EASTERN METROPOLITAN MELBOURNE REACTIVE SUPPORT - PROJECT SPECIFICATION CONSULTATION REPORT

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Executive Summary

AEMO's 2011 Victorian Annual Planning Report (VAPR) and 2010 National Transmission Network Development Plan (NTNDP) identified the need for additional reactive support in the Cranbourne or Rowville area by summer 2014-15. This additional support is required to ensure that stable voltage control is maintained following unplanned network outages.

Following on from the VAPR studies, AEMO has decided to undertake a Regulatory Investment Test for Transmission (RIT-T) which will assess the technical and economic viability of increasing reactive support in Eastern Metropolitan Melbourne.

The RIT-T is an economic cost-benefit test used to assess and rank different electricity transmission investment options that address an identified need to invest. Its purpose is to identify the investment option that maximises the present value of net economic benefit to all those who produce, consume and transport electricity in the market.

This Project Specification Consultation Report (PSCR) is the first stage of the RIT-T process and shows:

- How demand growth in Eastern Metropolitan Melbourne will require involuntary load reduction to maintain voltage stability.
- The network options that AEMO currently consider may address the identified need, including two of the following – one prior to summer 2014-15 and the second prior to summer 2015-16:
  - A 200 MVAr 220 kV capacitor bank at Cranbourne.
  - Three 50 MVAr 66 kV capacitor banks at Cranbourne .
  - A fourth 200 MVAr 220 kV capacitor bank at Rowville.
  - A 200 MVAr 500 kV capacitor bank at either Cranbourne or Rowville.
- The technical characteristics and performance requirements that a non-network option would need to deliver in order to address the forecast voltage stability issue.
- Discusses specific categories of market benefit and their applicability to this RIT-T.

The second stage of the RIT-T process, full option analysis and publication of the Project Assessment Draft Report (PADR), is expected to be published by the end of May 2012.

AEMO welcomes written submissions concerning this PSCR, particularly in relation to the credible options presented and issues addressed in this report.

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1 Introduction

This Project Specification Consultation Report (PSCR) has been prepared by the Australian Energy Market Operator (AEMO) in accordance with the requirements of clause 5.6.6 of the National Electricity Rules (NER) and in AEMO's capacity as the Transmission Network Service Provider responsible for planning and directing augmentations to the Declared Shared Network (DSN) in Victoria.

In line with these requirements, this PSCR:

- Describes the identified need that AEMO is seeking to address, and the assumptions used in identifying that need.
- Sets out the technical characteristics that a non-network option would need to deliver in order to address that identified need.
- Describes the credible options that AEMO currently consider may address the identified need.
- Discusses specific categories of market benefit which, in the case of this specific RIT-T assessment, are unlikely to be material.

1.1 Submissions

AEMO invites written submissions on this Project Specification Consultation Report from registered participants and interested parties. Submissions are sought particularly in relation to the credible options presented and issues addressed in this report.

Submissions are due 17 February 2012.

Submissions should be emailed to Planning@aemo.com.au. Submissions will be published on AEMO's website. If you do not want your submission to be publicly available, please clearly state this in writing when lodging your submission.

The second stage of the RIT-T process, full option analysis and publication of the Project Assessment Draft Report (PADR), is expected to be published by the end of May 2012.

Further details in relation to this project can be obtained from:

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2 Identified Need

2.1 Background

In the 2010 and 2011 Victorian Annual Planning Reports (VAPR) and the 2010 National Transmission Network Development Plan (NTNDP), AEMO identified an emerging need for additional reactive support in the vicinity of the Rowville and Cranbourne terminal stations to ensure that stable voltage control is maintained following the most severe credible contingency event. [1,2]

