

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

Consultation Questions

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

- I) Greenrock believes that the RA needs to define a better methodology as regards the Qualitative Analysis described in the IRP (Section 1.12) as the judgements contained within are inherently subjective and can lead to perverse results. It is not clear, from the IRP itself, how the particular factors are fully defined, despite the factor descriptions in Table 1-3.
 - a. For example, 'Environmental Sustainability' encompasses more than simply GHG emissions (as important as that is), such as impact on air and water pollution, inclusive of impact on the nearshore environment as regards new infrastructure (docks, regasification plants, risk of oil spills or uncontrolled gasification of LNG). A more expansive definition of this factor should be developed – and this can be quantified as well.
 - b. Security & Cost Resilience – this factor could in theory also consider the impact of catastrophic accidents (terrorist attacks or accidental uncontrolled gasification of LNG) and better quantified.
 - c. Economic Development – focusing solely on the degree that this factor leads directly to job creation can lead to a perverse outcome, as noted in the Oxcerpta report note 5.10. A more robust metric for this factor could be developed.
- II) Greenrock believes that the RA should better define the evaluation of GHG (CO₂ equivalent) in terms of the IRP. Of particular concern from our perspective is that the IRP adopts a purely 'point of consumption' approach to GHG emissions, whereas we believe a more appropriate metric would be that of a life-cycle assessment. By adopting a point of consumption approach, the analysis indicates that LNG has one of the lowest carbon footprints. However, the production and transportation process of LNG are not factored into this equation, whereas these are factored into the life-cycle assessment approach. Notably, the amount of Methane released into the atmosphere from the production process of LNG greatly increases the carbon footprint of LNG – indications are that this increases the carbon

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footprint by 8,000%. By adopting a life-cycle assessment the LNG model is properly seen as having the largest carbon footprint of all the scenarios proposed.

- a. Of particular note for measuring the life-cycle carbon production of LNG is the paper by Howarth (2015)¹ which indicates that the actual carbon emissions of LNG are substantially greater than coal or oil fuel sources. This paper concluded that LNG is inappropriate as a bridge fuel or as an approach to reducing carbon emissions overall.
 - b. We also note the importance of incorporating the carbon emissions involved in preparing LNG for transport and the construction of infrastructure on island. Bradbury (2013)² provides a useful overview of these matters for consideration.
 - c. The work by Asah & Salcito (2013)³ also provides additional information regarding the proper carbon footprint of LNG relative to alternative fuel sources.
- III) We are not convinced that the economic cost of building the infrastructure required for supporting LNG in Bermuda (terminal, pipelines) has been adequately captured in this report; we believe that the value suggested is far below the likely actual cost and believe this requires closer scrutiny.

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

- I) Section 2.7.2 of the IRP highlights the LNG viability study conducted in 2016; however we are aware that no such viability study of solar power in Bermuda has been studied. We are aware that such studies have been conducted for other small island developing states, and that this has greatly informed IRP processes for them, by providing Regulators with all the relevant information they need to determine the best possible mix of energy generation for the jurisdiction in question. The lack of such information, along with similar such reports for biomass (locally produced such as cooking oil waste and imported such as wood pellets) and marine hydro would also benefit the Regulator in determining the most suitable energy mix for Bermuda with existing technology. We would advocate that the RA require that such studies should be done before the completion of this IRP process.

¹ Howarth, R.W. (2015) *Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: implications for policy*. Energy and Emission Control Technologies; vol 3; pp.45-54. Available online at: http://www.eeb.cornell.edu/howarth/publications/f_EECT-61539-perspectives-on-air-emissions-of-methane-and-climatic-warmin_100815_27470.pdf

² Bradbury, J. (2013) US Energy Abundance: Exports and the Changing Global Energy Landscape. <https://docs.house.gov/meetings/IF/IF03/20130507/100793/HHRG-113-IF03-Wstate-BradburyJ-20130507.pdf>

³ Afsah, S. & Salcito, K. (2013) Shale Gas: Killing Coal Without Cutting CO2. <https://co2scorecard.org/home/researchitem/28>

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

- I) We do not have a strong position on this matter at the moment. At most we believe that there is value in competitive bidding for all aspects in order to ensure (a) transparency; and (b) the best value for money (especially in as much as the costs are borne by the customers, that is, the population of Bermuda).
- II) On this we are disappointed that the RA did not insist, as part of approving the NPS, that this again be subject to competitive bidding due to the elapsed time between the 2011 bidding and the current time. On this we note section 4.9 of the Oxcera report to the RA concerning options to revise the parameters in question.

(4) Are there alternative scenarios not included in the IRP Proposal, which may provide for an electricity generation mix that is more consistent with the purposes of the EA?

- I) As noted above we believe that in order to make an adequate electricity generation mix proposal we require some additional information. There are existing studies concerning viability of wind power and LNG for Bermuda, however we are lacking similar studies looking at the potential for solar power, marine hydro and biomass. Of these we believe that the solar power viability study is the main 'missing link' which is required in order to develop a proper IRP. Until we have a greater idea of the total potential solar power generation for Bermuda (in terms of both distributed generation, i.e. residential, commercial and institutional land; and utility scale, such as the finger, the space vacated by the decommissioning of old engines at the BELCO plant) it is difficult to ascertain what the best electricity mix with current technology is.
- II) As such, we believe that an independent study on the viability of (i) solar power; (ii) biomass; and (iii) marine hydro should be conducted as part of the IRP process to determine the best options available to Bermuda.

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

- I) We have concerns with the Qualitative Assessment aspect of the IRP outlined in section 1.12 of the IRP (see above, 1(i)).
- II) We have concerns about the approach taken by the IRP to measure carbon emissions solely from the point of consumption rather than adopting a life-cycle assessment approach (see above, 1(ii)).

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- III) We have some concerns about the approach taken by the IRP regarding carbon monetisation. We note for example that the USA's Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases had as its central estimate of the cost of carbon per ton to be US\$50 at a 3% discount rate in 2017 USD. While the cost of carbon requires regular updating to reflect the latest evidence about damage functions, and the current administration in the USA has since disbanded the IWG, we believe that their methodology and estimates are superior to that produced by Synapse and the values should be used instead. We recommend that the RA adopt the IWG's methodology⁴ for carbon monetization and apply it to the IRP process itself. We also recommend that the RA review the UK Government's official carbon valuation policy and methodology⁵ and apply these to the IRP. Importantly, as stressed in section 1(ii) above, the IRP misrepresents the carbon footprint of LNG versus other fuel or energy sources by only adopting a point-of-consumption measurement, whereas a more appropriate measure is that of life-cycle analysis, measuring the GHG emissions of LNG from production and transportation as well as consumption in Bermuda. We understand this to be best practice as per the IPCC's Fifth Assessment Report (specifically Annex II, Metrics and Methodology, section A.II.6, p.1,297-1,300)⁶.
- IV) We have concerns about how the IRP assumed the NPS replacement generation will be built under all scenarios. We viewed the approval granted to BELCO to proceed with the NPS as fundamentally undermining the IRP process in that it effectively prejudiced the IRP outcome by being approved prior to the completion of the IRP itself. We would expect the RA to require BELCO to amend their scenarios by creating new ones that do not assume the NPS is built in all scenarios, and in so doing providing greater clarity on what would be the best option for the development of the energy market in Bermuda. We note that these concerns were also highlighted in the Oxcera report and believe that the RA should take action to remedy this during the IRP process.
- V) We are not convinced that the LCOE approach undertaken in the IRP; we concur with the Oxcera report that this approach can be invalid and misleading. While it can provide useful information as part of the IRP process, we caution about it being a deciding factor. In particular, we note that this LCOE approach does not fully capture the benefits and costs to the power system, the wider economy, society, public health and the environment of both wind power and solar PV. We would recommend that the RA follows the implied recommendation of the Oxcera report (sections 5.3 to 5.6, particularly the recommendation of 5.6) to utilise an alternative method to the LCOE approach as part of its review of the IRP in question.

⁴ IWG (2016) Technical Support Document - Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.

https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

⁵ See <https://www.gov.uk/government/collections/carbon-valuation--2>

⁶ See Masera, et al (2014) https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_annex-ii.pdf

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- VI) While not made explicit in the IRP, we do have some concerns about the implementation of a smart grid (smart meters) which BELCO has been installing and is part of their widely advertised three pronged strategy, under the heading of Transmission & Distribution Upgrade. Specifically, they note that as part of their grid modernisation they intend to introduce Advanced Metering infrastructure (AMI). We are currently reviewing the environmental and economic impacts of such a transition and are preparing a more document for the RA to consider. Our concerns stem. In principle the idea of such smart metering sounds good, in terms of the ability to (i) raise awareness to consumers about energy usage; and (ii) theoretically allowing for behavioural change leading to flattening out peaks and troughs in energy demand. However, there appears to be limited evidence of behavioural change in the literature; the evidence we have seen so far is that it leads to just 3% behavioural change. Additionally, if smart meters are coupled with dynamic pricing (the cost of electricity changing based on demand, with the theoretical impact of encouraging consumers to use electricity at cheaper times) this could lead to the utility escaping regulatory oversight while not leading to substantial changes in consumption patterns. In a larger country than Bermuda this 3% behavioural change may well lead to substantial energy savings, in Bermuda this would be insubstantial due to scale. We also understand that the utility for smart meters are better for industrial economies, where it is easier to change the patterns of industrial production than it is to change the patterns of daily domestic life. From a worker perspective, smart meters lead to job losses without providing much in the way of new job opportunities, a situation that is reversed in a transition to renewable energy. We are also researching the potential environmental impact of a wholesale transition to smart meters in terms of impacts on biodiversity. Beyond these concerns there are also risks relating to security and privacy which require consideration. As noted, Greenrock will be preparing a document on our concerns around this for the RA's review shortly, however we felt it important to provide an overview of our concerns at this point.

(6) Do you have any alternative proposals for the bulk generation or demand side resources that should be considered in the IRP?

- I) Unfortunately Greenrock does not possess the resources to generate a full alternative IRP for this exercise. However we do believe that:
- a. Of the four scenarios presented, when incorporating the life-cycle assessment approach to carbon footprint, scenario 2 (focus on renewable energy, existing fuel oil, energy efficiency and electric vehicles) is the optimal scenario for Bermuda.
 - b. We believe that scenario 2 however takes too timid an approach to forecasting both energy efficiency and potential renewable energy generation; we believe that a proper study on solar PV potential in Bermuda should be conducted to better inform the IRP on this aspect.
 - c. We do not believe that LNG is the best option for Bermuda due to (i) the carbon footprint of this being the largest of all the options (based on life-cycle assessment); (ii)

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the infrastructure requirements for LNG in Bermuda are substantial and, we believe, incompatible with Bermuda's size (in terms of the need for a secure zone around the regasification plant and pipeline to the power plant); (iii) It does not appear that the IRP has properly costed the infrastructure costs associated with IRP into their models, including the need for brownfield remediation.

- d. While we believe in the ability of Bermuda to transition to a renewable energy future, we recognise the need for an energy bridge while we transition to that (through energy efficient technologies and renewable energy sources). We do not consider LNG a viable bridging power source for that. While we are not fans of fossil fuels in general, we do believe that the current fuel used by BELCO is less problematic in terms of carbon footprint than LNG and, with the installation of more modern and efficient turbines, can provide that energy bridge.
- e. As such we believe that an ideal IRP for Bermuda would be a more ambitious version of scenario 2 outlined in the existing IRP combined with more efficient turbines utilising existing fuel sources.

Consultation questions

1. Are there any provisions in the IRP Proposal that should be modified? Please include any reasoning and evidence in your answers.
2. Do you consider that the procurement strategy outlined in the IRP Proposal is appropriate?
3. Which generation resources should the TD&R Licensee procure using competitive bidding, if any?
4. Are there alternative scenarios not included in the IRP Proposal, which may provide for an electricity generation mix that is more consistent with the purposes of the EA (e.g. least-cost provision of reliable electricity)?
5. Do you have any additional views on the assumptions, assessment methodology, and conclusions set out in the IRP Proposal?
6. Do you have any Alternative Proposals for bulk generation or demand side resources that should be considered in the IRP?

Looking at the IRP proposal it seems to me that the projected goals are far too unambitious and make no mention of solar power. Bermuda needs to move away from reliance of overseas oil/gas imports - with all the problems that go along with that - fluctuating prices, pollution (in production, shipping and local burning) and insecurity. It is also a huge drain on Bermuda's budget.

With the major and rapid improvements in renewables, especially solar power and batteries, Bermuda can, and must do better to ensure a secure and affordable energy supply. On a personal note, I had a small bank (10) of solar panels put in 4 years ago and have been very pleased with the results. I do wonder though how BELCO decided on the greatly increased Facilities Charge.

The huge cost of LNP infrastructure would tie Bermuda into costly energy for at least 20 yrs. We cannot wait that long. Bermuda is particularly vulnerable to the effects of climate change - ocean acidification, warming waters, rising sea levels, intensified storm systems - and whilst our efforts may make a small dent in planetary pollution, if Bermuda is not prepared to help itself, one would ask why other nations should be concerned on our behalf.

LPG does not require the massive investment so can be phased out more expeditiously.

Energy efficiency will also reduce demand, yet the target set for 2038 by BELCO (less than 5%) is frankly appalling. The Government has set a laudable, but conservative goal of 15%. We can and must do better. Review of import restrictions and/or taxes could be used to encourage consumers towards energy efficiency as we know that the use of LED lighting, energy efficient equipment (particularly air conditioners) electric vehicles, timers can all work to improve EE. Perhaps it could be mandated that new builds and substantial building renovations/conversions include EE appliances, timers on heaters and photovoltaic panels. If Government Bldgs were solar powered, the reduced costs of energy would quite quickly pay for the install.

Thank you for offering this opportunity to comment.

Sincerely

Jennifer Flood

**Response to the
2018 Integrated Resource Plan Proposal
Bermuda Electric Light Company Limited
Leidos – February 5, 2018**

Summary:

Many critical assumptions in the IRP are not supported, and there are a number of glaring errors and omissions. Based on the analysis below it is apparent that the IRP should not be accepted and does not support its stated conclusion of “implementation of the Preferred Plan outlined in Scenario 3 [full conversion to natural gas “NG”]” (ES-2). The Regulatory Authority (RA) should not accept the conclusions of the IRP, but should ask BELCO/Leidos to provide additional detail in its analyses and prepare a revised version of the IRP for public discussion.

Consultation questions:

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

a) The IRP assumptions on rooftop PV are flawed and will affect the demand forecast

The IRP apparently assumes that there will be no further penetration of rooftop PV and that it will remain stable at about 1% of power generated for the next 20 years. This is a very unrealistic assumption given that the price of small scale PV continues to tumble and installations of rooftop PV in every country in the world are increasing steadily. This will likely be the case in Bermuda as well, particularly in the context of increasing retail electricity prices (see below).

Rooftop solar is treated as a commercial generation resource and therefore the calculation of the NPV of rooftop solar and solar thermal hot-water is done on a LCOE basis on the implicit assumption that the electricity (or avoided electricity use in the case of solar thermal hot water) is sold back into the grid. However, rooftop solar is mostly consumed behind the meter, and therefore displaces electricity at the full retail price, so LCOE is not the correct calculation. In this context, although Leidos says that “This IRP is focused on the projected cost of producing the net energy to serve Bermuda’s electric system load over the Study Period, and does not reflect the translation of estimated production costs into retail rates for any of BELCO TD&R’s rate sectors” (Section 1.1 p. 1-1) it is relevant for the IRP to consider the impact of various pathways on electricity prices, as any increase in retail electricity prices (likely to be the case in all scenarios) will result in rooftop PV becoming an increasingly attractive option. Retail price trajectories could have a very significant impact on the contribution from rooftop PV.

