Oakley Greenwood

Oakley Greenwood Pty Ltd
2/20 Baynes Street
Margate Beach QLD 4019
PO Box 125
Margate Beach QLD 4019
**Phone** +617 3283 3249
**Fax** +617 3112 5068

www.oakleygreenwood.com.au

June 2018

Mr R Korte, Executive Manager Asset Management

ElectraNet
East Terrace
Adelaide
South Australia 5000

Dear Rainer

## Re: RIT-T Market Modelling, high level review

This letter responds to your request for comment on the adequacy of the framework for economic modelling of the NEM power system as part of the preparation of a Regulated Investment Test for Transmission (RIT-T) for the South Australian Energy Transformation (SAET).

## Introduction & background

In any commentary on modelling it is important to consider both the context and reason for undertaking the modelling. In the case of a RIT-T, the primary purpose of modelling is to inform an economic cost-benefit analysis designed to identify the preferable option to meet an identified need for investment as required under the National Electricity Rules (NER) for all regulated transmission investments. A preferable option for transmission investment is one that can meet a reliability requirement at least cost or, as is the case for the SAET project, the option that delivers the highest net market benefit. In a RIT-T, market benefit is the reduction in overall cost to meet customer demand resulting from a network investment, for example when expenditure on additional network allows an even greater saving in the cost of building and operating generation across the NEM as a whole.

This letter provides comment only on the market modelling for the base case (counterfactual) of no investment. Where the formal need is to obtain market benefits, a counterfactual comparing investment outcomes to outcomes with no investment is needed. This is different to other situations where a RIT-T compares alternative ways of meeting reliability requirements and some form of investment is essential in all cases (as the no investment case would contravene reliability standards).

This letter does not address the description of need for investment or the selection or analysis of options which may be considered to meet the need which will be required for ElectraNet to identify a preferred option before making an investment.

Before making comment on the construction of the base case we note that while price is clearly of interest, it is not a direct consideration in the assessment of the preferable option within a RIT-T. The aim of a RIT-T is to find the most efficient investment for the NEM as a whole. Also a preferable option may increase transmission costs (and therefore charges to customers) but decrease generation capital and fuel costs which should lead to a reduction in energy price. The requirement for a focus on costs in the first instance is clear in the provisions of the AER's Regulatory Test for Transmission (June 2010). By contrast, price may be a factor where the analysis includes assessment of the impact of changes in customer demand in response to price and/or changes in investment as a result of competition benefits.

The focus on costs means that market modelling for a RIT-T is generally undertaken on a cost basis rather than the far more complex analysis required to assess NEM market prices which involves consideration of price-based bidding activity. Cost-based modelling is sometimes described as being undertaken using short run marginal cost (SRMC) bidding.

The key inputs to any economic modelling of the electricity sector are;

- Demand;
- Supply, from incumbent and future generation of different technologies and costs;
- Storage (as it can switch between demand and supply) using incumbent and future options and technologies;
- Network configuration; and
- Operational reserves and constraints.

Key analytical considerations in modelling include the way the model determines additions and subtractions of each of key inputs (for example what are the criteria by which new generation plant is added to or existing generation exits the mix).

The following sections review the source of each of the inputs and the analytical approach. We have undertaken our review based on ElectraNet's Market Modelling Report and have not analysed the most recent model runs.

Our broad conclusion is that the work as presented in the Market Modelling Report is fit for purpose. The reasons for this assessment are discussed in the following sections.

## Network representation

It is useful to explain and review the representation of the network used by ElectraNet as the first item as this affects other components of the analysis. ElectraNet notes that it has assessed entry and exit of generation and storage within a long term (LT) module that uses a single representative regional node representation of the networks in each region of the NEM. ElectraNet has then assessed dispatch of the generation fleet established in the LT module using a detailed representation of each major transmission line in a short term (ST) module for all regions of the NEM except for Tasmania. In Tasmania a single regional node has been retained as a means of reducing model complexity on the assumption hydro generation will dominate Tasmanian operation and not be affected by the SAET.

A less complex load block representation in the LT module has been used to reduce the complexity of the computation needed to assess entry and exit over the full modelling horizon. A more detailed representation is practicable and is used for the ST module where entry and exit has already been decided. This is a reasonable approach providing risks associated with different representations are considered – for example different representation in LT and ST modules creates a risk that generation investment might be based on an assumption that network limits will constrain output or that inter-regional flows are different in the LT and ST.

However, a more detailed representation is needed in order to assess the need for complementary or supporting network investments, for example due to additional export or import that need to be transported to or from a boundary. In this regard we note that (see section 6.2) limits for flow between NSW and Victoria are different in the ST and LT modules which we understand is to reflect the effect of intra-regional constraints that can only be represented in the detailed ST module. ElectraNet also notes that it has addressed the risk of misalignment between LT and ST generally by revisiting the constraints in the LT based on initial results of the ST dispatch.