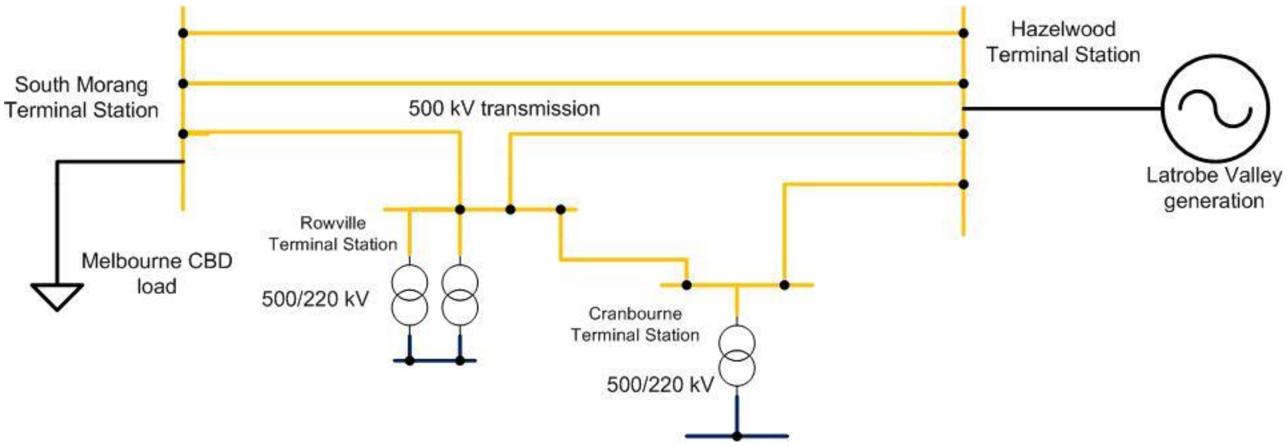
The Cranbourne and Rowville terminal stations are located 40 and 28 km south-east of Melbourne respectively. The terminal stations are connected by a 115 km and 136 km 500 kV transmission line respectively to the major source of Victorian power generation in the Latrobe Valley to the east. A 21 km 500 kV line also connects the two terminal stations with each other.

Three 200 MVAr capacitor banks and two static var compensators (SVC) are currently in service and connected to the 220 kV buses at the Rowville Terminal Station. There are no customers directly connected to the Rowville Terminal Station; however, there are large loads connected via 220 kV transmission lines to nearby terminal stations at East Rowville, Heatherton, Malvern, Richmond, Ringwood and Springvale.

There are neither capacitor banks nor dynamic reactive compensation (e.g. SVCs) currently installed at the Cranbourne Terminal Station at any voltage level. However, there is directly connected customer load connected at 66 kV via three 220/66 kV transformers at the Cranbourne Terminal Station and loads connected via 220 kV transmission lines to East Rowville, Tyabb and Western Port.

A simplified system diagram of the 500 kV network supplying Melbourne is provided in Figure 1.

Figure 1 – Simplified system diagram of 500 kV network supplying Melbourne



2.2 Description of the identified need

Demand is forecast to increase steadily in south-east Melbourne, and in particular around the Cranbourne and Rowville area. Additional reactive power support is required to support this demand, which must be located close to the load growth centres.

[1] AEMO. “2011 Victorian Annual Planning Report”. Available http://www.aemo.com.au/planning/VAPR2011/vapr.html. Accessed November 2011.

[2] AEMO. “2010 National Transmission Network Development Plan”. Available http://www.aemo.com.au/planning/ntndp.html. Accessed November 2011.

Without the proposed additional reactive support, an unplanned outage of the Hazelwood-Cranbourne 500 kV line during peak demand periods, or other severe contingencies, could cause voltages around Cranbourne to drop uncontrollably, leading to voltage collapse and, ultimately, network instability.

In order to ensure system security and avoid voltage collapse, load will need to be shed in preparation for an unplanned outage of the most severe credible contingency event, a trip of the Hazelwood–Cranbourne 500 kV line, at peak demand times from summer 2014-15.

Table 1 shows that sufficient reactive margin exists for the Hazelwood–Cranbourne contingency event at the measured locations until 2013-14 with all existing and committed generators in service. Insufficient reactive margin is expected at Cranbourne and Rowville from 2014-15.