If the assumptions are corrected and rooftop solar penetration is recalculated then this could significantly change the demand trajectories – affecting the NPV of all scenarios.

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

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

This note addresses both question 2 and 3 above:

BELCO should use competitive bidding to assess all commercial generation resources. With the caveats contained in this response, a combination of quantitative (LCOE and NPV, including the option value of different resources) and qualitative criteria should be used.

However, there should also be the facility to conduct competitive bidding on EE and EC measures, including rooftop solar thermal installation. These should not be conducted using LCOE as a benchmark and the process outlined above as (other than a DSM business as discussed below point 6) these are essentially standard services offerings and can use a standard business procurement process.

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

a) An aggressive Renewable Energy scenario should have been tested

There is no explanation for why the different cases were chosen for study – Leidos state that “based on discussions with BELCO and the sum total of work conducted as delineated in this report, the following cases are the subject of the production cost modelling” (Section 1.11.1). There is no explanation of why, for example, an aggressive renewable energy (RE) strategy is not tested, despite the fact that this would be consistent with 2011 Energy White Paper objectives, and the stated objective of the qualitative analysis which to “address a sustainability objective, since the least cost plan based on quantitative analysis may exclude these resources” (Section 1.12, p. 1-16). Ironically the conclusion in Section 2.2 recommends Scenario 3 (LNG conversion) partly because “the NG scenario, Scenario 3, has the lowest carbon footprint over the source of the study period” (Section 2.2 p 2-4) – which would certainly not be true if an aggressive RE scenario had been assessed.

What would an aggressive RE strategy look like? It would include expansions of commercial scale and residential PV (both of which have been included to a limited extent in the current scenarios) as well as wind and wave energy – with demand management and/or batteries to manage intermittency and help with voltage balancing. A significant increase in rooftop solar is not only feasible, given the area of rooftops available, but also very likely (see point 4 below). The aggressive RE scenario would likely still require a small baseload plant, but the reduced scale would probably make LNG unattractive. An aggressive RE scenario may well end up not being the most attractive, but it should have been tested given the goals of the 2011 White Paper to reduce Bermuda’s dependence on imported fuel.

The IRP employs a hand-waving dismissal of the potential for wind and wave energy. Wind energy is dismissed as follows: “offshore wind resources were screened out from further consideration because of cost and logistical uncertainties that require addressing in a feasibility study” (Section 2.1 p. 2-1). Wave energy is also not considered because “no utility scale installations have been completed” (Appendix II-F, p. 4) despite the report going on to acknowledge in Appendix II.F that “Commercial roll

out of CETO 6 or island jurisdictions is anticipated for 2020/2021” which is well within the study timeframe (ibid p.6).

The issue here is that the enthusiastic endorsement of LNG may well result in very high levels of capital investment in LNG infrastructure which will preclude Bermuda from ever investing in alternative technologies despite the rapidly advancing opportunity. This also results in the loss of opportunity value (see point 3 below).

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

a) LNG capital costs are not fully captured

The capital investment used to calculate the NPV of the LNG scenario are not consistent with previous studies and do not appear to reflect the full cost of investing in the infrastructure needed to make LNG available for electricity generation.

The IRP draws heavily on the Castalia report of 2016¹ – however, the Castalia report cites the minimum cost of LNG infrastructure for the island as “\$258 million over 5 years with the new power plant alone representing a capital investment of \$138 million dollars” (Castalia report p.26). Given this, there is no explanation for why the capital cost for conversion to LNG included in the NPV calculation is given as \$117.091 million. If assumptions have been made that a third party will invest in LNG infrastructure, they will still need to recoup at least some of the costs from the utility, so these costs should be included in the NPV calculation.

It is also worth noting that the Castalia report compared the viability of LNG vs fuel oil only, not vs alternative generation technology, and recommended “a detailed evaluation of costs, social risks, and environmental risks” (ibid Executive Summary p vii) before proceeding.

b) LNG looks very unattractive if the option value of alternatives is considered.

The different scenarios have very different value propositions if one takes into account the future opportunities that remain open, or are taken off the table, depending on the scenario implemented. It is possible to assign a value (both conceptually and quantitatively) to the ability to dynamically respond to uncertainty such as non-linear changes in fossil fuel pricing, or higher than forecast global response to climate change. There is also value in leaving open the option to implement new technology as it becomes attractive (see discussion of wind and wave technology in point 1 above).

LNG as a fuel option requires investing hundreds of millions of dollars in LNG infrastructure for the island and locks Bermuda into a full LNG option immediately, making the country dependent on imported fuel for the foreseeable future. This dramatically reduces the option value of alternative technologies or fuels. The LPG scenario has a very similar NPV to the LNG option, but given that investment is more incremental (requiring upgrading and expansion of current facilities) it leaves open the opportunity for a

¹ See Section 5 of the March 2016 report “Viability of Liquefied Natural Gas (LNG) in Bermuda”.

course correction if the assumptions in the IRP on renewable energy, variability in fuel pricing, or the introduction of carbon pricing prove to be incorrect.

Option values of pathways can be calculated explicitly² and should then be included in NPV values to allow comparison of different scenarios – this should be done before a final decision is made.

c) Qualitative assessment scores are biased towards LNG.

There is very little explanation of how the qualitative assessment scores (Section 2.5, p. 2-14) were derived: they are essentially assertions. Without more depth it is hard to understand how, for example, Natural Gas/Fuel Oil scored the highest for “Economic Development”; presumably based on the jobs during the installation and ongoing O&M. In this case an argument can be made that “economic development” for residential solar thermal and PV should be at least as high, given there are forecast to be many more ongoing jobs on the island installing rooftop PV than in installing NG. In addition, local PV installation results in the investment staying on the island and contributing to ongoing economic health of Bermuda, while fossil fuel-based electricity generation will result in the export of millions of dollars of currency to pay for the fuel.

d) The cost of Energy Efficiency and Demand Management is inaccurately modelled

The assumptions for the cost and impact of Energy Efficiency (EE) do not appear to be detailed in the 2018 IRP but can be found in the 2016 draft IRP in Table 1-3, p 1-17. Leidos states that they have assumed that the ‘low hanging fruit’ represents only the first 1-2% of energy conservation and the cost of EE will rise steadily in order to access further efficiency (Leidos has assumed that the cost of EE or EC continues to rise in a straight line over the next 20 years). This may be true if all measures were taken today, but it is incorrect to extrapolate these assumptions over the 20 year life of the study.

This assumption of steadily and significantly increasing cost is very unlikely to be true, as basic technology for appliances such as air conditioners and washing machines is becoming much more efficient and this is expected to continue. Therefore a significant proportion of EE will be achieved through normal appliance lifecycles without any investment by the utility.

In addition, the advance of the “internet of things” means that Energy Conservation (EC) will be able to be accessed more cheaply and easily over time. For example, pool pumps or hot water heaters can be accessed and linked remotely to solar power generation so that there is no additional draw on grid energy. Therefore the assumption that the cost of accessing EC continues to increase linearly is unlikely to be true: These assumptions should be corrected in calculations of forecast load.

e) See note 1 a on how assumptions on rooftop solar will affect the demand trajectory calculation.

² For example: Luehrman T., “Investment Opportunities as Real Options”, *Harvard Business Review*, July - Aug. 1998, and Luehrman T., “Strategy as a Portfolio of Real Options”, *Harvard Business Review*, Sept. - Oct, 1998

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

Note – another quite likely source of power over the next 20 years is the appearance of demand side management as a business. The ability to connect and remotely control devices can be packaged into a “negawatts” generation business, and the ability to shed load via discretionary high load devices, such as pool pumps will be available via standard PPAs. This is already the case in parts of the US and Australia.

Comment on the Conclusions in the IRP:

Given the flaws in the IRP, and in particular the lack of inclusion of all costs in the LNG NPV and the loss of option value if the “preferred” scenario is implemented, it would be very damaging for the Regulatory Authority to accept the stated conclusions without a thorough review and revision.

It is also very concerning that BELCO have apparently already jumped ahead to implementing the LNG policy. Their website <https://yourenergyfuture.bm/> states that “Three major upgrade projects are proposed which will increase reliability, stabilize rates, create jobs, decrease environmental impact, bring economic benefits to the island, expand renewable energy sources and introduce value -added services for our customers”. One of these “major upgrade projects” is to **“Implement Liquefied Natural Gas”**. This appears to be presented as a *fait accompli*, without the conclusion of the IRP process or blessing of the Regulatory Authority. The website states “Our Solution: within three years, introduce liquefied natural gas to Bermuda through a competitive LNG procurement process with appropriate government oversight” including “an LNG import terminal and gas transmission pipeline to BELCO’s central plant”.

Given the flawed conclusions in the IRP it is far from clear that LNG is the best option for Bermuda – it is imperative that the RA uphold their authority and step in to ensure that Bermuda has the best outcome for today and 20 years in the future.

Judith Landsberg

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Dr Judith Landsberg has a PhD in Physics from Oxford University and a Masters in Environmental Leadership with a focus on energy policy from Duke University. She has more than 10 years’ experience of energy systems and energy advocacy, and is a former President and Director of Greenrock.

12 May 2018

Regulatory Authority of Bermuda

RE: Consultation Process with regards to the IRP submitted by the TD&R

Good day,

My name is Kathy Cervino and I have a number of concerns regarding the IRP submitted by the TD&R to the RA. My hope is that you will take these points into consideration.

- The average Bermudian is not properly engaged. There is no obvious advertising to the public (pamphlets, newspaper advertising, news interviews) nor any explanation at a basic level nor availability for education about the subject to engage all Bermudians in a decision that will affect every Bermudian, their children and their grandchildren over the next 30 years.
- The consultation at the Town Hall meeting was at too high of a level for the average Bermudian to grasp how this will affect them economically and socially. It was apparent from that meeting based on the questions that were asked that the average Bermudian does not understand the IRP process (even after explanation at the Town Hall Meeting)! What does the RA propose to do to fully engage the average and the majority of Bermudians in this consultation process for their energy future?
- Has the RA considered doing a survey of the public to see if they understand what the RA is and what the IRP process entails? Have they considered doing some basic level advertising such as "This is Your Energy Future" and explain in very basic terms what is at stake and how this short period is their only time to provide their input?
- "Least cost" was mentioned many times at the Town Hall meeting. How can the RA determine the "least cost" input in absence of security of future supply of LNG and absence of future certainty of LNG prices over the next 30 years? Without knowing future prices of LNG, how can the RA assure the Bermudian people that "least cost" today will not be "most cost" tomorrow or 30 years down the road? I would like to ask the RA if they are certain of LNG prices over the next 30 years and if so please explain how they are certain of those prices in order to be able to determine the "least cost" generation for Bermuda?
- Also, how can the RA determine the "least cost" input in the absence of a price placed on CO2 emissions in Bermuda? We do not have a carbon tax in place and therefore, it is impossible to determine the "least cost" input which includes the cost of damage that is being done to our environment (public health, tank water, land, sea and air). Can the RA include in the "least cost" input calculation an avoided cost of damage to our environment?
- In my opinion, within the aspiration mix of energy generation in the IRP, there is little to no renewable energy generation that will help the Government meet the goals of the Paris Accord and the 2011 Bermuda White Paper. In its 2011 Energy White Paper, Bermuda stated a goal of generating 30% of its energy demands from renewable sources by 2020 (two years time). What is the RA doing to ensure the aspiration mix of energy meets the Department of Energy's goals and any other international goals and standards that we, as a reputable, international business centre, should be attaining?

- The people of Bermuda should be allowed to hold a referendum on whether they want LNG as the main source of input or whether they want to go down a path towards 100% renewable energy. In Italy, for example, when the Government was determining if they were going to allow nuclear energy into the country as a form of energy generation it was put to a referendum for the people of Italy to decide and they turned out to the polls in droves and ultimately decided a resounding NO that nuclear energy was not an option for the country and therefore the energy mix had to be reinvented based on the will of the people. We should NOT assume that in order to bring a secure energy source to Bermuda that we are ultimately resigned to accepting LNG as a base load. Seeing that this decision is one of the most crucial decisions for the next 30 years which will affect all Bermudians, is this something the RA could put forth to the Government of Bermuda for the Bermudian people to ultimately decide by way of referendum whether to permit LNG or to go towards a path of 100% renewable energy? After all, it is their energy future.
- The technology is available today to put Bermuda towards a path of 100% renewable energy. What is the RA doing to ensure that the latest renewable energy technology will be deployed in Bermuda and is the RA including in the calculation of “least cost” with regard to renewable energy sources the rapidly falling prices and predicted future prices of those renewable energy technologies?
- In the UK, the Crown Estate lays the foundation for offshore wind investments (they map the seabed and provide leasable seabed to interested investors in the offshore wind sector). What, if anything, can the RA do to provide available seabed leasing?
- The Crown Estate has openly stated that they would be willing to assist Bermuda in setting up the regulatory path for seabed leasing. Is the RA open to speaking with someone from the Crown Estate on behalf of Bermuda to set up this regulatory framework for investors seeking setting up solid investments in offshore wind?

<https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/>

- In that regard, would the RA be willing to set up an Offshore Wind Programme Board?

<https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/working-with-us/offshore-wind-programme-board/>

- In light of the recent Bren School of Environmental Science and Management offshore wind study that was conducted in 2014 which stated that offshore wind was a viable form of energy generation for Bermuda and that a 35MW wind farm would help Bermuda achieve its 2020 goals under the 2011 Energy White Paper. What is the RA doing to incorporate this study and the stated LCOE of \$0.261/kWh in the calculation of “least cost” energy generation?

https://www.bren.ucsb.edu/research/2014Group_Projects/documents/BermudaWind_Final_Report_2014-05-07.pdf

- By supporting developers as they harness the potential of offshore wind through some of the largest infrastructure projects in the world, this can provide valuable jobs to local

communities as well as underpin the Government's commitment to renewable energy and a reduction in CO2 levels, as well as an increase in energy security. What is the RA doing to ensure that "least cost" includes a negative cost of added jobs, supporting developers and increased energy security?

<https://www.thecrownestate.co.uk/media/5462/ei-offshore-wind-operational-report-2016.pdf>

- What responsibility does the RA have to ensure CO2 levels are lowered given the pressing issues with Climate Change and the fact that 90% of scientists around the world are stating this is rapidly becoming more urgent than previously predicted?
- Does the RA include in the "least cost" calculation the avoided cost of estimated damage to real property from rising sea levels due to the amount of continued CO2 emitted in Bermuda?

<https://www.bnt.bm/images/newslettersandreports/Climate%20Change%20Report%202008.pdf>

- Does the RA include in the "least cost" calculation the avoided cost of losing our entire reef ecosystem?

[http://www.ivm.vu.nl/en/Images/BDA_402_TEV_Executive_Summary_\(2\)_tcm234-195841.pdf](http://www.ivm.vu.nl/en/Images/BDA_402_TEV_Executive_Summary_(2)_tcm234-195841.pdf)

I appreciate responses to the above questions and hope these will be considered in your final consultation process. I am happy to further discuss any of the above concerns and can be reached at cervinoinelba@gmail.com should you need any further information.

Thank you for your attention, your feedback and more importantly thank you for your time spent on one of the most important decisions Bermuda is currently facing.

Kind regards

Kathy Cervino

27 May, 2018

RE: IRP Consulation Process

To whom it may concern,

The RA must go back to BELCO and ask them to include in their investment proposal any associated cost of damage to the environment, whether this be for battery storage, solar, wind, or LNG. This cost of damage should include damage done to the environment starting with the production of the proposed energy solution to the implementation of the solution and to the decommissioning of the proposed energy solution.

The public of Bermuda cannot possibly move forward with this IRP without knowing what is considered total "least cost" for Bermuda (which includes environmental damage either here in Bermuda or in the USA at the production phase) without this information.