It is not practicable for us to review the detailed analysis and formation of constraints. However, the use of different constraints is consistent with consideration of the risk of inadvertent different treatment and also with the fact that ElectraNet is responsible for advising AEMO of network constraints and is therefore the authorative source of limits and formulation of constraints. Further we note that as a RIT-T is concerned with differences between the base case and options, approximations will be common to both base and option cases, thereby diminishing any residual inaccuracy. We also note that the detailed network representation is based on physical impedances and therefore is valid for assessment of network losses and does not fall into the trap of assessing total losses on the basis of the marginal loss factors used to determine market prices.

In short, the approach is reasonable in the circumstances for assessment of entry and exit and also facilitates assessment of the detailed network requirements that are ElectraNet's responsibility.

## Demand

Supply must match prevailing demand in an electricity network and the forecast level of demand is therefore a critical input to assessments of future supply. Recent developments such as for 'behind the meter' control of batteries and the effect of rooftop PV are now material considerations that mean demand is now, in part, a variable. These behind-the-meter facilities can be explicitly accounted for in a model, or their affect taken into account to modify the effective ('in front of the meter') demand of consumers. The latter is the usual choice as it is this demand that must be supplied by retailers and therefore purchased from the wholesale market. Considerable care is therefore needed to avoid double counting or not including the effect of, for example, controllable batteries located behind the meter which can switch from taking load to generating but because they are behind the meter are effectively negative demand.

ElectraNet has based its analysis on forecasts published by AEMO with a number of amendments and more detailed treatment. As noted, the SRMC based RIT-T modelling does not forecast price and therefore cannot model price responsiveness. As a result, ElectraNet has used typical profiles of consumption and supply for batteries and an assumption about the number that will be responsive to price and that will cycle on a standard daily basis. In common with a number of approximations in modelling this is a reasonable approach and can only be tested by undertaking price-based modelling. We note the profiles have been taken from AEMO's forecasts and the total amount of storage has been developed within the ElectraNet analysis.

ElectraNet has also separately assessed demand to related to generator auxiliaries, transmission losses, demand-side activity, storage and small-scale distributed resources. It has done this by subtracting AEMO's generic allowances for each of these factors from AEMO's total forecast and calculating replacement values from its own analysis. This means the values for each are specific to the analysis for the SAET and sets up a framework to independently assess each for the options when it comes time to assess them.

On balance the treatment of demand is a reasonable balance between detail and practicality in particular as the RIT-T is assessing differences in costs to meet demand.

## Supply side

Entry, exit and dispatch of generation receives much of the attention in modelling and is critical as changes in capital and operating costs of generation are a significant source of any resulting market benefits. Market models match the forecast demand by adding (entry) and subtracting (exit) generation capacity, demand-side and storage and dispatching them to meet the demand and maintain reserves.

In an SRMC bidding model the criteria for entry are to:

- Ensure sufficient capacity to meet a capacity reserve margin;
- Accommodate any plants that are under construction or have been committed to be built;
- Satisfy policy constraints imposed such as for renewable or low emissions generation; and
- Provide the lowest aggregate combination of capital and operating cost over the modelling horizon.

The criteria for exit include:

- Accommodation of announced retirements;
- Assumptions regarding age-related, but not yet announced, retirements; and
- Low utilisation that is judged by modellers to imply particular plant would be uneconomic such as when significant new entry of plant that has lower operating cost occurs and 'squeezes' the dispatch of an incumbent. Note, this an approximation of how a price-based model would assess the revenue likely to be received from the market based on market price. ElectraNet notes that Loy Yang A is the only power station that has been retired in the (base case) model on the basis of low capacity factor and that is not until 2038 in the high emission scenario. Note, when a new interconnection is added, benefits may be realised because of increased opportunity for dispatch of low cost generation in place of dispatch of existing plant(s) which may also be pushed to uneconomic levels of utilisation and withdrawn.

The LT model used to determine new entry uses a standard industry approach of representing the capital cost as the amortised capital cost of each facility over its financial life. The exception is storage where, as ElectraNet notes, the model set up incorporates the full capital cost incurred in the year of investment.

The evolving National Energy Guarantee (NEG) is the most prominent current policy constraint affecting the NEM as a whole and this is included along with the national Large Scale Renewable Energy Target and the Queensland and Victorian Renewable Energy Targets. ElectraNet notes that the SRMC-based modelling builds sufficient capacity to meet the NEM Reliability Standard and therefore meets the reliability limb of the NEG with no further action. The emission limb is incorporated in constraints that can affect entry and the modelling report describes the emission limits used. ElectraNet also notes that retirement of coal-fired plant means that in a number of cases the emission targets are met with no further action.