Table 1 – Reactive margins (MVAr) for 2013-14, 2014-15 and 2015-16

Terminal Station Bus Voltage (kV)	Target Reactive Margin[3] (MVAr)	Forecast Year		
		2013-14	2014-15	2015-16
CBTS 220 kV	96	210	46	-185
ROTS 220 kV	104	228	58	-198

2.2.1 Market benefits

The purpose of the RIT-T is to identify the credible option that maximises the present value of net benefit to all those that produce, consume and transport electricity in the market.[4]

To measure the increase in net market benefit, AEMO will analyse the classes of market benefit required for consideration under the RIT-T, as set out in subparagraph 5 of the RIT-T.[5]

AEMO considers that the classes of market benefit that are most likely to change as a result of providing the additional reactive support in the Cranbourne–Rowville area are:

- **Changes in involuntary load shedding**

  Additional reactive support will reduce the quantity and duration of involuntary load shedding required to maintain voltage stability.

- **Changes in costs for parties, other than the TNSP, due to differences in the timing of new plant, capital and operating and maintenance costs**

  Adding new capacitor banks at Cranbourne 66 kV is expected to defer the augmentation of a fourth 220/66 kV transformer, also required at Cranbourne, and the planned Nar Nar Goon Terminal Station.[6]

- **Changes in voluntary load shedding**

  A demand-side reduction non-network option may lead to an increase in the amount of voluntary load curtailment (and a decrease in involuntary load shedding).

[3] Target Reactive Margin is 1% of maximum fault level as per NER S5.1.8. Fault levels as per 2011 VAPR for summer 2014/15.

[4] NER clause 5.6.5B (b)

[5] NER 5.6.5B(c)(4); and AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 5, page 4.

[6] United Energy Distribution, the Australian Energy Market Operator and SPI Electricity. "Joint Request For Information Notice − Cranbourne Supply Area". Available http://www.aemo.com.au/consultations/0179-0195.html. Accessed November 2011.

- **Changes in fuel consumption arising through different patterns of generation dispatch**

  Newport Power Station may need to be constrained to generate for security purposes. Additional reactive support will reduce the need to dispatch Newport Power Station and hence allow lower cost generation to be dispatched.

- **Changes in network losses**

  Additional reactive support would reduce the reactive losses by providing the support locally, and would reduce the active power losses by raising the system voltage. Similarly, a non-network option such as new local generation would provide new supply in close proximity to the bulk demand area, could also be expected to reduce network losses.

It is expected that the market benefits arising from changes in dispatch costs and changes in network losses will be significantly less than market benefits arising from reductions in involuntary load shedding.

The market benefits that are not material to this RIT-T assessment are discussed in section 4.

AEMO considers that this project may be provided as a contestable service.

2.2.2 Assumptions made in relation to the identified need

The following key assumptions drive the market benefits expected from relieving the reactive deficiency in the Cranbourne–Rowville vicinity:

- Characteristics of the load profile.
- Forecast demand growth.
- Generation re-dispatch costs.
- Generator unit outage rates.
- Supply development scenarios.

