many policies and programs existing in other markets that result in lower generation costs and greater environmental benefits simply are not feasible and regulatory reforms to mirror them should not be advanced. The cost of unreliable infrastructure is simply too high. In our view, BELCO's proposal offers the most reasonable, efficient and sustainable path to obtaining the RA's goal of simultaneously lowering end-user costs and substantially reducing emissions.

We appreciated the opportunity to provide this feedback and are available should any follow up questions need response.

Respectfully,

Ashlee F. Fox

Ashlee F. Fox

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