Thank you in advance for your consideration.

Kind regards,

Kathy Cervino

How can the RA make a decision of least cost without taking into consideration the effects of LNG vs renewable energy on our coral reef ecosystem? How will 30 years of emissions of LNG fuel affect our coral reef system (bleaching) and, God forbid, if there is a spill of the liquid natural gas into our ocean what will the implications on our economy be?

This video (some of which is about plastics) and the .pdf study below is a good reminder of how precious our immediate surrounding ecosystem is to the island both economically and socially and cannot be overlooked on this decision to be made by the RA. It could be too costly to Bermuda and her people.

<https://www.facebook.com/bbc/videos/1884556108244603/>

http://jncc.defra.gov.uk/pdf/ot_coralreef_ExecSummTEVFEb10-2.pdf

"The average annual value of the coral reef ecosystem [in Bermuda] amounts to \$722 million. This high number certainly suggests that this ecosystem is highly valuable and worth conserving from an ecological, social and economic perspective. Lower and upper bound estimates were determined for each ecosystem service recognizing the uncertainty surrounding the economic analysis, resulting in a TEV ranging from \$488 million per year to \$1.1 billion per year. "

"The economic value of the coastal protection function of coral reefs in Bermuda was determined at US\$266 million per year."

"The sum of all research and education activities associated with coral reefs in Bermuda amounts to US\$2.3 million in 2007."

"The sum of the reef-associated commercial fishery (both finfish and lobster) and of the reef-associated recreational fishery (finfish and lobster) result in a fishery ecosystem value estimated at US\$5 million per year. "

"To place the TEV of coral reefs in context of the economy of Bermuda: in 2007, the Gross Domestic Product (GDP) of Bermuda amounted to US\$5.85 billion in 2007 (Government of Bermuda 2008). The TEV of coral reefs constitutes 12% of Bermuda's GDP."

Good day,

Please allow me to submit this article arguing LNG is not a short-term gap-fill solution for the Bermudian electricity rate payers.

<https://www.vox.com/energy-and-environment/2018/7/13/17551878/natural-gas-markets-renewable-energy>

I urge you all to read this article and in particular the following paragraphs:

Around 2015, though, just five years into gas's rise to power, complications for this narrative began to appear. First, wind and solar costs fell so far, so fast that they are now undercutting the cost of new gas in a growing number of regions. And then batteries — which can “firm up” variable renewables, diminishing the need for natural gas's flexibility — also started getting cheap faster than anyone expected. It happened so fast that, in certain limited circumstances, solar+storage or wind+storage is already cheaper than new natural gas plants and able to play all the same roles (and more).

The cost of natural gas power is tethered to the commodity price of natural gas, which is inherently volatile. The price of controllable, storable renewable energy is tethered only to technology costs, which are going down, down, down. Recent forecasts suggest that it may be cheaper to build new renewables+storage than to continue operating existing natural gas plants by 2035.

That means natural gas plants built today could be rendered uncompetitive well before their rated lifespan. They could become “stranded assets,” saddling utility ratepayers and investors with the costs of premature decommissioning.

The Regulatory Authority of Bermuda MUST take into consideration predicted falling future prices in renewable energy and battery storage vs. uncertain and potentially rising future costs of LNG and MUST present this argument when considering BELCO's IRP. If we Bermudians are required to pay for the capital infrastructure of LNG but then must also pay for the predicted decommissioning of that LNG infrastructure well before the full lifespan of that asset is reached, doesn't this in the long-term make LNG a more expensive choice than an initial heavy investment in renewable energy today?

Thank you for your consideration.

Kind regards,

Kathy Cervino

BELCO Integrated Resource Plan (IRP) 2018 Proposal
Public Consultation Submission



A MATTER OF NATIONAL SECURITY

Submitted By

Nick Hutchings

About the author

Nick Hutchings is semi-retired from his marine contracting business and has taken a keen interest in promoting renewable energy.

He is an advocate for the Rocky Mountain Institute community scale solar “Shine” program which leverages, system standardization, economies of scale and innovative business models to make solar energy more affordable and therefore more widely available.

As a marine contractor he has had many years of experience pricing and successfully completing small contracts of similar size and scope to residential solar installations as well as larger commercial contracts. Having worked on the water all his life, he is also very aware of the changes that are occurring in the ocean around us.

Nick is a member of the Energy Coalition of Bermuda, the Bermuda Solar Energy Association and is a Bernews columnist on energy.

Abstract

Just as in ancient times, a modern-day Noah is predicting a flood of biblical proportions. Only today, the name is spelt NOAA and if not relaying the actual voice of God, NOAA's collective scientific voice is perhaps the next best thing, and it is telling us there is overwhelming scientific evidence that Earth is warming and there is a preponderance of scientific evidence that human activities are the main cause.

Thousands of weather stations worldwide, over land and ocean, have been recording daily high and low temperatures for many decades and, in some locations, for more than a century. When different scientific and technical teams in different U.S. agencies (e.g., NOAA and NASA) and in other countries (e.g., the U.K.'s Hadley Centre) average these data together, essentially the same results are found.

The main culprit is CO₂, the main cause is burning fossil fuel and, waiting to see if NOAA is wrong, is the "dumbest experiment in history". Just as Noah's neighbours ignored his warning, many Bermudians today are ignoring NOAA's warning but, if you want to know the future, just ask anyone from the Caribbean.

More importantly, if you want to know what to do about it, take heed of BVI's Deputy Premier, the Honourable Dr. Kedrick Pickering's advice to Bermuda at the recent Ocean Risk Conference at BIOS: (to paraphrase) diversify your energy supply mix stupid! Dr. Pickering is far too gracious to have put it exactly that way but, to anyone actually listening, the message was clear enough.



Any discussion about energy, whether about security of supply, least cost or environmental sustainability, must start with a discussion on climate change.

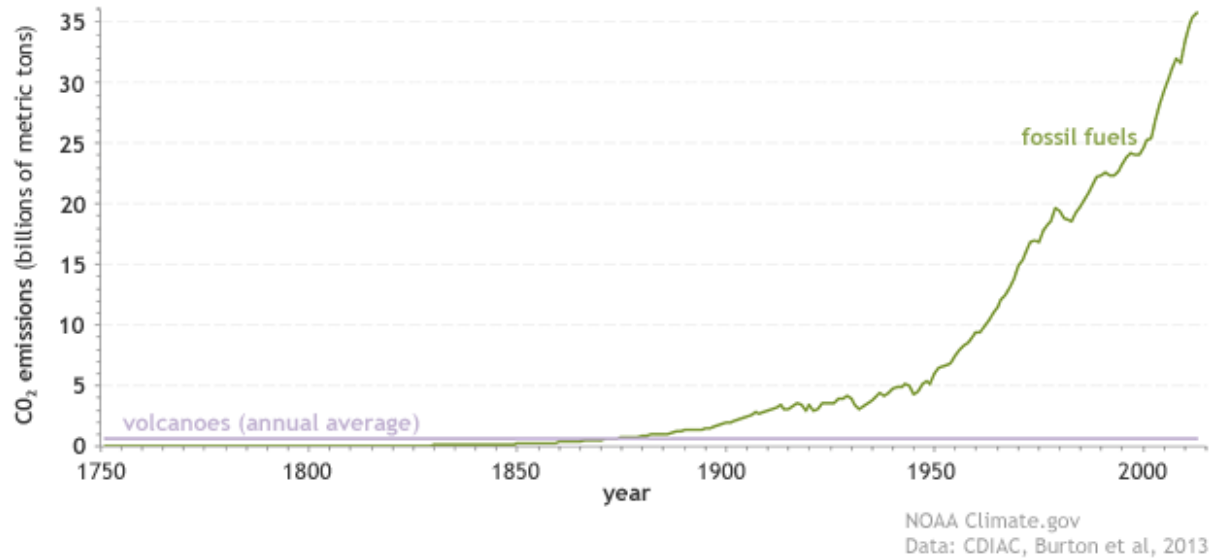
For credible information on climate change, go to <https://climate.nasa.gov> the NOAA climate web site, <https://climate.nasa.gov/> the NASA Global Climate Change web site and [United Nations Framework Convention on Climate Change](#) (UNFCCC).

Global threat

According to NASA, 97% of climate scientists agree that climate-warming trends over the past century are very likely due to the burning of fossil fuels like coal and oil which has increased the concentration of atmospheric carbon dioxide and most of the leading scientific organizations worldwide have issued public statements endorsing this position.

Human activities

Fossil fuel versus volcanic emissions



Since the start of the Industrial Revolution, human emissions of carbon dioxide from fossil fuels (green line) have risen to more than 35 billion metric tons per year. NOAA Climate.gov graph, based on [data](#) from the [Carbon Dioxide Information Analysis Center \(CDIAC\)](#) at the DOE's Oak Ridge National Laboratory and Burton *et al.*, 2013.

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

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

Donald Trump's denial of climate change aside, Elon Musk has it right when he says: "waiting to see if 97% of the world's climate scientists are wrong is the dumbest experiment in history".

A Simple Question

Do the members of the Board and the Executive of the Regulatory Authority of Bermuda believe 97% of climate scientists are correct in their assertion that climate change is, to a very large degree, a result of burning fossil fuel.

If so, will you stand with the vast majority of the international Governmental and Regulatory community, regardless of whether Bermuda has a treaty obligation to do so under the Paris Agreement, and make a public commitment to put forward your best efforts, within your remit, in order to strengthen the global response to the threat of climate change?

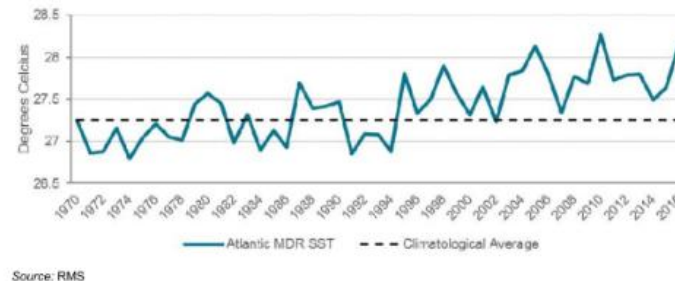
Local Threat

While such a gesture would be completely worthy of you, the truth is, that noble as it would be, the actual significance, given Bermuda's minute impact on climate compared to countries like China and Brazil, would merely be symbolic.

Having said that however, making a commitment to strengthen our local response to the threat of climate change is nothing less than a matter of national security.

Imagine for a minute what will happen if the lights go out for a sustained period of time like they did all over the Caribbean last year. What do you think International Business will do? How would that affect key economic factors like national debt service, GDP, foreign earnings, the balance of trade and, in turn, job security?

Figure 12. Sea Surface Temperature



Security of our energy supply starts and finishes with the weather. Since ocean temperatures have begun to rise around Bermuda, three significant things are happening.

1. More extreme “king” tides i.e. highest astronomical tides (HAT) combined with warm water eddies like we saw on the 18th October 2017 that flooded Town Square.
2. An increase in the severity and frequency of major storms.
3. More intense rainfall due to higher evaporation rates over warmer water.

According to a paper prepared by the Bermuda Weather Service titled *Hurricanes - General Information for Bermuda*, between 1960 and 2000 only two major hurricanes reached our latitude within 300 miles the island. Since 2000, six major hurricanes have threatened Bermuda, including Ophelia, which passed 90 miles to our east on October 1st, 2011, and was one of only two Cat 4 storms on record to make it this far North. Of the six, three were direct hits and Nicole downgraded to a cat 3 just prior to hitting us.

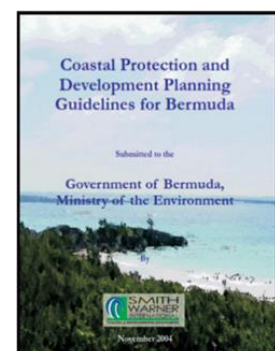
Heavy rain is often associated with hurricanes but in August 2017, Harvey broke all the records after it made landfall at San José Island, Texas as a cat 4 hurricane then downgraded and stalled further along the coastline dropping torrential and unprecedented amounts of rainfall over the state. Many areas received more than 40 inches of rain as the system slowly meandered over eastern Texas and adjacent waters, causing unprecedented flooding. Research shows there has been a 6% increase in the chance of a Harvey scale rainfall event over the last two decades.

<http://news.mit.edu/2017/texas-odds-harvey-scale-rainfall-increase-end-century-1113>

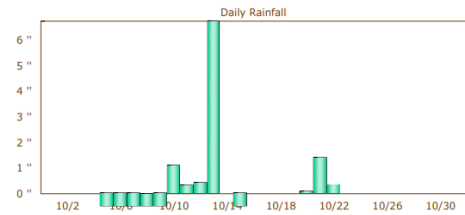
Worst case scenario

The worst-case scenario for BELCO would be a combination of three events all of which have happened either in September or October but not, so far, at the same time.

5th September 2003 – Fabian, a major hurricane moving slowly from the south east taking eight hours to pass over the island. Fabian’s wind veered south west at high tide exposing the Mill’s Creek entrance to a storm surge plus wave action resulting in the maximum inundation level which, according to the *Coastal Protection and Development Planning Guidelines*, produced by Smith Warner International for the Department of Planning, is 2.2-3.5 meters (7.3-11.6 feet). See tables in Appendix I



13th October 2016 – Nicole, a fast-moving, intense hurricane that downgraded from a cat 4 just prior to hitting us and moved over the island in 2 hours. The Esso Pier Tide Gauge recorded a storm surge of 4 feet, mitigated by the fact that it was low tide when Nicole passed over. Localized flooding occurred as Nicole brought about 7 inches of rain. (Graph shows rainfall for October 2016)



18th October 2017 – “King” Tide, a confluence of highest astronomical tide (HAT) and a warm water eddy. HAT is 2.6 feet above the ordinance survey (OS) datum. The warm water eddy put the water level another 1.5 feet above HAT for a combined 3.1 feet above OS datum. See NOAA tide data Appendix I

Note: plans submitted to the Department of Planning by BELCO show the average contour at the North Power Station (NPS) site is 2.3 feet above OS datum.



Perfect storm

In the perfect storm scenario, a slow moving, major hurricane hits Bermuda from the south east but stalls just north of the island. Like Fabian, the wind veers south west at high tide and water surges over the land at the entrance of Mill’s Creek filling the bay and flowing into the low-lying area (BELCO Basin) beyond. Only in this scenario it happens during a “king” tide and the NPS site is already 18 inches underwater. The rapidly rising water at BELCO is alarming but no serious damage occurs. Unless, this is not a dry storm like Fabian but more like Nicole and averages 3.5 inches of rainfall per hour. After 8 hours, nearly 30 inches of rain falls. The water accumulating in the BELCO Basin has no place to go as extreme high tides combined with the storm surge prevents the water from dissipating as it normally would, through Mill’s Creek. Storm runoff from the hills surrounding BELCO only makes matters worse.

Even in such an extreme case, BELCO’s new NPS generators, which are to be installed on pedestals 14 feet above OS datum, would likely be OK. However, other vital infrastructure like transformers, switching gear and transmission lines along with many of their gas turbines would be inundated long before the water got anywhere near that height. It is not likely that BELCO would go down completely but, their generating capacity, especially their ability to meet peak demand, could be seriously impacted; possibly over a long period of time.

Modeling the risk

These three separate events i.e. a slow moving major storm from the south east, torrential rainfall associated with a major storm and a “King” tide have all happened separately at the height of hurricane season and it is completely within the range of possibility that all three of these events could happen simultaneously at some time in the future which would be the worst-case weather scenario for BELCO.