Characteristics of the load profile

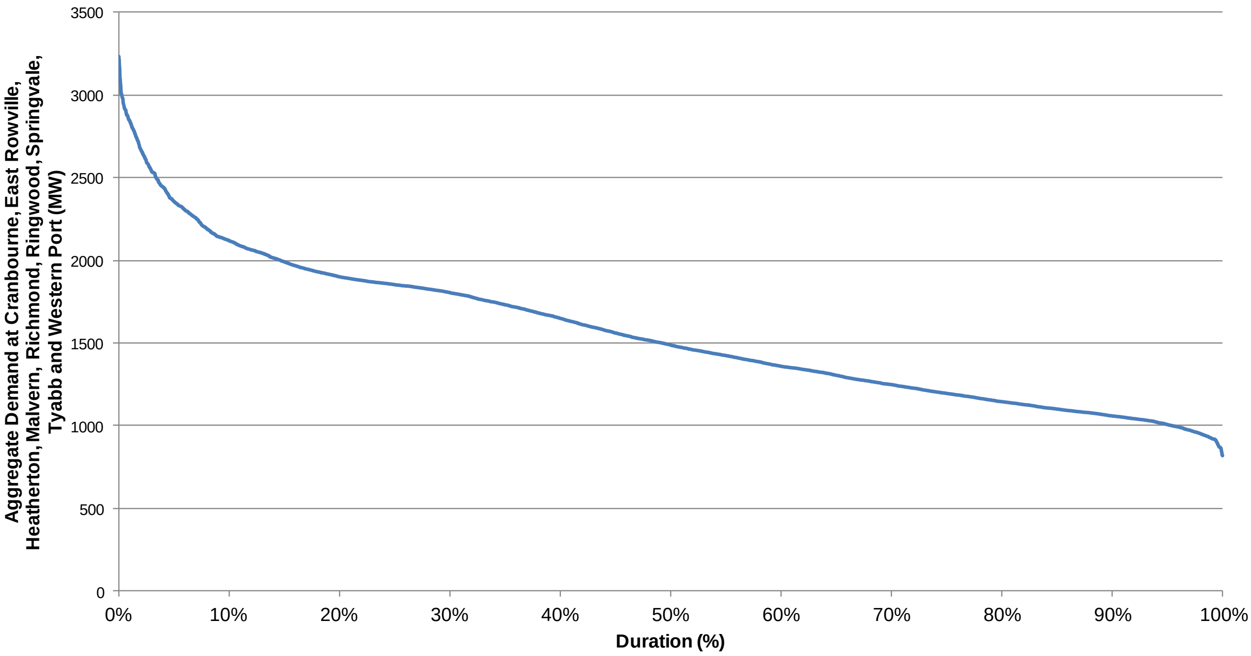
The Eastern Metropolitan Melbourne area predominantly supplies residential loads, along with the BlueScope steel works facility at Western Port. The annual peak demand for the Eastern Metropolitan Melbourne area occurs generally on hot summer afternoons due to increased residential air conditioner load.

Figure 2 shows the load duration curve for the combined loads east of Melbourne for summer 2009-10. [7] The figure shows a sharp peak of short duration, and average to low demand for most of the summer, with the top 30% of the demand lasting less than 10% of the period.

The active and reactive capacity required to meet the peak load in every summer occurs only for a short time. Consequently, involuntary load shedding may be a more economic method of managing that congestion for a reasonable period. However, as the load grows, the duration for which this involuntary load shedding is required also grows.

[7] Cranbourne, East Rowville, Heatherton, Malvern, Richmond, Ringwood, Springvale, Tyabb and Western Port

