Review of the IRP Proposal's compliance with guidelines

Note prepared for the Regulatory Authority of Bermuda

1 May 2018

1 Introduction

1.1 The Regulatory Authority of Bermuda ('the Authority') commissioned Oxera to review the extent to which the Integrated Resource Plan Proposal (the 'IRP Proposal'), dated 15 February 2018 prepared and submitted by the Bermuda Electric Light Company Limited ('BELCO') in its capacity as the Transmission, Distribution and Retail ('TD&R') Licensee, is compliant with the Authority's IRP guidelines.

1.2 This note explains the role of the IRP in the development of the electricity market in Bermuda, and presents a review of the IRP Proposal in terms of its compliance with the Authority's guidelines.

1.3 On 17 November 2017, the Authority issued a Notice, which required the TD&R Licensee to submit an IRP Proposal by 17 February 2018. On 6 December 2017, the Authority issued an Order setting Integrated Resource Plan Guidelines (the 'Guidelines Order') to provide guidance on the development of the IRP Proposal to the TD&R Licensee. As a result, the IRP Proposal has to be compliant with the Electricity Act 2016 ('EA 2016'), the Guidelines Order and the Notice.

1.4 This document is structured as follows:

- section 2 provides the legislative background for developing the IRP;
- section 3 explains the role of the IRP in the development of the electricity market in Bermuda;
- section 4 provides a discussion on the replacement generation proposal submitted by the TD&R Licensee;
- section 5 provides our review of the IRP Proposal's compliance with the Authority's guidelines.

2 Legislative background

2.1 The EA 2016 requires that the TD&R Licensee prepares an IRP at least every five years as determined by the Authority or as directed by the Minister. This should contain:[1]

> (a) a resource plan that includes the expected demand for the period and the state of the TD&R Licensee's existing resources; and
> (b) a procurement plan that details how the licensee proposes to meet this demand.

2.2 In preparing the IRP Proposal, the TD&R Licensee was required to consider: (i) all possible resources, including new generation capacity, demand-side resources (including demand response and energy efficiency), and retirement of generation capacity; and (ii) a range of renewable energy and efficient generation options, and a prudent diversification of the generation portfolio.

2.3 The IRP Proposal is also required to: (i) prioritise actions that most meet the purposes of the EA 2016, conform to Ministerial directions, and be reasonably likely to supply electricity at the least cost, subject to trade-offs contained in the Ministerial directions or instructions from the Authority; (ii) include recommendations on whether any resources should be procured through competitive bidding; and (iii) propose limits for total distributed generation capacity over the planning period.

2.4 The Authority may, subsequent to a process of consultation and review, approve the final draft of the IRP as issued by the TD&R Licensee, provided that it is the most appropriate approach to meeting the purposes of the EA 2016 and complies with Ministerial directions.[2]

3 The role of the IRP

3.1 An IRP is a plan that seeks to balance the future demand and supply of electricity. The IRP's purpose is therefore to set out the strategy for the procurement and retirement of generation assets as well as demand-side resources that meet the needs of consumers in a cost-efficient manner that is also consistent with Bermuda's energy policy objectives.

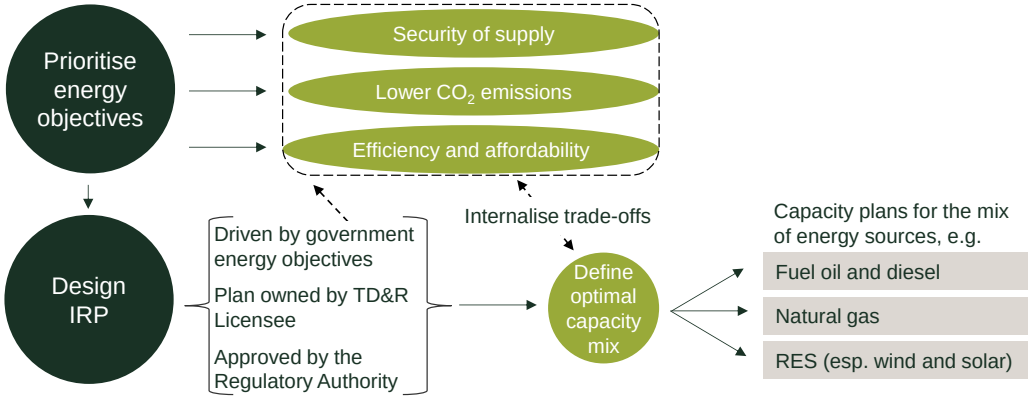
3.2 Accordingly, this plan should incorporate the latest evidence on the costs and technical characteristics of different generation and load management technologies in order to evaluate the least-cost capacity expansion plan for the