Rachael Gosling VP, Head of Catastrophe Modelling, Markel Global Reinsurance has provided a loss curve – also called the EP (Exceedance Probability) curve which is shown below. This is saying that approximately 1 in 25 years we could expect a storm that would cause \$456 million of damage. Fabian caused \$300 million and Gonzalo caused \$200 million. This curve model is a

reasonable way to predict our exposure to damage from major hurricanes. The \$500 million storms are strong Cat 2 and Cat 3 storms. The 100-year loss at \$2 billion is from Cat 4 and strong Cat 3 storms. The higher losses are Cat 4 and Cat 5 storms hitting us.

Critical Prob.	Return Period	Bda Co (USD) Gross Loss AEP	Bda Co (USD) Gross Loss OEP	Bda Co (USD) Net Loss Pre Cat AEP	Bda Co (USD) Net Loss Pre Cat OEP
0.01%	10,000	23,018,197,636	22,938,404,804	23,018,197,636	22,938,404,804
0.02%	5,000	17,789,078,401	17,664,060,394	17,789,078,401	17,664,060,394
0.04%	2,500	11,939,868,947	11,817,474,170	11,939,868,947	11,817,474,170
0.10%	1,000	7,606,271,710	7,493,515,566	7,606,271,710	7,493,515,566
0.20%	500	5,227,409,457	5,113,099,262	5,227,409,457	5,113,099,262
0.40%	250	3,652,611,555	3,565,557,139	3,652,611,555	3,565,557,139
0.50%	200	3,248,334,665	3,168,804,136	3,248,334,665	3,168,804,136
1.00%	100	2,121,551,082	2,059,650,506	2,121,551,082	2,059,650,506
2.00%	50	1,209,579,054	1,166,543,745	1,209,579,054	1,166,543,745
4.00%	25	590,038,786	566,269,400	590,038,786	566,269,400
10.00%	10	136,186,137	129,964,557	136,186,137	129,964,557
20.00%	5	17,208,383	16,468,990	17,208,383	16,468,990
	Gross Loss	Net Loss Pre Cat			
Pure Premium	101,311,917	101,311,917			
Standard Deviation	602,295,589	602,295,589			

Also, the impact (floodwater heights) that would result from the BELCO “perfect Storm” needs to be professionally modelled by properly qualified persons, taking into consideration, the contours of the BELCO Basin and the surrounding hills, predicted storm runoff and the capacity of Mill’s Creek to drain the basin during such an extreme event. I do not have the resources to engage such a study for this submission, but I highly recommend that the RA does so as part of its due diligence during the IRP process.

It is important that we learn from hurricanes Katrina and Sandy. Like New Orleans and New York, we should not assume that we are safe just because low-lying areas in Bermuda have not suffered devastating floods in the past.

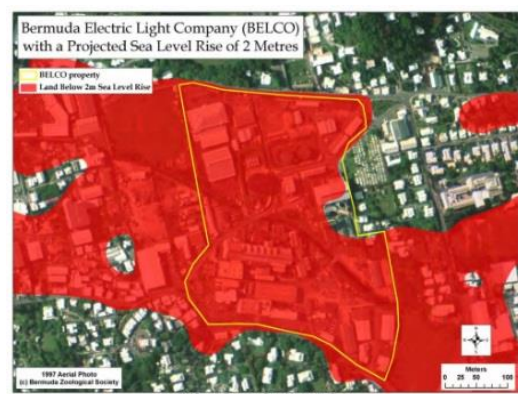
Fire risk

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

Decentralizing our energy supply mix

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

The bottom line is that the more distributed energy we connect to our grid, the more secure our energy supply will be and consequently the more resilient the whole system will become. Residential and small commercial solar along with energy efficiency and



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

Community scale solar

DER has always been secure, clean and self-funding but, until very recently was too expensive to be considered a major player. Now with community scale solar programs recently developed by the Rocky Mountain Institute which leverage system standardization, economies of scale and innovative business models to make solar energy more affordable and therefore more widely available, this has changed. As a result, distributed energy resources, which were already growing organically in Bermuda, are expected to expand rapidly.

As it stands now, an independent customer acting cooperatively with 5 other people (6 systems fit in a 20' container) can source a 7.8 KW solar system that generates an annual daily average of 29 KWh for 5 cents/KWh. See *UMA Solar quote and Solar Co-op spread sheet attached in Appendix II*.

A community scale solar co-operative provisionally called Shine Bermuda has been conceived. The structure will be a flow through co-operative, limited by guarantee. 10% will be added to the cost of each system, part of which will pay for the administration of the Co-op and part of which will go towards solarizing schools and other important civic buildings. Based on a quote from Canadian Solar for tier I Monocrystalline panels CIF (cargo, insurance, freight) Bermuda of 42 cents per watt see *Appendix II* and inverter and racking cost being the same as in the solar co-op spread sheet, an installed cost of \$1.65 per watt is expected to be achieved.

Also, a Tesla Powerwall II, when they become available on the island, will store power for 18 cents/KWh (10 cents/KWh with an extended warranty). See *LCOE Energy Storage, Appendix II*.

Combined, residential solar and battery storage can dispatch home power as needed for 23 cents/KWh.

DER resource

Unlike Kauai, which is installing utility scale solar with battery storage this year for a PPA of 11 cents per KWh, we do not have large tracks of land suitable for utility scale solar. What we do have however, is roof area. According to the Government GIS (geographic information system) Bermuda's roof area is about 4.9 million m² and covers a little under 10% of the island's land mass. See *correspondence from Mandy Shailer MSc (GIS), GIS Mapping Analyst, Government of Bermuda - Appendix II*

Installed rooftop solar averages 8 KW "nameplate" per 46.6 m² so if we use 20% of the total roof area, we can develop 160 MW DC "nameplate" capacity which, when converted to AC, will generate 36% of our 1,617 MW of daily demand. Combined with a modest 15% reduction in energy use from energy efficiency and conservation, the DER (distributed energy resource) will provide 50% of our electricity demand.

Apart from the added security gained by diversifying our energy supply mix, developing our distributed energy resource will increase economic stability by providing a hedge against rising oil and gas prices. Further economic benefit will be derived if DER is self-funded with Bermuda dollars

through reduced outflow of cash for imported oil and repayment of foreign sourced CAPX, keeping more money in the local economy thus improving the balance of trade and in turn, growing GDP.

We will still need fossil fuel generators for some time to come, but their role will increasingly be as back up for clean, secure, renewable energy. In the meantime, the more DER we can develop in the outer perimeters of the grid the better. In this, time is of the essence.

With the recent availability of inexpensive battery storage, solar is now “dispatchable” which makes distributed solar the cleanest, most cost effective, and secure mature energy supply available in Bermuda today.

We may have been a little slow off the starting line but expect significant DER uptake over the next 5 to 10 years. Certainly, enough to take a major bite out of BELCO’s GDP tied load forecast.

BELCO’s de facto proposed 2.8% cap on DER

I am concerned about BELCO’s forecast 2.8% cap on DER through 2038 in their 2018 IRP proposal especially given section 49 in the Act which states: “The TD&R Licensee shall execute a Standard Contract with a person that applies for distributed generation if— entry by the TD&R Licensee into the contract with that third party would not put the TD&R Licensee beyond the limit of the distributed generation capacity agreed by the TD&R Licensee under the approved Integrated Resource Plan”.

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

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

This would be a huge mistake as it would ultimately drive 50% of their demand of the grid. DER represents a \$500 million emerging market opportunity and is the only potential for exceptional growth in the sector. Instead of seeing it as an opportunity and getting their grid ready for this new business, BELCO appears to see it as a threat and to be deliberately making moves to prevent it.

To Quote Chris Worboys, arguable Bermuda’s best mind when it comes to the integration of renewables in our energy supply:

“I expect the main constraint around Bermuda's eventual solar capacity is going to have more to do with the how much BELCo, the Government and the RA decide between them can be deployed than the available area.

Batteries will get around this to some extent by allowing people to defect from the grid but would be inefficient at the societal level as a lot of systems would have excess capacity in order to meet demand during periods of lower irradiation. It would make far more sense to pool everyone's electricity generation capacity through the grid and also share storage capacity.”

The gold standard of small island utilities

Just as Flora Duffy has come to represent the gold standard for performance, so has Kauai Island Utility Cooperative (KIUC) come to represent the highest standard of excellence for modern, small-island utilities. <http://website.kiuc.coop/content/about-us> The sad truth is, BELCO doesn't even qualify for the race. Instead of embracing the future, BELCO has chosen to become a living fossil. The following is from the KIUC web site and every Bermudian should be embarrassed by comparison.

Kauai Island Utility Cooperative (KIUC) purchased Connecticut-based Citizens Communications' Kauai Electric in November of 2002.

KIUC operates as a not-for-profit organization that is owned and controlled by the people it serves. KIUC's location presents some unique challenges that make it different from its sister cooperatives on the mainland. While most co-ops purchase electricity from large coal-fired power plants and huge hydroelectric power stations that can be hundreds of miles away, KIUC must generate all of its power on the island of Kauai. These smaller generating plants are powered by imported fossil fuels – which is less efficient and more expensive than mainland power sources.

In an effort to reduce its power cost, decrease its use of imported fossil fuels and increase the amount of energy generated from Kauai's own resources, KIUC has launched a strategic initiative to generate 50 percent of its electricity from renewable sources by 2023.

KIUC by the numbers

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

Aspirational Mix

We should follow Kauai's example and set our energy future on the fastest possible course towards energy independence by embracing affordable, secure, clean renewable energy and we should start by setting the most ambitious energy targets, realistically achievable, in a new aspirational mix.

Based on real life results achieved by KIUC and bearing in mind that our most abundant local energy resource is distributed energy, I think such an aspirational mix could look like this:

Fuel/Resource Type	2023	2028	2038
HFO	70%	20%	
LPG		20%	20%
Utility Scale Renewables	10%	20%	30%
Distributed Solar	10%	20%	30%
Energy Efficiency & Conservation	10%	20%	20%

Last year, KIUC and AES Corp. announced plans to pair a 28 MW solar array with a 20 MW, 100 MWh battery system to deliver dispatchable renewable generation to the Hawaiian island for 11 cents/KWh. <http://www.utilitydive.com/news/hawaii-co-op-signs-deal-for-solar-storage-project-at-11kwh/433744/> and according to Bloomberg New Energy Finance, offshore wind's LCOE is \$118 per MWh this year, while lithium-ion battery prices fell from \$1,000 per kWh in 2010 to \$209 per kWh in 2017. <https://about.bnef.com/blog/tumbling-costs-wind-solar-batteries-squeezing-fossil-fuels/>

As a private citizen, I do not have the necessary resources to provide a quantitative analyses but, given the cost of renewables are now on par with or below oil and gas fired generation and going down, compared oil and gas prices which are rising, logic dictates that the above ambitious, but achievable aspiration of 80% renewables by 2038 would lead to significantly lower energy costs, better security of supply and cleaner energy than any of the scenarios in the 2018 IRP proposal submitted by BELCO.

The alternate possible

Bloomberg New Energy Finance goes on to say in the same article mentioned above: "we are seeing record-low prices being set for wind and solar, and then those records being broken again and again on a regular basis. This is having a powerful effect – it is changing perceptions."

To quote Einstein: "we cannot solve our problems with the same thinking we used when we created them". It is time to pursue the "alternate possible" which Steve Scott, science author and proponent of the idea, says is almost always achieved through collaboration within a diverse network.

I commend the RA for facilitating this public consultation and in so doing, striving for an energy future built on an aspirational foundation reflective of broad based societal input. I am confident your leadership will result in an energy future that all Bermudians can be proud of.

Appendixes

There are two Appendixes attached with this submission.

Appendix I shows predicted storm surge with corresponding inundation levels from the *Coastal Protection and Development Planning Guidelines*, produced by Smith Warner International for the Department of Planning and NOAA Tidal Data from the Bermuda Weather Service.

Appendix II shows a correspondence from Mandy Shailer MSc (GIS), GIS Mapping Analyst, Government of Bermuda, UMA Solar Quote for a 7.8 KM Solar System FOB San Ferdinandina Beach, Panel quote from Canadian Solar CIF Bermuda, Solar Co-op Spread sheet and LCOE of Energy Storage worksheet.

APPENDIX I

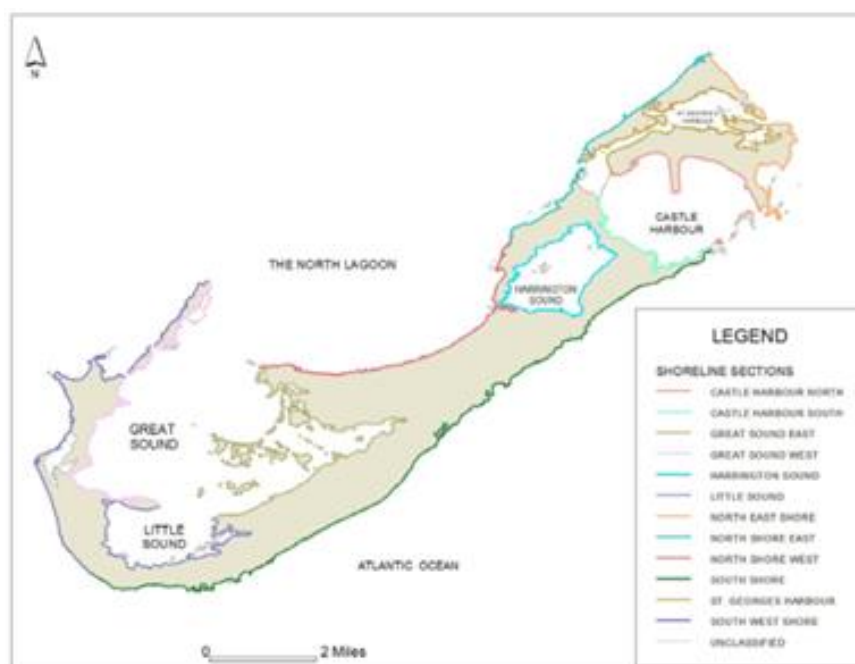


Figure 4.1 Division of Shoreline by Maximum Wave Heights, Orientation and Type

Table 4.1 Wave Height and Storm Surge by Shoreline Section

Location	Wave Height in 10m-depth		Static Storm Surge at Shore	
	50-year	150-yr	50-year	150-yr
North Shore - East	3.0-3.5	4.0-6.0	1.3-1.4	1.6-1.8
North Shore - West	2.5-5.0	3.0-5.0	1.4-1.5	1.8-2.0
West Shore	3.0-4.0	3.0-5.0	1.4-1.6	1.8-2.0
South West Shore	2.5-4.0	3.0-5.0	1.6-1.8	2.0-2.3
South Shore	5.0-8.0	5.0-8.0	1.7-1.9	2.0-2.2
North East Shore	3.0-7.0	3.0-7.0	1.5-1.7	1.7-2.1
St. Georges Harbour	1.5-2.0	1.5-2.5	1.4-1.5	1.7-2.0
Castle Harbour - North	2.0-3.0	2.5-4.0	1.7-1.8	2.0-2.3
Castle Harbour - South	1.5-2.5	2.0-2.5	1.7-1.9	2.0-2.3
Harrington Sound	1.5-2.5	1.5-2.5	1.4-1.5	1.8-2.0
Great Sound- East	1.5-2.0	2.0-3.0	1.4-1.5	1.7-1.8
Little Sound	1.5-2.5	2.0-3.0	1.4-1.5	1.7-1.9
Great Sound-West	2.5-4.0	2.5-4.0	1.4-1.5	1.7-1.9

