Overview of Integrated Resource Plan Alternative Proposals

Report for the Regulatory Authority of Bermuda

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Abbreviations

IRP	Integrated Resource Plan
HFO	Heavy fuel oil
LCOE	Levelised cost of electricity
LFO	Light fuel oil
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MW	Megawatts

1 Introduction

The Bermuda Electricity Act 2016 describes the process for drafting and approving an Integrated Resource Plan (IRP) to be used for planning of electricity generation projects in Bermuda. As the Transmission, Distribution & Retail Licensee, BELCO submitted an IRP proposal to the Regulatory Authority of Bermuda ("the Authority") on 15 February 2018. The Authority published the IRP proposal on its website for public consultation on 2 May 2018.

Eight alternative proposals for bulk generation or demand side resources were received during the consultation for the IRP proposal, which concluded on 17 August 2018. As part of the consultation, the Authority published *Bulk Generation Proposal Guidelines* ("the Guidelines"), which listed the requirements for alternative proposals to be considered in the IRP consultation process. The Guidelines are provided in Appendix A.

In accordance with the requirements of the Electricity Act, the Authority will publish the eight alternative proposals for public consultation. This report is intended to provide an overview of the alternative proposals to assist the public in the review of the proposals.

2 Requirements for alternative proposals

This report will provide a high-level overview of each alternative proposal and an assessment of whether it complies with the requirements for alternative proposals as laid out in the Electricity Act and the Guidelines.

Clause 42 (3) of the Electricity Act states the alternative proposals shall demonstrate:

a) how its inclusion in the Integrated Resource Plan would result in an electricity supply that is more consistent with the purposes of [the Electricity Act] and Ministerial directions;
b) how it uses technology that is in commercial operation in another jurisdiction.

Further to a) above, the purposes of the Electricity Act are listed in Clause 6 and are copied below:

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

The Guidelines published by the Authority state that “input assumptions for alternative generation proposals should be consistent with the requirement for a quantitative modelling methodology as the IRP requires a large number of numerical inputs and assumptions to be used;” and lists the following expected inputs:

i. Data on capital, operating and fuel costs of future generation;
ii. Technical and other operating characteristics, and expected retirement dates;
iii. Assumptions on future macroeconomic performance (e.g., growth) and government policy;
iv. Technical and operating characteristics of future generation technologies and their availability;
v. The price for input fuels and other related commodities, as well at the availability and price considerations of import infrastructure;
vi. Costs related to network infrastructure upgrades (if required);
vii. Sensitivity analysis of possible “high” and “low” cases along with base case scenarios for each source of uncertainty. These scenarios would be expected to be targeted at the assumptions that have the greatest impact on overall system costs. The uncertainties can include, but not limited to:
    a. production uncertainty;
    b. fuel price uncertainty;
    c. alternative capital and operating cost assumptions for future generation resources.

In addition, the Guidelines state that data inputs and assumptions should “be transparent and well documented. In particular, the alternative generation proposal would be expected to include detailed references and other supporting documentation…”

In this report, the compliance of each alternative proposal to the requirements of the Electricity Act and the Guidelines will be summarised using the following checklist. Items 1 and 2 are mandatory requirements from the Electricity Act, while items 3 to 8 are recommended requirements from the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	
2	Demonstration of the technology’s commercial operation in another jurisdiction	
3	Data on capital, operating and fuel costs	
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	
6	Price for input fuels and other related commodities as well as import infrastructure	
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

The alternative proposals are assessed against these requirements in Section 0.

3 Summary of alternative proposals

3.1 BCM McAlpine and Bouygues Energies & Services

The alternative proposal from BCM McAlpine and Bouygues Energies & Services appears to be an expression of interest to conduct a feasibility study into different generation technologies that could be deployed at the Marginal Wharf site. Three possible fuel options are suggested for distributed generation:

1. Liquefied oil products: Heavy fuel oil (HFO) or light fuel oil (LFO) – with reciprocating engines;
2. Liquefied gas: Liquefied natural gas (LNG) or liquefied petroleum gas (LPG) – with reciprocating engines; and
3. Biomass – with boiler and steam turbine plant.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	
6	Price for input fuels and other related commodities as well as import infrastructure	
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

This alternative proposal does not appear to satisfy the mandatory requirement no. 1.

3.2 Bermuda Engineering Company Limited (BE Solar)

The alternative proposal from Bermuda Engineering Company Limited (BE Solar) effectively provides another version of an IRP for Bermuda. It assesses several scenarios, some of which include a significant energy efficiency component and high renewables deployment. The preferred option features a 60 MW offshore wind farm, which is proposed to be operational by 2023.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	✓
4	Assumptions on future macroeconomic performance and government policy	✓
5	Technical and operating characteristics and availability	✓ *
6	Price for input fuels and other related commodities as well as import infrastructure	✓
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	✓

* Although assumptions are not thoroughly justified or referenced.

3.3 Bermuda Environment Energy Solutions Group Consortium

The alternative proposal from Bermuda Environment Energy Solutions Group Consortium (BEESG) provides details of a proposed bulk generation plant at Marginal Wharf comprised of 6 dual fuel reciprocating internal combustion engines, giving a total generating capacity of about 55 MW.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	✓
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	✓
6	Price for input fuels and other related commodities as well as import infrastructure	*
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

* The assumptions of the IRP have been retained.