Figure 2 – Historical load duration curve for summer 2009-10



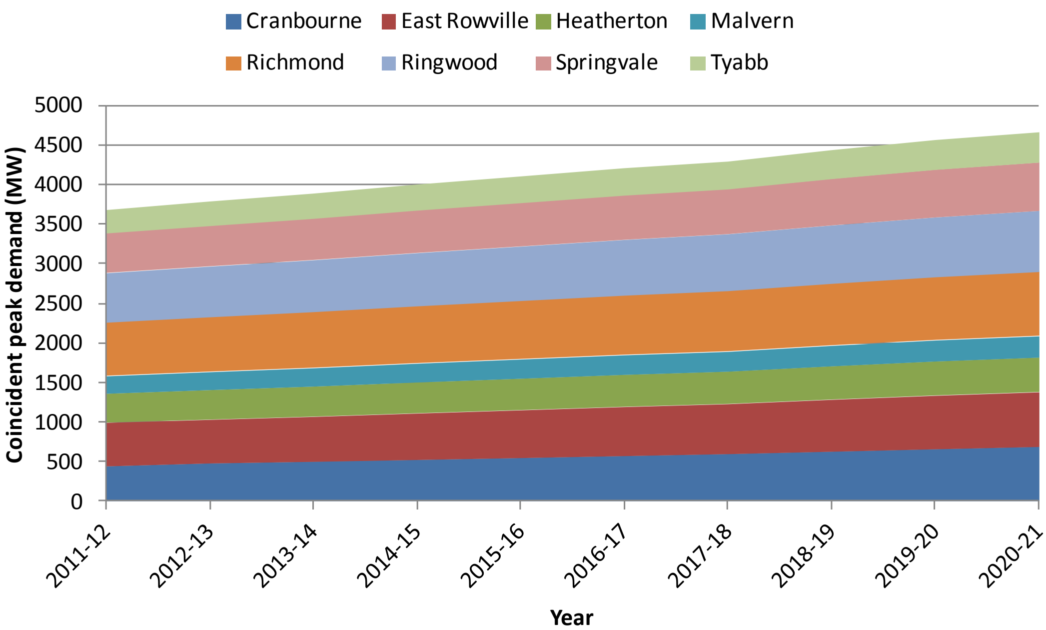
Forecast demand growth

Electricity demand in the Metropolitan Melbourne area is continuing to grow rapidly, particularly due to the increase in housing developments in Melbourne's south-eastern suburbs around Cranbourne.

Figure 3 shows the forecast maximum demand growth for eastern Melbourne loads (Cranbourne, East Rowville, Heatherton, Malvern, Richmond, Ringwood, Springvale, Tyabb and Western Port). The forecasts are based on the medium economic growth scenario and represent the 10% probability of exceedance (POE) demand levels.

Uncertainty in the demand forecasts is accounted for by applying a 10% POE demand forecast and a 50% POE demand forecast and weighting them 30% and 70% respectively to calculate the expected unserved energy shown in Table 2.

Figure 3 – Demand growth for eastern Melbourne loads over summer in the next ten years



Value of customer reliability

The cost of unserved energy is calculated using the value of customer reliability (VCR), which is an estimate of the value electricity consumers place on a reliable electricity supply. This value is equivalent to the cost to consumers of having their electricity supply interrupted for a short time.

The Victorian VCR is currently $57,877 per MWh (in 2011-12 Australian dollars), and has been used by AEMO to calculate the cost of expected unserved energy for this RIT-T.

Generation re-dispatch cost

Re-dispatch of generation is valued using the short run marginal cost (SRMC) of generation, including any price on carbon. The SRMC of generation used in this RIT-T derives from the 2010 NTNDP database.[8]

Generator unit outage rates

The generator unit outage rates used for this RIT-T are assumed to vary based on generator technology, and are derived from the 2010 NTNDP database.

Supply development scenarios

Reactive support requirements in the Cranbourne and Rowville area are primarily dependent on demand growth in the surrounding suburbs. AEMO considers that the number of generation expansion scenarios can therefore be limited without significantly impacting the investment decisions of this RIT-T.

The NTNDP scenario considered most appropriate to assess the Eastern Metropolitan Melbourne voltage stability limitation is the Decentralised World scenario. As detailed in AEMO's 2010 NTNDP, the Decentralised World scenario describes a world where moderate emissions targets are coupled with medium economic and population growth, and all sectors of the Australian economy do well. For the purpose of this RIT-T, the Decentralised World scenario is assessed with two different carbon price trajectories: a low carbon price sensitivity (DW-Low) and a medium carbon price sensitivity (DW-Medium). The low carbon price trajectory is the most similar to the Australian Government's carbon price modelling.[9]

The base scenario, and that considered the most likely to occur, is Decentralised World with a low carbon price (DW-Low). Decentralised World with a medium carbon price (DW-Medium) has been considered as a sensitivity study.

2.2.3 Expected cost of limitation

Table 2 shows the estimated growth of the involuntary load shedding over the next 10 years, which is assumed to be shed in equal proportions from Cranbourne, East Rowville, Heatherton, Malvern, Richmond, Ringwood, Springvale, Tyabb and Western Port. It is possible that differing quantities at different locations, including locations other than those listed, may result in lower quantities of load needing to be shed.

The table shows:

- Load and energy at risk, which is the MW load shedding required to avoid the network limitation, and the resulting unserved energy during contingency events under 10% POE demand conditions.
- Expected unserved energy, which is a portion of the energy at risk after taking into account the probability of the limitation occurring, including the probability of the contingency events occurring and the probability of the demand conditions occurring.
- Limitation cost, which is the cost of the expected unserved energy, obtained by multiplying the expected unserved energy by the VCR.