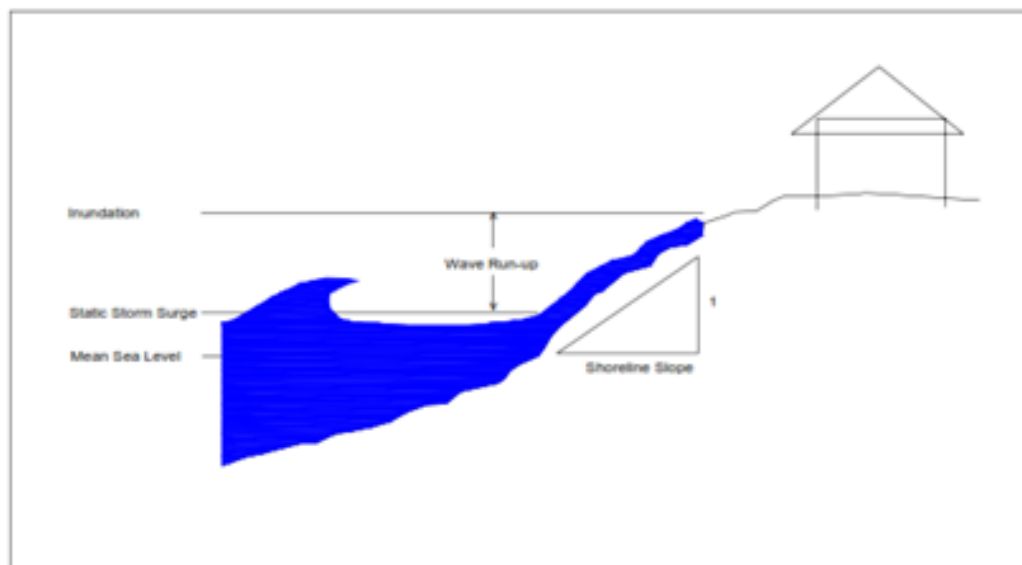


Figure 4.2 Definition sketch for calculation of Inundation Levels

Table 4.2 Inundation levels by Shoreline Section

Location	Inundation Levels above Mean Sea Level (MSL)			
	Beach	Flat Rock	Low Cliff	High Cliff
North Shore - East	4.4-6.2	3.0-4.4	5.3-7.1	7.1-9.4
North Shore - West	4.6-6.4	3.2-4.6	5.3-7.3	7.3-9.6
West Shore	4.6-6.4	3.2-4.6	5.5-7.3	7.3-9.6
South West Shore	3.0-5.1	2.6-3.9	3.3-5.7	3.9-7.2
South Shore	5.1-9.6	3.3-6.6	6.9-11.1	9.3-14.9
North East Shore	4.6-6.4	3.2-4.6	5.5-7.3	7.3-9.6
St. Georges Harbour	2.7-4.8	2.3-3.6	3.0-5.4	3.6-6.8
Castle Harbour - North	4.8-6.6	3.4-4.8	5.7-7.5	7.5-9.6
Castle Harbour - South	3.0-5.1	2.6-3.9	3.3-5.7	3.9-7.2
Harrington Sound	2.8-4.9	2.4-3.7	3.1-5.5	3.7-6.9
Great Sound- East	2.6-4.7	2.2-3.5	2.9-5.3	3.5-6.7
Little Sound	2.7-4.8	2.3-3.6	3.0-5.4	3.6-6.8
Great Sound-West	4.5-6.3	3.1-4.5	5.4-7.2	7.2-9.5

Absolute Differences Between Hydrographic and Topographic Datums

UPDATED April 2015

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

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

Source Data Notes:

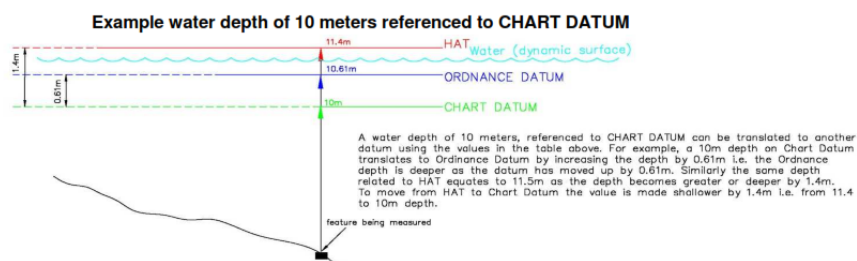
Elevation diff btwn MLLW and OS Datum, for Tidal BM # 4, also known as GBM 80225 (G1/9)

Data as stated on Savage OS Map Series

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

Data obtained from email, noaa, Thomas Landon regarding Station Datum values above Station Datum, Esso Pier

Benchmark Sheet for 2695540 dated 11/23/2011



APPENDIX II

Corporate Office
950 Sunshine Lane
Altamonte Springs, FL 32714
800-79-SOLAR (407) 831-1941
(407) 834-8696 FAX
orderdesk@umasolar.com



Quote Name	Bermuda Coop (Bermuda Coop)	Quote Date	4/4/2018
Quote Num	60781	Expiration Date	4/19/2018
Sage100 Customer	02-DOUGH	FOB	
Customer P.O.	Bermuda Coop	Ship VIA	WILLCALL
Bill To Name	Doug Hagg	Ship To Name	Will Call
Bill To	950 SUNSHINE LN ALTAMONTE SPRINGS, FL 32714-3803 US	Ship To	950 SUNSHINE LN ALTAMONTE SPRINGS, FL 32714-3803 US
Confirm TO		Terms	COD (UMA) - No Disc.
SalesPerson	DH		

Product	WHSE	Extended Description	UOM Code	Quantity	Sales Price	Total Price
1-6500-006	002	Cable Tie - Black 14-1/2" 50lb Break Strength	b100	1.00	\$5.27	\$5.27
3-6000-038	002	PV Module - 300 Watt Mono Silver Frame- Heliene	each	26.00	\$182.85	\$4,754.10
3-6020-024	002	Label Kit - PV General .	each	1.00	\$30.00	\$30.00
3-6060-084	002	Rail - 204" (17") XR-100 Clear - IronRidge XR-100-204A	each	11.00	\$45.59	\$501.49
3-6060-085	002	End Cap - XR100 Bag of 10 Sets IronRidge XR-100-CAP	pack	1.00	\$7.10	\$7.10
3-6060-124	002	Weeb Grounding Lug - IronRidge GD-LUG-003	b2	3.00	\$7.07	\$21.21
3-6060-125	002	Splice Kit - XR100 Bonded XR-100-SPLC-BD	each	8.00	\$4.26	\$34.08
3-6060-127	002	UFO Clamp Kit - Clear 4 pcs. UFO-CL-001 Universal Module Clamp	b4	14.00	\$7.06	\$98.84
3-6060-133	002	UFO Stopper Sleeve 40-MM Clear 4/kit UFO-STP-40MM	b4	4.00	\$1.06	\$4.24
3-6060-135	002	Bonding Hardware Kit - 1/4x3/4, T-Bolt for Micro Inverter - MI-BHW	b2	13.00	\$1.54	\$20.02
3-6060-147	002	L-Foot - Slotted Black 4/bag No Bonding Hardware (FM-LFT-003-B)3-6060-147.jpg	b4	15.00	\$6.46	\$96.90
3-6060-220	002	L-Foot Bonding Hardware Bolt & Nut for Slotted L-Foot Mill & Black (FM-SQ-BHW-V2)	b4	15.00	\$4.00	\$60.00
3-6070-017	002	Zigbee Ethernet Kit - Solaredge SE1000-ZBGW-K-NA	each	1.00	\$241.50	\$241.50
3-6070-053	002	Optimizer - SE P320W Solaredge P-320 MC4 Connectors for 60 cell	each	26.00	\$57.19	\$1,486.94
3-6070-057	002	Inverter - SE 7600H-US- HDWave SE 7.6 kW Single Phase	each	1.00	\$1,449.55	\$1,449.55
3-6500-003	002	Fuse Holder - Up to 30 Amp Gray	each	4.00	\$7.03	\$28.12
3-6500-005	002	Combiner Box - Roof Mount Soladeck	each	1.00	\$74.60	\$74.60
3-6500-020	002	Cord Grip - 1/2" Non-Metallic LAPP	each	2.00	\$1.69	\$3.38
3-6500-021	002	Fuse - 15 Amp 1000 Volt DC - Midget	each	4.00	\$5.07	\$20.28

Signature \s1\

Net Order	\$8,937.62
*Freight	\$0.00
Tax	\$0.00

Prices for items on Sales Orders not shipped within 15 days are subject to change. Customer's signature indicates agreement to the order and prices as shown above and that customer understands that UMA's Terms and Conditions of Sale as outlined in UMA's Price Catalog will apply to this order.

Grand Total	\$8,937.62
-------------	------------

QUOTE



Quote Name CAR-300118-NH_CIF Created Date 1/30/2018

SELLER

Company Canadian Solar (USA) Inc.
Address 3000 Oak Road, Ste. 400,
Walnut Creek, CA 94597
USA
Contact Name Belem Eslava
Contact Email belem.eslava@canadiansolar.com

BUYER

Company Nathaniel Hutchings
Address 36 Middle Road
Paget PG03
, Bermuda
Bermuda
Contact Name Nathaniel Hutchings
Contact Email nhutchings@logic.bm

Additional Information

INCOTERM 2010 FOB, FOB China DESTINATION FOB China, United States
End Market Bermuda Currency USD
Total Volume(Wp) 446,040
Requested Date March, 2018

Comments Product shipped from China and delivered at port of Bermuda

Product

Product	Module Type	Certification	Wattage	Volume(Wp)	Quantity	Sales Price	Amount	Currency
CS3K-MS	Standard	UL1703-1000V	305	230,580	756.00	USD 0.4300	99,149.40	USD
CS3K-P	Standard	UL1703-1000V	285	215,460	756.00	USD 0.3850	82,952.10	USD

Total Line Item Amount 182,101.50
Shipping and Handling 0.00
Tax 0.00
Total Amount 182,101.50

PAYMENT

Payment Description	Amount	Currency
20% down payment 5 days after PO date	36,420.30	USD
80% down payment 15 days before delivery	145,681.20	USD

TERMS

The above volume based pricing and terms are dependant on overall purchase volume and stated delivery schedule. Changes to delivery schedule or overall purchase volume may result in a change in pricing and/or terms. All pricing and terms are subject to Canadian Solar's Standard Terms & Conditions, unless otherwise mutually agreed upon in a subsequent Master Supply Agreement. **[QUOTATION IS VALID FOR 10 DAYS.]**

Canadian Solar (USA) Inc.
3000 Oak Road, Ste. 400, Walnut Creek, CA 94597
Tel: 925-866-2700 | Fax 925-866-2704

Solar Co-op Pilot Project

	Price	Price per Watt		
UMA 7.8 System (panels, micro-inverters (extended warranty 25yrs), racking) FOB Jacksonville.	\$ 8,937.62	\$ 1.15	Performance Assumptions	
Shipping	\$ 500.00	\$ 0.06	Watts DC per Solar System	7800
Wharfage	\$ 111.72	\$ 0.01	Number of 7.8 KW DC Solar Systems per 20' Container	6
Insurance	\$ 178.75	\$ 0.02	Cost of Shipping 20' Container from Florida	\$ 3,000.00
Clearance per 20' Container	\$ 100.00		Performance Assumptions	
Trucking per 20' Container	\$ 250.00		Annual Daily Average - KWh AC per KW Installed DC Capacity	3.7
Unloading per 20' Container	\$ 250.00		Value of Power used during production	\$ 0.36
Total Clearance, Trucking, Unloading per 20' Container	\$ 600.00	\$ 0.01	Value of Power Sold to BELCO	\$ 0.17
Total Cost per Watt on Site		\$ 1.25	% of Power used during Production	20%
Permitting	\$ 500.00	\$ 0.06		
BELCO Connection				
Installation	\$ 2,400.00	\$ 0.31		
Total Cost of 7.8 KW DC Solar System Installed	\$ 12,728.09	\$ 1.62		
Performance				
Total Value per KWh of Power Produced (see performance assumptions)	\$ 0.21			
Annual KWh Production	10533.9			
Annual Gross Value	\$ 2,216.33			
Net Value Over 25 years	\$ 42,680.22			
Annual Net Value	\$ 1,707.21			
ROI Over 25 Years	13%			
KWh Production over 25 Years	263347.5			
Cost per KWh	\$ 0.05			

Powerwall II LCOE work sheet

Cost - (www.tesla.com/powerwall)	\$ 6,600.00	Powerwall II Specs	
Overland Freight	\$ 100.00	Capacity - KWh	13.5
Shipping and Handling	185	Cycles (365 x 10 years)	3650
Insurance	\$ 99.00	Cycles - Extended Warranty (365 x 20 years)	7300
Wharfage	\$ 84.00	Efficiency	90%
Trucking	\$ 85.00	Depth of Discharge (DoD)	100%
Installation	\$ 1,000.00		
Total Installed Cost	\$ 8,153.00		
Total Installed Cost - Extended Warranty	\$ 9,153.00		
LCOE per KWh (Formula - www.reneweconomy.com.au)	\$ 0.18		
LCOE per KWh - Extended Warranty	\$ 0.10		

Nick Hutchings

From: Shailer, Mandy L. <mlshailer@gov.bm>
Sent: Monday, July 02, 2018 12:29 PM
To: nhutchings@logic.bm
Subject: Building Footprint Areas

Hi Nick,

Sorry for the extreme delay on this.

From the 2012 Topographic Map Data, provided by the Dept of Land Surveys, there was an estimated building footprint area of 4.97 square kilometres.
This value excludes any buildings categorized as being derelict or ruin.

If there is anything else I can do to help just let me know.

Cheers,
Mandy



Mandy Shailer MSc (GIS)
GIS Mapping Analyst
Government of Bermuda | [Department of Environment and Natural Resources](#)
Shorelands | 17 North Shore Road | Hamilton Parish, Bermuda FL04
Telephone: 441 299 2329 ex 2139
Email: mlshailer@gov.bm

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Email secured by Check Point

BELCO Integrated Resource Plan (IRP) 2018 Proposal
Public Consultation Submission



A MATTER OF NATIONAL SECURITY

Submitted By

Nick Hutchings

About the author

Nick Hutchings is semi-retired from his marine contracting business and has taken a keen interest in promoting renewable energy.

He is an advocate for the Rocky Mountain Institute community scale solar “Shine” program which leverages, system standardization, economies of scale and innovative business models to make solar energy more affordable and therefore more widely available.

As a marine contractor he has had many years of experience pricing and successfully completing small contracts of similar size and scope to residential solar installations as well as larger commercial contracts. Having worked on the water all his life, he is also very aware of the changes that are occurring in the ocean around us.

Nick is a member of the Energy Coalition of Bermuda, the Bermuda Solar Energy Association, the BEST Energy Committee and is a Bernews columnist on energy.

Abstract

As with most things, it is useful to begin with the end in mind. I would suggest the following aspirational mix is realistically achievable and will fast-track clean, affordable and secure renewable energy sources for the benefit of all Bermudians.

Fuel/Resource Type	2023	2028	2038
HFO	80%	20%	
LPG		15%	15%
Utility Scale Renewables: Bio-mass, Utility Scale Solar/Offshore Wind with BESS	5%	10%	40%
Distributed Solar	5%	15%	25%
Energy Efficiency & Conservation	10%	15%	20%

Notes:

- (i) There will be a continued need for some fossil fueled generation throughout the forecast period, but it will be reduced over time to backup for renewables. LPG is best suited for this because it is a low carbon fuel (LCF) having a smaller carbon footprint and lower public health added costs than oil. LPG also requires significantly less infrastructure than LNG. LPG's lower CAPEX and lower associated debt service require a smaller share of the forecast demand to be financially viable creating more room for renewables and reducing the risk of stranded assets.
- (ii) The numbers for distributed solar, energy efficiency and conservation have been offset to account for additional demand from the uptake of electric vehicles over the forecast period.