3.4 Bermuda General Agency Ltd.

The alternative proposal from Bermuda General Agency Ltd. (BGA) is for a wave energy park for bulk generation capacity up to 20 MW.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	*
3	Data on capital, operating and fuel costs	**
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	***
6	Price for input fuels and other related commodities as well as import infrastructure	Not applicable
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

* The proposal makes reference to a demonstration facility (Sotenäs) that was connected to the Nordic grid in Kungshamn and generated power for the first time in January 2016. It also refers to a pilot project in Ghana, which ran from 2014 to 2016. The total generation capacity of these two projects is not given and information regarding reliability and availability are not provided. It is not clear from the proposal whether these projects were commercially viable. Therefore this alternative proposal may not satisfy the mandatory requirement no. 2.

** Levelised cost of electricity values were reported, but no information was provided on underlying capital and operating cost assumptions.

*** Basic technical specifications were provided but operating and availability data was not provided.

3.5 Brad Sorensen and Arpheion Inc.

The alternative proposal from Brad Sorensen and Arpheion Inc. is for "at least 200 MW of clean energy and clean water generators, located underground, that plug into a new underground grid and water supply system." It is unclear from the proposal what technology is being proposed.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	
3	Data on capital, operating and fuel costs	*
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	
6	Price for input fuels and other related commodities as well as import infrastructure	**
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

* An average power purchase price was proposed but limited information has been provided for capital costs and no information is provided for operating costs.

** Fuel costs are claimed to be zero. No details were provided on infrastructure costs associated with each configuration option presented.

This alternative proposal does not appear to satisfy the mandatory requirement no. 2.

3.6 Enviva and Albioma

The alternative proposal from Enviva and Albioma provides details of a proposed distributed generation plant at Marginal Wharf based on biomass technology with a total generation capacity of 47 MW. It is understood that this generation plant would be generating electricity from wood pellets, manufactured remotely and imported to Bermuda.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	✓ *
4	Assumptions on future macroeconomic performance and government policy	✓
5	Technical and operating characteristics and availability	✓
6	Price for input fuels and other related commodities as well as import infrastructure	✓
7	Costs related to network infrastructure upgrades (if required)	✓
8	Sensitivity analysis	

* It is unclear whether the fuel costs are inclusive of transport and handling costs.

3.7 Offshore Utilities

The alternative proposal from Offshore Utilities provides details of a ship-based floating power plant anchored offshore using LNG as a fuel with generation capacity of at least 100 MW.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	*
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	
6	Price for input fuels and other related commodities as well as import infrastructure	
7	Costs related to network infrastructure upgrades (if required)	
8	Sensitivity analysis	

* An average power purchase price range has been proposed, but no information has been provided for capital, operating and fuel costs.

3.8 Sol

The alternative proposal from Sol is for a bulk generation plant based on HFO/LNG dual-fuel reciprocating internal combustion engines located at Sol's Ferry Reach Terminal. Two options are considered: 18.4 MW and 55.2 MW. The lower capacity option is the maximum size that could be exported without grid reinforcement and the latter is the maximum potential of the site if changes were made to the grid to export the power.

The table below summarises how this alternative proposal complies with the requirements of the Electricity Act and the Guidelines.

No.	Requirement	Check
1	Demonstration of how its inclusion would result in an electricity supply that is more consistent with the purposes of the Electricity Act and Ministerial directions	✓
2	Demonstration of the technology's commercial operation in another jurisdiction	✓
3	Data on capital, operating and fuel costs	✓
4	Assumptions on future macroeconomic performance and government policy	
5	Technical and operating characteristics and availability	✓
6	Price for input fuels and other related commodities as well as import infrastructure	✓
7	Costs related to network infrastructure upgrades (if required)	*
8	Sensitivity analysis	

* Sol cites studies conducted in 2013/14 which found that an 18.4 MW plan would not require network upgrades to export the electricity generated. The 55.2 MW option would require network upgrades, but costs for this were not provided in the proposal.

Appendix A: Bulk Generation Proposal Guidelines

Bulk Generation Proposal Guidelines

1 Introduction

1.1 This note provides guidelines on what would be expected to be included in the Bulk Generation proposal in order to ensure that the Regulatory Authority of Bermuda ('the Authority') is able to: meet its obligations under the Electricity Act 2016 ('EA 2016') in a manner that is consistent with the National Electricity Policy; and implement the regulatory regime established by the electricity sector licences. The recommendations in this note reflect established practice and precedents for the development of IRPs and similar capacity planning exercises seen in a wide variety of relevant regulatory jurisdictions.

2 Bulk Generation Proposal Requirements

2.1 Input assumptions for alternative generation proposals should be consistent with the requirement for a quantitative modelling methodology as the IRP requires a large number of numerical inputs and assumptions to be used. For example, these inputs would be expected to include (this list is not intended to be exhaustive):

(i) Data on capital, operating and fuel cost of future generation technical and other

(ii) operating characteristics, and expected retirement dates;

(iii) Assumptions on future macroeconomic performance (e.g., growth) and government policy.

(iv) Technical and operating characteristics of future generation technologies and their availability;

(v) The price for input fuels and other related commodities, as well at the availability and price considerations of import infrastructure;

(vi) Costs related to network infrastructure upgrades (if required),

(vii) Sensitivity analysis of possible "high" and "low" cases along with base case scenarios for each source of uncertainty. These scenarios would be expected to be targeted at the assumptions that have the greatest impact on overall system costs. The uncertainties can include, but not limited to:

a. production uncertainty;
b. fuel price uncertainty;
c. alternative capital and operating cost assumptions for future generation resources.

2.2 In order to ensure that the alternative generation proposal is credible, comprehensive, and auditable, the data inputs and assumptions used would be expected to be transparent and well documented. In particular, the alternative generation proposal would be expected to include detailed references and other supporting documentation where necessary to show how the various input assumptions were selected.

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