[1] Bermuda Electricity Act (2016),Section 40.
[2] Ibid., Section. 44 (2).

electricity market of Bermuda. The plan should include both a resource plan—including a forecast of expected demand and the state of the existing generation resources—and a procurement plan, which details how the TD&R Licensee proposes to meet the expected demand.

3.3 The IRP should balance competing considerations of affordability, sustainability and security of supply in order to create a system that is consistent with Bermuda's energy policy objectives. This process is summarised in the figure below.

Figure 3.1 Illustration of the role of the IRP within policy and regulation



Note: RES—renewable energy sources.

Source: Oxera

3.4 The IRP must therefore be credible, comprehensive in its treatment of available resources (whether currently available or anticipated to be available in future), auditable, and robust to identifiable sources of uncertainty in order to enable the Authority to:

- approve the least-cost, or otherwise most appropriate, electricity capacity expansion plan that meets demand at lowest overall cost and with acceptable levels of system reliability and implementation risk to consumers;
- assess the economic, environmental, and social implications of adopting alternative capacity expansion plans so as to be able to determine the optimal trade-offs contained in Ministerial directions; and
- evaluate the merits of applications by prospective IPPs or other licensees as well as other proposals that entail deviations from the IRP, in particular by calculating their benefits, costs, and risks to the electricity system.

3.5 The IRP is particularly important in the current context. In particular, any substantial investment in new capacity may 'crowd out' alternative generation projects until some existing assets need to be replaced or electricity demand increases. The IRP is the crucial instrument to ensure the most efficient development of the electricity market in Bermuda.

4 Condition 20 request

4.1 BELCO submitted a proposal for replacement generation ('the replacement generation proposal') to the Authority on 22 December 2017. The replacement proposal included the following.

- Battery energy storage system (BESS)—a utility-scale battery energy storage system with an output capacity of 10MW and storage of 5MW/h to be installed on BELCO's Pembroke campus (budget price of $8.8m). BESS is expected to provide a portion of the spinning reserve margin;
- North Power Station (NPS)—four new dual-fuel engines totalling 56 MW to be constructed on a site adjacent to existing generating assets on BELCO's Pembroke campus (budget price of $110m).[3]

4.2 We understand that the supplier of BESS was selected on the basis of a competitive tendering exercise with the assistance of a third-party engineering consultancy in 2017.

4.3 A competitive tendering exercise for NPS was completed by BELCO in 2011 with the assistance of a third-party engineering, management and development consultancy firm. In 2017, BELCO again approached the successful tender and asked for a revised price estimate. The revised price estimate was then analysed by their third-party engineering, management and development consultancy firm, concluding that the price offered by the successful tender is in line with similar projects in other countries and represents acceptable value for money.

4.4 However, given an elapsed period of around six years between the original competitive tender and the recent price revision and the fact that no competitive tender has been undertaken since, it has not been possible for the Authority to test if the price offered by successful tender currently represents good value for money.

[3] BELCO (2017), 'Proposal for the replacement of the Generation Facilities', 22 December.

4.5 Two options were considered in relation to the replacement generation proposal:

- accept the replacement generation proposal; or
- delay the decommissioning of the existing plant (thereby requiring the procurement of temporary generation) in order to undertake a new competitive tender.

4.6 Discussions and correspondence between the Authority and its technical advisers, Ricardo Energy & Environment, since July 2017 made it apparent that the critical state of the TD&R Licensee's generation assets would not allow for further delay of decommissioning the existing generation assets.