Just as in ancient times, a modern-day Noah is predicting a flood of biblical proportions. Only today, the name is spelt NOAA and if not relaying the actual voice of God, NOAA's collective scientific voice is perhaps the next best thing, and it is telling us there is overwhelming scientific evidence that Earth is warming and there is a preponderance of scientific evidence that human activities are the main cause.

If you want to know what to do about it, take heed of BVI's Deputy Premier, the Honourable Dr. Kedrick Pickering's advice to Bermuda at the recent Ocean Risk Conference at BIOS: (to paraphrase) diversify your energy supply mix stupid! Dr. Pickering is far too gracious to have put it exactly that way but, to anyone actually listening, the message was clear enough.

Making a commitment to strengthen our local response to the threat of climate change is nothing less than a matter of national security.

Imagine for a minute what will happen if the lights go out for a sustained period of time like they did all over the Caribbean last year. What do you think International Business will do? How would that affect key economic factors like national debt service, GDP, foreign earnings, the balance of trade and, in turn, job security?

As sea water temperatures rise, we can expect to see more extreme tides and an increase of the number and severity of major hurricanes.

BELCO's hub and spoke grid connected to a central generation plant located on land less than one foot above high tide is at risk for catastrophic failure due to flood and or fire. We need to heed Dr. Pickering's advice and take proactive measures to spread the risk by diversifying our supply mix as soon as possible.

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

Residential and small commercial solar along with energy efficiency and energy conservation are valuable distributed energy resources (DER) and provide highly diversified energy sources that feed the grid from the outside in providing an important buffer in the case of a partial or catastrophic central plant failure.

DER has always been secure, clean and self-funding but, until very recently, was too expensive to be considered a major player. Now with community scale solar programs recently developed by the Rocky Mountain Institute which leverage system standardization, economies of scale and innovative business models to make solar energy more affordable and therefore more widely available, this has changed. As a result, distributed energy resources, which were already growing organically in Bermuda, are expected to expand rapidly.

Apart from the added security gained by diversifying our energy supply mix, developing our distributed energy resource will increase economic stability by providing a hedge against rising oil and gas prices. Further economic benefit will be derived if DER is self-funded with Bermuda dollars through reduced outflow of cash for imported oil and repayment of foreign sourced CAPX, keeping more money in the local economy thus improving the balance of trade and in turn, growing GDP.

In their 2018 IRP document, BELCO proposes a 2.8% cap on DER through 2038. This is cause for concern in light of section 49 in the Act which states: "The TD&R Licensee shall execute a Standard Contract with a person that applies for distributed generation if— entry by the TD&R Licensee into the contract with that third party would not put the TD&R Licensee beyond the limit of the distributed generation capacity agreed by the TD&R Licensee under the approved Integrated Resource Plan".

If the limit of distributed generation capacity is set too low, it could drive enough demand off the grid to make BELCO financially unviable.

DER represents a \$500 million emerging market opportunity and is the only potential for exceptional growth in the sector. Instead of seeing this as an opportunity and getting their grid ready for the new business, BELCO appears to see it as a threat and to be deliberately making moves to prevent it.

We can do much better. Kauai Island Utility Cooperative (KIUC) has come to represent the highest standard of excellence for modern, small-island utilities.

In 2011, 90% of KIUC's power came from burning oil. In an effort to reduce its power cost, decrease its use of imported fossil fuels and increase the amount of energy generated from Kauai's own resources, the utility launched a strategic initiative to generate 50 percent of its electricity from renewable sources by 2023 and is further committed to generating 70% from renewables by 2030.

KIUC is similar in size to BELCO having 33,562 meters (electric accounts) and a total generating capacity of 125 MW but, with a larger land mass of 562 square miles, KIUC owns and maintains a much larger grid (1,400 miles of transmission and distribution lines) delivering safe and reliable electricity to the citizens of Kauai with half the employees (151) of BELCO.

As of this year, 40% of KIUC's electricity comes from renewable energy sources which they sell for 15 cents per KWh having obtained 99.96 percent system reliability each year from 2014-2016.

Kauai has a similar population to us but is a larger island and as such has a different mix of energy resources, but the most significant resource they have developed and that we have not, is the human resource of inspired leadership at the utility level in its energy sector.

Global threat

Any discussion about energy, whether about security of supply, least cost or environmental sustainability, must start with a discussion on climate change.



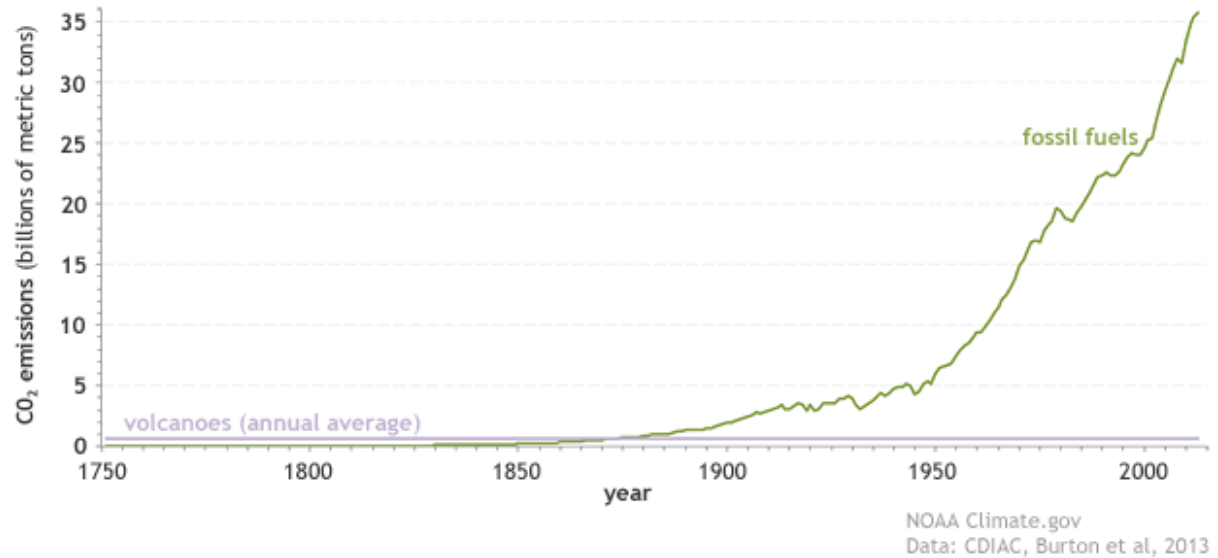
According to NASA, 97% of climate scientists agree that climate-warming trends over the past century are very likely due to the burning of fossil fuels like coal and oil which has increased the concentration of atmospheric carbon dioxide and most of the leading scientific organizations worldwide have issued public statements endorsing this position.

Thousands of weather stations worldwide, over land and ocean, have been recording daily high and low temperatures for many decades and, in some locations, for more than a century. When different scientific and technical teams in different U.S. agencies (e.g., NOAA and NASA) and in other countries (e.g., the U.K.'s Hadley Centre) average these data together, essentially the same results are found.

The main culprit is CO₂, the main cause is burning fossil fuel and, waiting to see if NOAA is wrong, is the "dumbest experiment in history". Just as Noah's neighbours ignored his warning, many Bermudians today are ignoring NOAA's warning but, if you want to know the future, just ask anyone from the Caribbean.

Human activities

Fossil fuel versus volcanic emissions



Since the start of the Industrial Revolution, human emissions of carbon dioxide from fossil fuels (green line) have risen to more than 35 billion metric tons per year. NOAA Climate.gov graph, based on [data](#) from the [Carbon Dioxide Information Analysis Center \(CDIAC\)](#) at the DOE's Oak Ridge National Laboratory and Burton *et al.*, 2013.

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

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

Donald Trump's denial of climate change aside, Elon Musk has it right when he says: "waiting to see if 97% of the world's climate scientists are wrong is the dumbest experiment in history". For credible information on climate change, go to <https://climate.nasa.gov> the NOAA climate web site, <https://climate.nasa.gov/> the NASA Global Climate Change web site and [United Nations Framework Convention on Climate Change](#) (UNFCCC).

A Simple Question

Do the members of the Board and the Executive of the Regulatory Authority of Bermuda believe 97% of climate scientists are correct in their assertion that climate change is, to a very large degree, a result of burning fossil fuel.

If so, will you stand with the vast majority of the international Governmental and Regulatory community, regardless of whether Bermuda has a treaty obligation to do so under the Paris Agreement, and make a public commitment to put forward your best efforts, within your remit, in order to strengthen the global response to the threat of climate change?

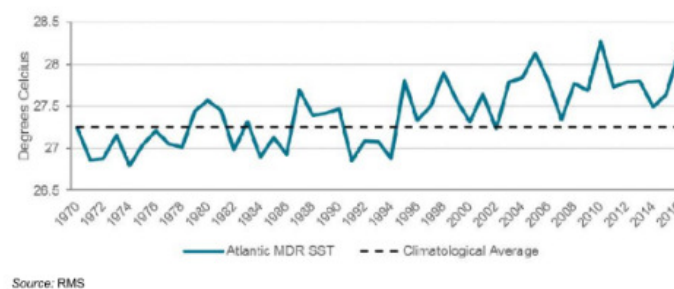
Local Threat

While such a gesture would be completely worthy of you, the truth is, that noble as it would be, the actual significance, given Bermuda's minute impact on climate compared to countries like China and Brazil, would merely be symbolic.

Having said that however, making a commitment to strengthen our local response to the threat of climate change is nothing less than a matter of national security.

Imagine for a minute what will happen if the lights go out for a sustained period of time like they did all over the Caribbean last year. What do you think International Business will do? How would that affect key economic factors like national debt service, GDP, foreign earnings, the balance of trade and, in turn, job security?

Figure 12. Sea Surface Temperature



Security of our energy supply starts and finishes with the weather. Since ocean temperatures have begun to rise around Bermuda, three significant things are happening.

1. More extreme “king” tides i.e. highest astronomical tides (HAT) combined with warm water eddies like we saw on the 18th October 2017 that flooded Town Square.
2. An increase in the severity and frequency of major storms.
3. More intense rainfall due to higher evaporation rates over warmer water.

According to a paper prepared by the Bermuda Weather Service titled *Hurricanes - General Information for Bermuda*, between 1960 and 2000 only two major hurricanes reached our latitude within 300 miles the island. Since 2000, six major hurricanes have threatened Bermuda, including Ophelia, which passed 90 miles to our east on October 1st, 2011, and was one of only two Cat 4 storms on record to make it this far North. Of the six, three were direct hits and Nicole downgraded to a cat 3 just prior to hitting us.

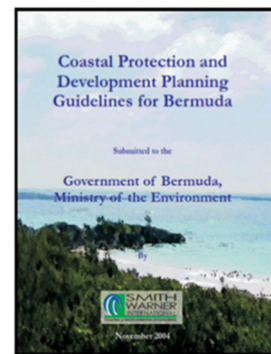
Heavy rain is often associated with hurricanes but in August 2017, Harvey broke all the records after it made landfall at San José Island, Texas as a cat 4 hurricane then downgraded and stalled further along the coastline dropping torrential and unprecedented amounts of rainfall over the state. Many areas received more than 40 inches of rain as the system slowly meandered over eastern Texas and adjacent waters, causing unprecedented flooding. Research shows there has been a 6% increase in the chance of a Harvey scale rainfall event over the last two decades.

<http://news.mit.edu/2017/texas-odds-harvey-scale-rainfall-increase-end-century-1113>

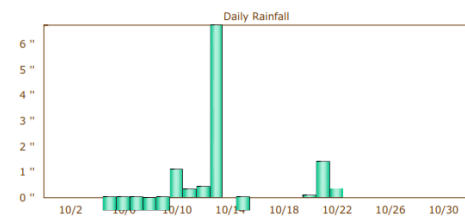
Worst case scenario

The worst-case scenario for BELCO would be a combination of three events all of which have happened either in September or October but not, so far, at the same time.

5th September 2003 – Fabian, a major hurricane moving slowly from the south east taking eight hours to pass over the island. Fabian’s wind veered south west at high tide exposing the Mill’s Creek entrance to a storm surge plus wave action resulting in the maximum inundation level which, according to the *Coastal Protection and Development Planning Guidelines*, produced by Smith Warner International for the Department of Planning, is 2.2-3.5 meters (7.3-11.6 feet). *See tables in Appendix I*



13th October 2016 – Nicole, a fast-moving, intense hurricane that downgraded from a cat 4 just prior to hitting us and moved over the island in 2 hours. The Esso Pier Tide Gauge recorded a storm surge of 4 feet, mitigated by the fact that it was low tide when Nicole passed over. Localized flooding occurred as Nicole brought about 7 inches of rain. (Graph shows rainfall for October 2016)



18th October 2017 – “King” Tide, a confluence of highest astronomical tide (HAT) and a warm water eddy. HAT is 2.6 feet above the ordinance survey (OS) datum. The warm water eddy put the water level another 1.5 feet above HAT for a combined 3.1 feet above OS datum. *See NOAA tide data Appendix I*

Note: plans submitted to the Department of Planning by BELCO show the average contour at the North Power Station (NPS) site is 2.3 feet above OS datum.



Perfect storm

In the perfect storm scenario, a slow moving, major hurricane hits Bermuda from the south east but stalls just north of the island. Like Fabian, the wind veers south west at high tide and water surges over the land at the entrance of Mill’s Creek filling the bay and flowing into the low-lying area (BELCO Basin) beyond. Only in this scenario it happens during a “king” tide and the NPS site is already 18 inches underwater. The rapidly rising water at BELCO is alarming but no serious damage occurs.

Unless, this is not a dry storm like Fabian but more like Nicole and averages 3.5 inches of rainfall per hour. After 8 hours, nearly 30 inches of rain falls. The water accumulating in the BELCO Basin has no place to go as extreme high tides combined with the storm surge prevents the water from dissipating as it normally would, through Mill’s Creek. Storm runoff from the hills surrounding BELCO only makes matters worse.

Even in such an extreme case, BELCO’s new NPS generators, which are to be installed on pedestals 14 feet above OS datum, would likely be OK. However, other vital infrastructure like transformers, switching gear and transmission lines along with many of their gas turbines would be inundated long before the water got anywhere near that height. It is not likely that BELCO would go down

completely but, their generating capacity, especially their ability to meet peak demand, could be seriously impacted; possibly over a long period of time.

Modeling the risk

These three separate events i.e. a slow moving major storm from the south east, torrential rainfall associated with a major storm and a “King” tide have all happened separately at the height of hurricane season and it is completely within the range of possibility that all three of these events could happen simultaneously at some time in the future which would be the worst-case weather scenario for BELCO.

Rachael Gosling VP, Head of Catastrophe Modelling, Markel Global Reinsurance has provided a loss curve – also called the EP (Exceedance Probability) curve which is shown below. This model was developed by RMS (Risk Management Solutions), a catastrophe modelling company, and is saying that approximately 1 in 25 years we could expect a storm that would cause \$456 million of damage. Fabian caused \$300 million and Gonzalo caused \$200 million. This curve model is a reasonable way to predict our exposure to damage from major hurricanes. The \$500 million storms are strong Cat 2 and Cat 3 storms. The 100-year loss at \$2 billion is from Cat 4 and strong Cat 3 storms. The higher losses are Cat 4 and Cat 5 storms hitting us.