[8] AEMO. "2010 National Transmission Network Development Plan". Available http://www.aemo.com.au/planning/2010ntndp_cd/home.htm. Accessed November 2011.

[9] Australian Government. "Clean Energy Future". Available http://www.cleanenergyfuture.gov.au. Accessed 27 July 2011.

Table 2 shows a peak in the impact of the voltage stability limitation in 2016-17, with the impact reducing from 2017-18. This is caused by the assumed staged retirement of Latrobe Valley brown coal generation in the supply scenarios modelled. The majority of the new generation modelled in the supply scenarios is assumed to be in the south-west of Victoria, reducing the loading on the 500 kV lines from the Latrobe Valley into Melbourne into Melbourne.

Table 2 – Forecast market impact of voltage stability limitation

Year	Load at risk (MW)	Energy at risk (MWh)	Expected unserved energy (MWh)	Limitation cost ($ million)
2011-12	0	0	0	0
2012-13	0	0	0	0
2013-14	200	1,000	6	0
2014-15	400	7,400	140	8
2015-16	500	17,500	650	38
2016-17	700	45,850	1,165	67
2017-18	600	29,100	945	55
2018-19	500	14,750	785	45
2019-20	500	13,000	770	45
2020-21	500	11,750	750	42

2.3 Required technical characteristics for a non-network option

This section describes the technical characteristics of the identified need that a non-network option would be required to deliver. Table 3 indicates the estimated pre-contingent load reduction, or reactive support required, by location and the number of hours in each year that it would likely be required during summer 10% POE demand and during system normal conditions.[10] Table 2 showed an estimate of the load at risk, or network support required, during single contingency events.

These quantities are required to ensure that the one per cent reactive margin is maintained as required by the National Electricity Rules (NER).

It would also be feasible to combine elements of both load reduction and reactive support, and any proposal would be reviewed on its merits. It is also important to observe that neither the location nor quantity of load or reactive support has been optimised, and that different locations in different quantities may provide lower overall requirements.

The numbers are provided in order to give potential non-network solution providers an indication of the requirements. AEMO will work with non-network solution providers to determine the required quantity of support based on the location of the solution.

Because the network limitation is based on pre-contingent network conditions, a non-network option would be required to operate within the fifteen minute response time required operationally.

[10] System normal is the condition where all transmission network elements are in service.

Table 3 – Estimated load reduction or reactive support required

Year	Load Reduction by Aggregate / Location[11] (MW)	Reactive Support at Cranbourne 220kV (MVAr)	Anticipated Utilisation (hours)
2011-12	0	0	0
2012-13	0	0	0
2013-14	0	0	0
2014-15	100	150	3
2015-16	250	300	7
2016-17	300	400	9
2017-18	300	400	8
2018-19	300	400	8
2019-20	300	400	8
2020-21	300	400	7

[11] Total load reduced at Cranbourne, East Rowville, Heatherton, Malvern, Richmond, Ringwood, Springvale, Tyabb and Western Port

3 Potential credible options to address the identified need

This section summarises the credible network and non-network options of which AEMO is currently aware. None of these credible options are likely to have a material inter-regional impact.

3.1 Description of credible network options

The credible network options all pertain to augmenting the network with additional capacitor banks, as listed below. Any of these could be deferred by utilising network support in the first or subsequent years.

As indicated in Table 3, about 150 MVAr of additional reactive support is forecast to be required to maintain voltage stability in summer 2014-15, and about 300 MVAr is required for summer 2015-16. These quantities equate to at least 3 x 50 MVAr capacitor banks by summer 2014-15 and 1 x 200 MVAr capacitor bank by summer 2015-16; or equivalent.

The estimated construction periods are: October 2012 – October 2014 for the first capacitor bank, and October 2013 – October 2015 for the second. Estimated commissioning dates are October 2014 for the first capacitor bank, and October 2015 for the second.

Option 1 – Installation of a 200 MVAr 220 kV capacitor bank at Cranbourne

The estimated cost of this option is $8.1 million (±30%).