4.7 It was also clear from the advice of the Authority's technical advisers that the cost of delaying the installation of replacement generation by using temporary generation would have been prohibitive. The final report from the advisers on this matter confirmed that:

> [I]f the new generation plant was to be installed in 2021 rather than when it is needed in 2020, then the net additional cost of leasing temporary power to meet electricity demand in 2020 is estimated to be $44.0 million. To put this in perspective, the capital cost of the Project would need to be less than 63% of the current estimate to make this course of action more cost effective than having the Project operational in 2020. Similarly, if the new generation plant was to be installed in 2022 rather than when it is needed in 2020, then the net additional cost of leasing temporary power to meet electricity demand in 2020 and 2021 is estimated to be $87.8 million. Thus, the capital cost of the Project would need to be less than 26% of the current estimate to make this course of action more cost effective than having the Project operational in 2020.[4]

4.8 Under the EA 2016 and the Regulatory Authority Act 2011, the Authority has a duty to ensure security, adequacy, and reliability of electricity in Bermuda while also seeking least-cost electricity supply. In this instance, the Authority considered that any delays to the commissioning of the NPS was unduly risky as well as uneconomic. Put differently, the Authority deemed that the importance of ensuring security of supply considerations outweighed potential concerns over value for money, leading to the Authority's approval of BELCO's replacement generation.[5]

4.9 Given that the Authority only recently accepted BELCO's replacement generation programme, there may be opportunities to revise the parameters of

[4] Ricardo (2018), 'Temporary Generation Study Update Report', 8 March, p. 4.
[5] Regulatory Authority of Bermuda (2018), 'Order approving the request from the Bermuda Electric Light Company Limited ('BELCO') to the Authority dated 22 December 2017', 6 March.

this programme in response to the outcomes of the IRP consultation process and any other changes to system requirements. It would be important to confirm the extent of such flexibility at an early stage of the IRP consultation process.

5 IRP Proposal's compliance with the Authority's guidelines

5.1 Overall, Oxera considers that BELCO's IRP Proposal is broadly in line with the IRP guidelines. The IRP Proposal weighs up in appropriate detail feasible planning scenarios for Bermuda's energy system, with the selected scenarios representative of the main options that Bermuda now has in terms of electricity generation in the future.

5.2 Notwithstanding the conclusion that the IRP Proposal is broadly compliant with the guidelines, there are some concerns about the documentation provided by BELCO. These include the following.

- **Methodological concerns**. The use of Levelised Cost of Energy (LCOE) screening in developing the four feasible planning scenarios may only approximately gauge the efficacy of alternative generation options.
- **Replacement generation**. The IRP Proposal does not evaluate BELCO's replacement generation proposal—that is, the IRP Proposal assumes that the replacement generation proposal will be built under all scenarios. Therefore, the IRP Proposal provides limited information on whether the replacement generation proposal represented the best option for the development of the energy market in Bermuda.
- **Qualitative assessment**. The IRP Proposal includes a qualitative assessment of the four feasible planning scenarios. The *qualitative* assessment is inherently subjective, whereas the *quantitative* assessment presented in the IRP Proposal shows that the modelled scenarios are tightly grouped in terms of their overall cost. Therefore, the qualitative assessment (focused on attributes other than cost) has a large influence in selecting the preferred scenario.

5.3 In detail, the first concern is that the methodology pursued by Leidos—selecting a number of scenarios and modelling their implied system costs—may not facilitate the identification of the true least-cost options for electricity generation in Bermuda. The scenarios were identified on the basis of the

LCOE screening[6] and discussions with BELCO,[7] and, as such, the scenarios considered in the IRP Proposal represent an input to the modelling process rather than outputs as identified on the basis of the quantitative analysis.

5.4 While LCOE screening is one method to eliminate generation expansion alternatives that are significantly 'less economic', it is commonly recognised that this method does not account for all the costs and benefits of a particular generation technology. For example, the International Energy Agency has stated that 'whenever technologies differ according to the when, where and how of their generation, a comparison based on LCOE is no longer valid and may be misleading'.[8] LCOE screening is therefore likely to be less efficient than alternative methods based on mathematical optimisation approaches from the start.