Critical Prob.	Return Period	Bda Co (USD) Gross Loss AEP	Bda Co (USD) Gross Loss OEP	Bda Co (USD) Net Loss Pre Cat AEP	Bda Co (USD) Net Loss Pre Cat OEP
0.01%	10,000	23,018,197,636	22,938,404,804	23,018,197,636	22,938,404,804
0.02%	5,000	17,789,078,401	17,664,060,394	17,789,078,401	17,664,060,394
0.04%	2,500	11,939,868,947	11,817,474,170	11,939,868,947	11,817,474,170
0.10%	1,000	7,606,271,710	7,493,515,566	7,606,271,710	7,493,515,566
0.20%	500	5,227,409,457	5,113,099,262	5,227,409,457	5,113,099,262
0.40%	250	3,652,611,555	3,565,557,139	3,652,611,555	3,565,557,139
0.50%	200	3,248,334,665	3,168,804,136	3,248,334,665	3,168,804,136
1.00%	100	2,121,551,082	2,059,650,506	2,121,551,082	2,059,650,506
2.00%	50	1,209,579,054	1,166,543,745	1,209,579,054	1,166,543,745
4.00%	25	590,038,786	566,269,400	590,038,786	566,269,400
10.00%	10	136,186,137	129,964,557	136,186,137	129,964,557
20.00%	5	17,208,383	16,468,990	17,208,383	16,468,990
	Gross Loss	Net Loss Pre Cat			
Pure Premium	101,311,917	101,311,917			
Standard Deviation	602,295,589	602,295,589			

The impact (floodwater heights) that would result from the BELCO “perfect storm” needs to be modelled by properly qualified persons, taking into consideration, the contours of the BELCO Basin and the surrounding hills, predicted storm runoff and the capacity of Mill’s Creek to drain the basin during such an extreme event. I do not have the resources to engage such a study for this submission, but I highly recommend that the RA does so as part of its due diligence during the IRP process.

It is important that we learn from hurricanes Katrina and Sandy. Like New Orleans and New York, we should not assume that we are safe just because low-lying areas in Bermuda have not suffered devastating floods in the past.

Fire risk

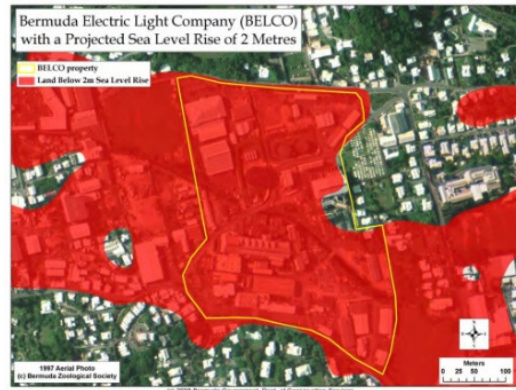
Storm related flooding is not the only security risk to the central plant, dangerous incidents like in September 2014, when insulation around the exhaust system of an engine ignited and in October 2013 when a switch caught fire and took over an hour to extinguish also pose a serious threat to our security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

Decentralizing our energy supply mix

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

The bottom line is that the more distributed energy we connect to our grid, the more secure our energy supply will be and consequently the more resilient the whole system will become. Residential and small commercial solar along with energy efficiency and energy conservation are valuable distributed energy resources (DER) and provide highly diversified energy sources that feed the grid from the outside in providing an important buffer in the case of a partial or catastrophic central plant failure. Properly engineered solar arrays are proven to withstand cat 5 conditions. See:

<https://www.rmi.org/news/solar-under-storm-designing-hurricane-resilient-pv-systems/>



Community scale solar

DER has always been secure, clean and self-funding but, until very recently was too expensive to be considered a major player. Now with community scale solar programs recently developed by the Rocky Mountain Institute which leverage system standardization, economies of scale and innovative business models to make solar energy more affordable and therefore more widely available, this has changed. As a result, distributed energy resources, which were already growing organically in Bermuda, are expected to expand rapidly.

As it stands now, an independent customer acting cooperatively with 5 other people (6 systems fit in a 20' container) can source a 7.8 KW solar system that generates an annual daily average of 29 KWh for 6 cents/KWh. See *UMA Solar quote and Solar Co-op spread sheet attached in Appendix II*.

A community scale solar co-operative provisionally called Shine Bermuda has been conceived. The structure will be a flow through co-operative, limited by guarantee. 10% will be added to the cost of each system, part of which will pay for the administration of the Co-op and part of which will go towards solarizing schools and other important civic buildings. Based on a quote from Canadian Solar for tier I Monocrystalline panels CIF (cargo, insurance, freight) Bermuda of 42 cents per watt see *Appendix II* and inverter and racking cost being the same as in the solar co-op spread sheet, an installed cost of \$1.65 per watt is expected to be achieved.

Also, a Tesla Powerwall II, when they become available on the island, will store power for 18 cents/KWh (10 cents/KWh with an extended warranty). See *LCOE Energy Storage, Appendix II*.

Combined, residential solar and battery storage can dispatch home power as needed for 24 cents/KWh.

DER resource

Unlike Kauai, which is installing utility scale solar with battery storage this year for a PPA of 11 cents per KWh, we do not have large tracks of land suitable for utility scale solar. What we do have however, is roof area. According to the Government GIS (geographic information system) Bermuda's roof area is about 4.9 million m² and covers a little under 10% of the island's land mass. See *correspondence from Mandy Shailer MSc (GIS), GIS Mapping Analyst, Government of Bermuda - Appendix II*

Installed rooftop solar averages 8 KW "nameplate" per 46.6 m² so if we use 20% of the total roof area, we can develop 160 MW DC "nameplate" capacity which, when converted to AC, will generate 36% of our 1,617 MW of daily demand. Combined with a modest 20% reduction in energy use from energy efficiency and conservation, the DER (distributed energy resource) will provide over half of our electricity demand.

Apart from the added security gained by diversifying our energy supply mix, developing our distributed energy resource will increase economic stability by providing a hedge against rising oil and gas prices. Further economic benefit will be derived if DER is self-funded with Bermuda dollars through reduced outflow of cash for imported oil and repayment of foreign sourced CAPX, keeping more money in the local economy thus improving the balance of trade and in turn, growing GDP.

We will still need fossil fuel generators for some time to come, but their role will increasingly be as back up for clean, secure, renewable energy. In the meantime, the more DER we can develop in the outer perimeters of the grid the better. In this, time is of the essence.

With the recent availability of inexpensive battery storage, solar is now "dispatchable" which makes distributed solar the cleanest, most cost effective, and secure mature energy supply available in Bermuda today.

We may have been a little slow off the starting line but expect significant DER uptake over the next 5 to 10 years. Certainly, enough to take a major bite out of BELCO's GDP tied load forecast.

BELCO's de facto proposed 2.8% cap on DER

I am concerned about proposed 2.8% cap on DER through 2038 in BELCO's 2018 IRP document, especially given section 49 in the Act which states: "The TD&R Licensee shall execute a Standard Contract with a person that applies for distributed generation if— entry by the TD&R Licensee into the contract with that third party would not put the TD&R Licensee beyond the limit of the distributed generation capacity agreed by the TD&R Licensee under the approved Integrated Resource Plan".

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

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

This would be a huge mistake as it could ultimately drive 50% of their demand off the grid. DER represents a \$500 million emerging market opportunity and is the only potential for exceptional growth in the sector. Instead of seeing it as an opportunity and getting their grid ready for this new business, BELCO appears to see it as a threat and to be deliberately making moves to prevent it.

To Quote Chris Worboys, arguable Bermuda's best mind when it comes to the integration of renewables in our energy supply:

"I expect the main constraint around Bermuda's eventual solar capacity is going to have more to do with the how much BELCo, the Government and the RA decide between them can be deployed than the available area.

Batteries will get around this to some extent by allowing people to defect from the grid but would be inefficient at the societal level as a lot of systems would have excess capacity in order to meet demand during periods of lower irradiation. It would make far more sense to pool everyone's electricity generation capacity through the grid and also share storage capacity."

The gold standard of small island utilities

Just as Flora Duffy has come to represent the gold standard for performance, so has Kauai Island Utility Cooperative (KIUC) come to represent the highest standard of excellence for modern, small-island utilities. <http://website.kiuc.coop/content/about-us> The sad truth is, BELCO doesn't even qualify for the race. Instead of embracing the future, BELCO has chosen to become a living fossil. The following is from the KIUC web site and every Bermudian should be embarrassed by comparison.

Kauai Island Utility Cooperative (KIUC) purchased Connecticut-based Citizens Communications' Kauai Electric in November of 2002.

KIUC operates as a not-for-profit organization that is owned and controlled by the people it serves. KIUC's location presents some unique challenges that make it different from its sister cooperatives on the mainland. While most co-ops purchase electricity from large coal-fired power plants and huge hydroelectric power stations that can be hundreds of miles away, KIUC must generate all of its power on the island of Kauai. These smaller generating plants are powered by imported fossil fuels – which is less efficient and more expensive than mainland power sources.

In an effort to reduce its power cost, decrease its use of imported fossil fuels and increase the amount of energy generated from Kauai's own resources, KIUC has launched a strategic initiative to generate 50 percent of its electricity from renewable sources by 2023.

KIUC by the numbers

- 33,562 – Number of meters (electric accounts) served by KIUC.
- 24,745 – Number of active member-owners
- 562 – Number of square miles in KIUC's service area
- 1,400 – Miles of 57.1kV transmission and 12.47kV distribution lines owned and maintained by the co-op
- 151 – Employees delivering safe and reliable electricity to the citizens of Kauai
- 40+ – Percent of KIUC's electricity that comes from renewable energy sources

- 70 – Percent of electricity KIUC is committed to generating from renewable resources by 2030
- \$26 million – Amount of money returned to members as patronage capital and refunds since the co-op was established
- 125 – Total generating capacity (in megawatts) of KIUC’s existing power plants
 - 3,273 residential solar rooftop systems in service
 - 99.96 percent system reliability each year from 2014-2016
 - 90 percent or more renewable power utilized in daylight hours on most sunny days

Aspirational Mix

We should follow Kauai’s example and set our energy future on the fastest possible course towards energy independence by embracing affordable, secure, clean renewable energy and we should start by setting the most ambitious energy targets, realistically achievable, in a new aspirational mix.

Based on real life results achieved by KIUC and bearing in mind that our most abundant local energy resource is distributed energy, I think such an aspirational mix could look like this:

Fuel/Resource Type	2023	2028	2038
HFO	80%	20%	
LPG		15%	15%
Utility Scale Renewables: Bio-mass, Utility Scale Solar/Offshore Wind with BESS	5%	10%	40%
Distributed Solar	5%	15%	25%
Energy Efficiency & Conservation	10%	15%	20%

Notes:

- (i) There will be a need for some fossil fueled generation throughout the forecast period, but it will be reduced over time to backup for renewables. LPG is best suited for this because it is a low carbon fuel (LCF) having a smaller carbon footprint and lower public health added costs than oil. LPG also requires significantly less infrastructure than LNG. LPG’s lower CAPEX and associated debt service require a smaller share of the forecast demand to be financially viable creating more room for renewables and reducing the risk of stranded assets.
- (ii) The numbers for distributed solar, energy efficiency and conservation have been offset to account for additional demand from the uptake of electric vehicles over the forecast period.

Last year, KIUC and AES Corp. announced plans to pair a 28 MW solar array with a 20 MW, 100 MWh battery system to deliver dispatchable renewable generation to the Hawaiian island for 11 cents/KWh. <http://www.utilitydive.com/news/hawaii-co-op-signs-deal-for-solar-storage-project-at-11kwh/433744/> and according to Bloomberg New Energy Finance, offshore wind’s LCOE is \$118 per MWh this year, while lithium-ion battery prices fell from \$1,000 per kWh in 2010 to \$209 per kWh in 2017. <https://about.bnef.com/blog/tumbling-costs-wind-solar-batteries-squeezing-fossil-fuels/>

As a private citizen, I do not have the necessary resources to provide a quantitative analyses but, given the cost of renewables are now on par with or below oil and gas fired generation and going down, compared to oil and gas prices which are rising, logic dictates that the above ambitious, but achievable aspiration of 85% renewables by 2038 would lead to significantly lower energy costs, better security of supply and cleaner energy than any of the scenarios in the 2018 IRP proposal submitted by BELCO.

The alternate possible

Bloomberg New Energy Finance goes on to say in the same article mentioned above: “we are seeing record-low prices being set for wind and solar, and then those records being broken again and again on a regular basis. This is having a powerful effect – it is changing perceptions.”

To quote Einstein: “we cannot solve our problems with the same thinking we used when we created them”. It is time to pursue the “alternate possible” which Steve Scott, science author and proponent of the idea, says is almost always achieved through collaboration within a diverse network.

I commend the RA for facilitating this public consultation and in so doing, striving for an energy future built on an aspirational foundation reflective of broad based societal input. I am confident your leadership will result in an energy future that all Bermudians can be proud of.

Appendixes

There are two Appendixes attached with this submission.

Appendix I shows predicted storm surge with corresponding inundation levels from the *Coastal Protection and Development Planning Guidelines*, produced by Smith Warner International for the Department of Planning and NOAA Tidal Data from the Bermuda Weather Service.

Appendix II shows the UMA Solar Quote for a 7.8 KM Solar System FOB San Fernandina Beach, a solar panel quote from Canadian Solar CIF Bermuda, the Solar Co-op Spread sheet and LCOE of Energy Storage worksheet along with a correspondence from Mandy Shailer MSc (GIS), GIS Mapping Analyst, Government of Bermuda.

APPENDIX I

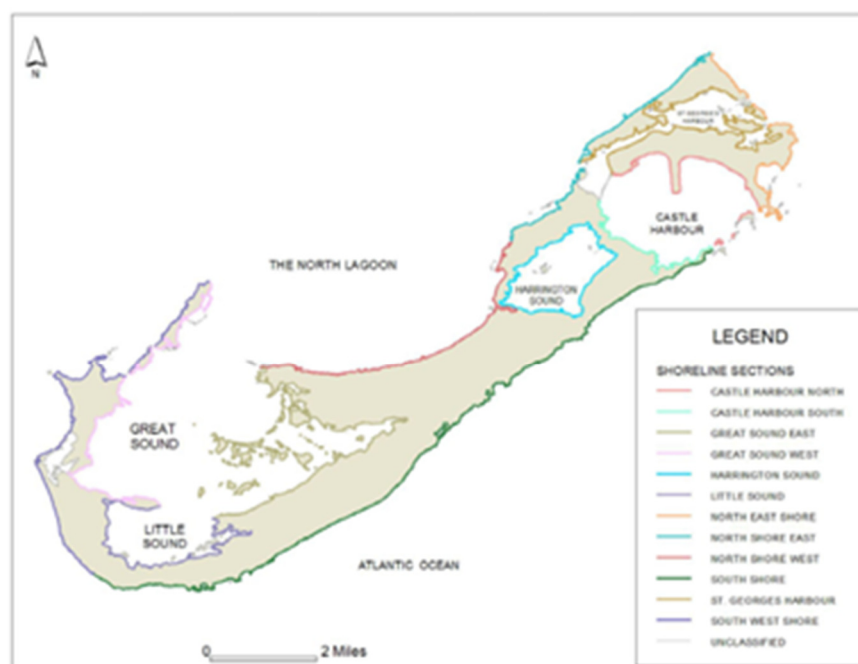


Figure 4.1 Division of Shoreline by Maximum Wave Heights, Orientation and Type

Table 4.1 Wave Height and Storm Surge by Shoreline Section

Location	Wave Height in 10m-depth		Static Storm Surge at Shore	
	50-year	150-yr	50-year	150-yr
North Shore - East	3.0-3.5	4.0-6.0	1.3-1.4	1.6-1.8
North Shore - West	2.5-5.0	3.0-5.0	1.4-1.5	1.8-2.0
West Shore	3.0-4.0	3.0-5.0	1.4-1.6	1.8-2.0
South West Shore	2.5-4.0	3.0-5.0	1.6-1.8	2.0-2.3
South Shore	5.0-8.0	5.0-8.0	1.7-1.9	2.0-2.2
North East Shore	3.0-7.0	3.0-7.0	1.5-1.7	1.7-2.1
St. Georges Harbour	1.5-2.0	1.5-2.5	1.4-1.5	1.7-2.0
Castle Harbour - North	2.0-3.0	2.5-4.0	1.7-1.8	2.0-2.3
Castle Harbour - South	1.5-2.5	2.0-2.5	1.7-1.9	2.0-2.3
Harrington Sound	1.5-2.5	1.5-2.5	1.4-1.5	1.8-2.0
Great Sound- East	1.5-2.0	2.0-3.0	1.4-1.5	1.7-1.8
Little Sound	1.5-2.5	2.0-3.0	1.4-1.5	1.7-1.9
Great Sound-West	2.5-4.0	2.5-4.0	1.4-1.5	1.7-1.9