Optimisation modelling of the nature employed in the LT model automatically considers the need for firming capacity for intermittent technologies, which has also been topical. However, the LT model used for the SAET analysis is based on average demands and average performance of intermittent sources. As a result it is possible that even more capacity could be required in order to meet the Reliability Standard once the variability of intermittent plant is fully considered. While this is an approximation, it is a similar approximation to the approach that will be taken in assessing options and is more likely to undervalue new or strengthened interconnections.

The approach used by ElectraNet to consider costs is consistent with well-established practice and published emission targets.

## Storage

The amount of small-scale storage in individual customer premises and larger grid-scale facilities are both growing strongly. ElectraNet's modelling accommodates small-scale storage as part of the forecast of demand. This approach is both pragmatic and reasonable as, in practice, the incentives for investment by individual customers are heavily influenced by the retail tariff and consumer preferences which can be decoupled from system conditions and costs that are the basis for investment in other technologies considered by the LT representation. Grid-scale storage is incorporated alongside generation capacity as an option for investment to be selected in the LT module.

ElectraNet notes that it has limited entry of standalone PV after it reaches specific levels in different parts of the network. After that point PV can only be installed in conjunction with storage. The specified amounts are related to regional demand and reflect the technical operating problems experienced when output of PV drives 'in front of the meter' demand to very low levels. Simple physical limits of this nature have been applied in the past and may be again but alternatively new, and as yet undeveloped, charging mechanisms may also emerge. However, for the purposes of a RIT-T, which as discussed is concerned with the difference between the base case (being reviewed here) and alternative options that provide market benefits, the simple approach is reasonable.

While the arrangement proposed by ElectraNet is reasonable in principle, there is a risk that bespoke approximations can have unintended and unexpected effects. The choice of trigger for requiring storage to be associated with new PV may affect the timing of entry of different technologies and as the costs of emerging technologies is changing (i.e., falling) the choice could impact technology selection at some point. For example, a trigger condition that results in the limitation applying at a later time could mean a technology such as solar thermal which also potentially brings substantial inertia is commercially viable in place of solar PV with battery support (even if credited with some inertia capability). Again, as this situation should impact both the base case and options its impact will be less material than a standalone forecast but is illustrative of the nature of the effect model input settings can have and why considerable care is needed to test for unexpected outcomes.

ElectraNet notes it has adopted concepts also used by AEMO in respect of dispatch of storage in the ST model. Specifically, it has divided the total installed level of storage between controlled (within the optimisation process) and uncontrolled with operation to a time-based profile. As storage is a rapidly advancing technology some form of approximation of the type adopted by ElectraNet is appropriate.

Storage (and intermittent) technologies present particular difficulty for load block approaches to modelling as employed in the LT as time sequential considerations can only be incorporated in the analysis with considerable pre-analysis and in a fixed format.

This is a reasonable approach for the purposes of a RIT-T.

However, there is a risk that the assumptions made in the LT module that impact investment decisions may not reflect the way the technology is ultimately dispatched in the ST module. This is an unavoidable risk with the separation of LT and ST as used in ElectraNet's (and many others') analysis. As noted earlier the validity of the assumption can be checked by taking the ST results and reworking the inputs for the LT module, which ElectraNet notes it has done.

## Costs

Within the supply and demand balance in modelling that uses SRMC-based costs and where investment choices are made to satisfy a reserve margin (rather than commercial profitability), the relativity of costs of different technologies is more important to the outcomes than the absolute value of the costs. This is because it is the relativity that determines which technologies are built. However, when the modelling is part of a RIT-T analysis, reductions in supply-side costs due to new network investment are compared with the cost of the new network. ElectraNet has relied on the costs published or supplied by AEMO in most cases where it has used information from recent investigations (for example, for grid scale storage). We have not reviewed the costs from AEMO or those developed by ElectraNet. However, we are aware that AEMO has undertaken extensive research and consultations to determine these costs.

## Operating constraints

Technical operating constraints are particularly significant to the operation of the South Australian power system and affect both investment and dispatch. TNSPs are the primary source of advice to AEMO about the limits on the operation of their systems. ElectraNet has incorporated a series of constraints it has developed in a document entitled Technical Assumptions (May 2018 update) where it notes key types of constraints are:

- System strength;
- RoCoF (rate of Change of Frequency); and
- Transient stability.

We are not in a position to review the technical content of the constraints beyond noting it is entirely plausible for limits of this nature to exist and hence the need for constraints of this nature.

## Summary

This document has presented a high-level review of ElectraNet's approach to modelling of a base case for use in a RIT-T to assess the SAET. The review has described the key features and considerations of the modelling required for a RIT-T and identified a number of the risks that have been addressed and approximations that have been adopted.

On balance we consider the approach, as described in the report entitled Market Modelling Report, SA Energy Transformation RIT-T is fit for purpose.

Regards

G.H. Thorpe
**Executive Director**