5.5 Since the generation technologies for each of BELCO's scenarios were pre-selected during their specification, the possibility of using a mathematical modelling approach to determine which generation technologies feature in each scenario is precluded. The PROMOD optimisation took as given predefined scenarios to perform dispatch to load modelling, but was not used in the selection of the optimum generation technologies for each scenario.[9]

5.6 Therefore, utilising a mathematical modelling approach from the outset (rather than an LCOE analysis) may lead to improvements in the system cost efficiency of the options presented. The IRP Proposal does not identify if there are any other feasible scenarios that should have been considered (or the selection of the generation technologies within each scenario).

5.7 The second concern is that the IRP Proposal proceeds under the assumption that the replacement generation Assets are not to be subject to the IRP process.[10] By effectively treating replacement generation as outside of the IRP process, the extent to which the policy objectives of the Government and the Authority, as well as the extent to which the replacement generation facilitates the least-cost provision of electricity, is not considered. By taking the replacement generation as an *input* rather than an *output* of the IRP process, it

[6] Leidos (2018), '2018 Integrated Resource Plan Proposal', p. ES-1.
[7] Leidos (2018), '2018 Integrated Resource Plan Proposal', p. 1–13.
[8] International Energy Agency (2014), 'The Power of Transformation: Wind, Sun and the Economics of Flexible Power Systems', Paris, p. 67. See also International Atomic Energy Agency, (1984). 'Expansion Planning for Electrical Generating Systems – A guidebook', Vienna, section 6.6.
[9] Leidos (2018), '2018 Integrated Resource Plan Proposal', p. 1–12.
[10] Leidos (2018), '2018 Integrated Resource Plan Proposal'. p. 1–8.

is not possible to observe the cost-efficiency of the replacement generation relative to the other options for new generation capacity that are available.

5.8 The third concern is that the qualitative assessment used in the IRP Proposal is inherently subject to judgement. The qualitative assessment assigns a score to different resource options against five qualitative criteria (i.e. supply quality, environmental sustainability, security and cost resilience, logistics, economic development). The scores assigned to each resource option are inherently subjective judgments and so remain open to debate. For example, the economic development criteria is focused on job creation in Bermuda. Under this criterion, a higher score would be assigned to a more expensive technology, as it is likely to generate more employment. We consider that inclusion of the qualitative factors, such as the economic development, distorts the results of the IRP Proposal.

5.9 The qualitative analysis is combined with the quantitative analysis in order to select the best option from the four feasible planning scenarios. These four feasible planning scenarios are as follows.

- **Scenario 1**. A reference scenario that reflects expansion with the continued use of fuel oil as the primary fuel.
- **Scenario 2**. A revised version of Scenario 1 with the addition of (i) cost-effective utility-scale renewables, (ii) EE, and (iii) EVs.
- **Scenario 3**. A full conversion of the NPS engines that are planned for installation in 2020, as well as other existing assets where suitable, to natural gas operation as soon as natural gas can be made available, and future expansion with (i) all thermal resources operating on natural gas, (ii) cost-effective utility-scale renewables, (iii) EE, and (iv) EVs.
- **Scenario 4**. Future expansion with thermal resources operating on liquefied petroleum gas, beginning when the next installation of thermal resources is required, and conversion of suitable existing thermal resources to operate on liquefied petroleum gas plus (i) cost-effective utility-scale renewables, (ii) EE, and (iii) EVs.

5.10 The importance of the qualitative analysis is magnified by the little dispersion in the results of the quantitative analysis. In particular, the IRP Proposal concludes that the conversion to natural gas (Scenario 3) is the preferred

option for Bermuda's energy system. However, had only the quantitative analysis been considered, then the continued use of fuel oil (Scenario 2) would have been the preferred option. This narrow range may suggest that the highest ranked scenario is not significantly better than the lowest ranked scenario. This is expected to be a significant consideration for the decision of whether to invest in a liquefied natural gas ('LNG') terminal in Bermuda.

5.11 Notwithstanding these concerns, on balance Oxera considers that the IRP Proposal could be accepted for public consultation. We recommend that the Authority undertakes further detailed analysis of the IRP Proposal in order to determine whether the proposal represents the least-cost capacity expansion plan for the electricity market of Bermuda.