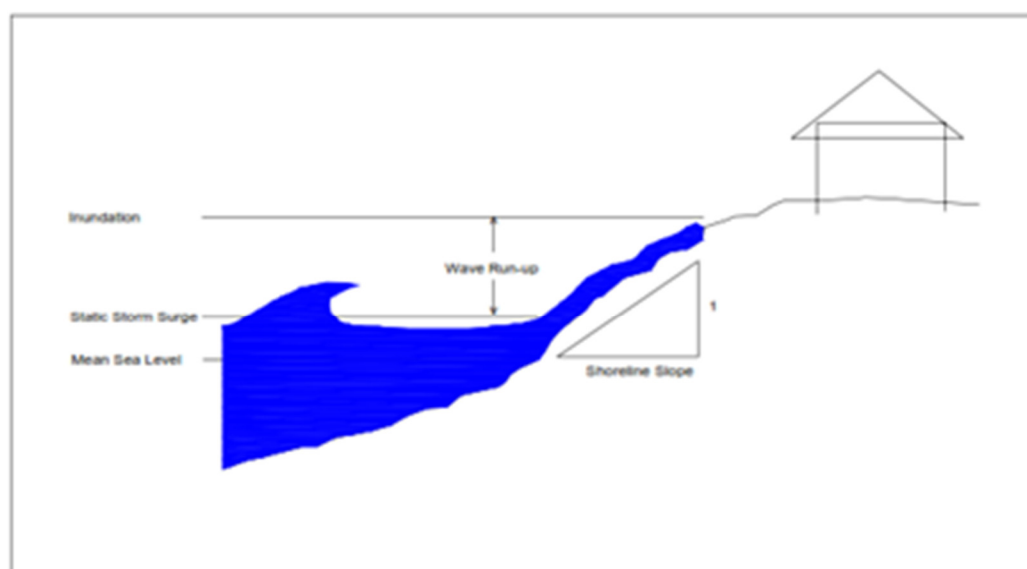


Figure 4.2 Definition sketch for calculation of Inundation Levels

Table 4.2 Inundation levels by Shoreline Section

Location	Inundation Levels above Mean Sea Level (MSL)			
	Beach	Flat Rock	Low Cliff	High Cliff
North Shore - East	4.4-6.2	3.0-4.4	5.3-7.1	7.1-9.4
North Shore - West	4.6-6.4	3.2-4.6	5.3-7.3	7.3-9.6
West Shore	4.6-6.4	3.2-4.6	5.5-7.3	7.3-9.6
South West Shore	3.0-5.1	2.6-3.9	3.3-5.7	3.9-7.2
South Shore	5.1-9.6	3.3-6.6	6.9-11.1	9.3-14.9
North East Shore	4.6-6.4	3.2-4.6	5.5-7.3	7.3-9.6
St. Georges Harbour	2.7-4.8	2.3-3.6	3.0-5.4	3.6-6.8
Castle Harbour - North	4.8-6.6	3.4-4.8	5.7-7.5	7.5-9.6
Castle Harbour - South	3.0-5.1	2.6-3.9	3.3-5.7	3.9-7.2
Harrington Sound	2.8-4.9	2.4-3.7	3.1-5.5	3.7-6.9
Great Sound- East	2.6-4.7	2.2-3.5	2.9-5.3	3.5-6.7
Little Sound	2.7-4.8	2.3-3.6	3.0-5.4	3.6-6.8
Great Sound-West	4.5-6.3	3.1-4.5	5.4-7.2	7.2-9.5

Absolute Differences Between Hydrographic and Topographic Datums

UPDATED April 2015

Main Side of Table													
HAT	0.206	0.285	0.300	0.500	0.700	0.790	1.000	1.044	1.068	1.200	1.300	1.400	2.097
MHHW	0.079	0.094	0.294	0.494	0.584	0.794	0.838	0.862	0.994	1.094	1.194	1.891	
MHW	0.015	0.215	0.415	0.505	0.715	0.759	0.783	0.915	1.015	1.115	1.812		
MHWS		0.200	0.400	0.490	0.700	0.744	0.768	0.900	1.000	1.100	1.797		
MHWN		0.200	0.290	0.500	0.544	0.568	0.700	0.800	0.900	1.000	1.597		
MSL	0.663	0.457	0.378	0.363	0.163	0.090	0.300	0.344	0.368	0.500	0.600	0.700	1.397
OS Datum					0.127	0.210	0.254	0.278	0.410	0.510	0.610	1.307	
MLWN					0.337	0.444	0.068	0.200	0.300	0.400	1.097		
MLW					0.381	0.024	0.156	0.256	0.356	1.053			
MLLW					0.405	0.132	0.232	0.332	1.029				
MLWS					0.547	0.100	0.200	0.897					
LAT					0.637	0.100	0.797						
Chart Datum					0.737								
Esso Sta. Datum					1.434								

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

Source Data Notes:

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

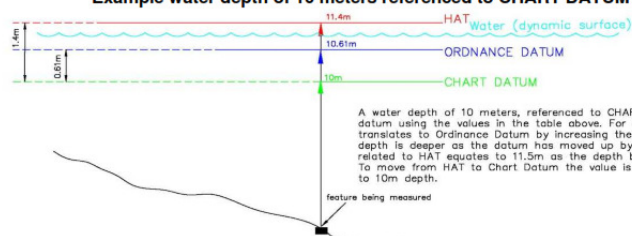
Data as stated on Savage OS Map Series

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

Data obtained from email, noaa, Thomas Landon regarding Station Datum values above Station Datum, Esso Pier

Benchmark Sheet for 2695540 dated 11/23/2011

Example water depth of 10 meters referenced to CHART DATUM



APPENDIX II

Corporate Office
950 Sunshine Lane
Altamonte Springs, FL 32714
800-79-SOLAR (407) 831-1941
(407) 834-8696 FAX
orderdesk@umasolar.com



Quote Name	Bermuda Coop (Bermuda Coop)	Quote Date	4/4/2018
Quote Num	60781	Expiration Date	4/19/2018
Sage100 Customer	02-DOUGH	FOB	
Customer P.O.	Bermuda Coop	Ship VIA	WILLCALL
Bill To Name	Doug Hagg	Ship To Name	Will Call
Bill To	950 SUNSHINE LN ALTAMONTE SPRINGS, FL 32714-3803 US	Ship To	950 SUNSHINE LN ALTAMONTE SPRINGS, FL 32714-3803 US
Confirm TO		Terms	COD (UMA) - No Disc.
SalesPerson	DH		

Product	WHSE	Extended Description	UOM Code	Quantity	Sales Price	Total Price
1-6500-006	002	Cable Tie - Black 14-1/2" 50lb Break Strength	b100	1.00	\$5.27	\$5.27
3-6000-038	002	PV Module - 300 Watt Mono Silver Frame- Heliene	each	26.00	\$182.85	\$4,754.10
3-6020-024	002	Label Kit - PV General .	each	1.00	\$30.00	\$30.00
3-6060-084	002	Rail - 204" (17") XR-100 Clear - IronRidge XR-100-204A	each	11.00	\$45.59	\$501.49
3-6060-085	002	End Cap - XR100 Bag of 10 Sets IronRidge XR-100-CAP	pack	1.00	\$7.10	\$7.10
3-6060-124	002	Weeb Grounding Lug - IronRidge GD-LUG-003	b2	3.00	\$7.07	\$21.21
3-6060-125	002	Splice Kit - XR100 Bonded XR-100-SPLC-BD	each	8.00	\$4.26	\$34.08
3-6060-127	002	UFO Clamp Kit - Clear 4 pcs. UFO-CL-001 Universal Module Clamp	b4	14.00	\$7.06	\$98.84
3-6060-133	002	UFO Stopper Sleeve 40-MM Clear 4/kit UFO-STP-40MM	b4	4.00	\$1.06	\$4.24
3-6060-135	002	Bonding Hardware Kit - 1/4x3/4, T-Bolt for Micro Inverter - MI-BHW	b2	13.00	\$1.54	\$20.02
3-6060-147	002	L-Foot - Slotted Black 4/bag No Bonding Hardware (FM-LFT-003-B)3-6060-147.jpg	b4	15.00	\$6.46	\$96.90
3-6060-220	002	L-Foot Bonding Hardware Bolt & Nut for Slotted L-Foot Mill & Black (FM-SQ-BHW-V2)	b4	15.00	\$4.00	\$60.00
3-6070-017	002	Zigbee Ethernet Kit - Solaredge SE1000-ZBGW-K-NA	each	1.00	\$241.50	\$241.50
3-6070-053	002	Optimizer - SE P320W Solaredge P-320 MC4 Connectors for 60 cell	each	26.00	\$57.19	\$1,486.94
3-6070-057	002	Inverter - SE 7600H-US- HDWave SE 7.6 kW Single Phase	each	1.00	\$1,449.55	\$1,449.55
3-6500-003	002	Fuse Holder - Up to 30 Amp Gray	each	4.00	\$7.03	\$28.12
3-6500-005	002	Combiner Box - Roof Mount Soladeck	each	1.00	\$74.60	\$74.60
3-6500-020	002	Cord Grip - 1/2" Non-Metallic LAPP	each	2.00	\$1.69	\$3.38
3-6500-021	002	Fuse - 15 Amp 1000 Volt DC - Midget	each	4.00	\$5.07	\$20.28

Signature \s1\

Net Order	\$8,937.62
*Freight	\$0.00
Tax	\$0.00

Prices for items on Sales Orders not shipped within 15 days are subject to change. Customer's signature indicates agreement to the order and prices as shown above and that customer understands that UMA's Terms and Conditions of Sale as outlined in UMA's Price Catalog will apply to this order.

Grand Total	\$8,937.62
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QUOTE



Quote Name CAR-300118-NH_CIF Created Date 1/30/2018

SELLER

Company Canadian Solar (USA) Inc.
Address 3000 Oak Road, Ste. 400,
Walnut Creek, CA 94597
USA
Contact Name Belem Eslava
Contact Email belem.eslava@canadiansolar.com

BUYER

Company Nathaniel Hutchings
Address 36 Middle Road
Paget PG03
, Bermuda
Bermuda
Contact Name Nathaniel Hutchings
Contact Email nhutchings@logic.bm

Additional Information

INCOTERM 2010 FOB, FOB China DESTINATION FOB China, United States
End Market Bermuda Currency USD
Total Volume(Wp) 446,040
Requested Date March, 2018

Comments Product shipped from China and delivered at port of Bermuda

Product

Product	Module Type	Certification	Wattage	Volume(Wp)	Quantity	Sales Price	Amount	Currency
CS3K-MS	Standard	UL1703-1000V	305	230,580	756.00	USD 0.4300	99,149.40	USD
CS3K-P	Standard	UL1703-1000V	285	215,460	756.00	USD 0.3850	82,952.10	USD

Total Line Item 182,101.50
Amount
Shipping and
Handling 0.00
Tax 0.00
Total Amount 182,101.50

PAYMENT

Payment Description	Amount	Currency
20% down payment 5 days after PO date	36,420.30	USD
80% down payment 15 days before delivery	145,681.20	USD

TERMS

The above volume based pricing and terms are dependant on overall purchase volume and stated delivery schedule. Changes to delivery schedule or overall purchase volume may result in a change in pricing and/or terms. All pricing and terms are subject to Canadian Solar's Standard Terms & Conditions, unless otherwise mutually agreed upon in a subsequent Master Supply Agreement. **【QUOTATION IS VALID FOR 10 DAYS.】**

Canadian Solar (USA) Inc.
3000 Oak Road, Ste. 400, Walnut Creek, CA 94597
Tel: 925-866-2700 | Fax 925-866-2704

Solar Co-op Pilot Project					
		Price	Price per Watt		
				Performance Assumptions	
UMA 7.8 System (panels, micro-inverters (extended warranty 25yrs), racking) FOB Jacksonville.		\$ 8,937.62	\$ 1.15	Watts DC per Solar System	7800
Shipping		\$ 500.00	\$ 0.06	Number of 7.8 KW DC Solar Systems per 20' Container	6
Wharfage		\$ 111.72	\$ 0.01	Cost of Shipping 20' Container from Florida	\$ 3,000.00
Insurance		\$ 178.75	\$ 0.02	Performance Assumptions	
Clearance per 20' Container		\$ 100.00		Annual Daily Average - KWh AC per KW Installed DC Capacity	3.7
Trucking per 20' Container		\$ 250.00		Value of Power used during production	\$ 0.36
Unloading per 20' Container		\$ 250.00		Value of Power Sold to BELCO	\$ 0.17
Total Clearance, Trucking, Unloading per 20' Container		\$ 600.00	\$ 0.01	% of Power used during Production	20%
Total Cost per Watt on Site			\$ 1.25		
Permitting		\$ 600.00	\$ 0.08		
BELCO Connection					
Installation		\$ 4,800.00	\$ 0.62		
Total Cost of 7.8 KW DC Solar System Installed		\$ 15,228.09	\$ 1.94		
Performance					
Total Value per KWh of Power Produced (see performance assumptions)		\$ 0.21			
Annual KWh Production	10533.9				
Annual Gross Value		\$ 2,216.33			
Net Value Over 25 years		\$ 40,180.22			
Annual Net Value		\$ 1,607.21			
ROI Over 25 Years	11%				
KWh Production over 25 Years	263347.5				
Cost per KWh		\$ 0.06			

Powerwall II LCOE work sheet					
Cost - (www.tesla.com/powerwall)		\$ 6,600.00		Powerwall II Specs	
Overland Freight		\$ 100.00			
Shipping and Handling		185		Capacity - KWh	13.5
Insurance		\$ 99.00		Cycles (365 x 10 years)	3650
Wharfage		\$ 84.00		Cycles - Extended Warranty (365 x 20 years)	7300
Trucking		\$ 85.00		Efficiency	90%
Installation		\$ 1,000.00		Depth of Discharge (DoD)	100%
Total Installed Cost		\$ 8,153.00			
Total Installed Cost - Extended Warranty		\$ 9,153.00			
LCOE per KWh (Formula - www.reneweconomy.com.au)		\$ 0.18			
LCOE per KWh - Extended Warranty		\$ 0.10			

Nick Hutchings

From: Shailer, Mandy L. <mlshailer@gov.bm>
Sent: Monday, July 02, 2018 12:29 PM
To: nhutchings@logic.bm
Subject: Building Footprint Areas

Hi Nick,

Sorry for the extreme delay on this.

From the 2012 Topographic Map Data, provided by the Dept of Land Surveys, there was an estimated building footprint area of 4.97 square kilometres. This value excludes any buildings categorized as being derelict or ruin.

If there is anything else I can do to help just let me know.

Cheers,
Mandy



Mandy Shailer MSc (GIS)
 GIS Mapping Analyst
 Government of Bermuda | [Department of Environment and Natural Resources](#)
 Shorelands | 17 North Shore Road | Hamilton Parish, Bermuda FL04
 Telephone: 441 299 2329 ex 2139
 Email: mlshailer@gov.bm

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