Option 2 – Installation of 3 x 50 MVAr 66 kV capacitor banks each individually switched at Cranbourne

There are expected to be additional benefits for this option. Through joint planning with distribution businesses SPI Electricity Pty Ltd (SPIE) and United Energy Distribution (UED), the installation of the capacitor banks at 66 kV is expected to defer both the proposed fourth 220/66 kV transformer at Cranbourne and the future Nar Nar Goon Terminal Station. The estimated cost of this option is $9.0 million (±30%).

Option 3 – Installation of 3 x 50 MVAr 66 kV capacitor banks, one individually switched and two step-switched at Cranbourne

There are also expected to be additional benefits for this option. Through joint planning with distribution businesses SPIE and UED, the installation of the capacitor banks at 66 kV is expected to defer both the proposed fourth 220/66 kV transformer at Cranbourne and the future Nar Nar Goon Terminal Station. The estimated cost of this option is $9.4 million (±30%).

Option 4 – Installation of a fourth 200 MVAr 220 kV capacitor bank at Rowville

The estimated cost of this option is $8.1 million (±50%).

Option 5 – Installation of a 200 MVAr 500 kV capacitor bank at Cranbourne

The estimated cost of this option is $9.1 million (±50%).

Option 6 – Installation of a 200 MVAr 500 kV capacitor bank at Rowville

The estimated cost of this option is $9.1 million (±50%).

3.2 Non-network options

AEMO has identified two potential non-network options that may create market benefits similar to those of the network options: demand management and network support. These options may present competitive alternatives to the network options. At this stage AEMO has not determined whether these options are commercially and technically feasible at the scale required, or whether they could be available in a similar timeframe to the network options.

Voluntary load reduction and embedded generation can decrease the quantity of involuntary unserved energy that would otherwise be required to maintain network loading within voltage stability limits.

Development of new or expanded transmission-connected generation capacity within the Metropolitan Melbourne area may also reduce the cost and quantity of unserved energy during system normal and outage conditions. Table 3 provides the estimated load reduction or additional reactive support required to defer any network option by at least one year. Similar load curtailment and reactive support would be anticipated for neighbouring 220 kV buses. Slightly lower requirements could be expected at 66 kV locations due to the reduction in losses.

3.2.1 Information to be provided by proponents of a non-network option

Proponents of non-network options are invited to lodge a submission to AEMO, as indicated in section 1.1 of this report, and should include the following details:

- Proponent name and contact details.
- A detailed description of the proposal.
- A nominated site.
- The capacity to be provided.
- A commissioning date with contingency specified.
- Availability and reliability performance benchmarks.
- Proposed contract period.
- Evidence of a planning application having been lodged, where appropriate.

All proposals must satisfy the requirements of any applicable laws and the requirements of any relevant regulatory authority.

Any network reinforcement costs required to accommodate the non-network solution will typically be borne by the proponent(s) of the non-network options. For example, some non-network alternatives such as embedded generation may require fault level mitigation measures and any associated costs would be borne by proponents.

4 Materiality of market benefits for this RIT-T assessment

AEMO notes the NER requirement that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that:

- A specific class (or classes) of market benefit are unlikely to be material in relation to the RIT-T assessment for a specific option.
- The cost of undertaking the analysis to quantify that benefit would likely be disproportionate to the "scale, size and potential benefits of each credible option being considered in the report".[12]

AEMO considers that the following market benefits are not material to the RIT-T assessment for any of the credible options:

- **Changes in ancillary services costs**

  There is no expected change to the costs of Frequency Control Ancillary Services (FCAS), Network Control Ancillary Services (NCAS), and System Restart Ancillary Services (SRAS) as a result of the options being considered. These costs are therefore not material to the outcome of the RIT-T assessment.

- **Option value**

  AEMO notes the AER's view that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered by the TNSP are sufficiently flexible to respond to that change.

  AEMO also notes the AER's view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T.

  For this RIT-T assessment, the estimation of any option value benefit over and above that already captured via the scenario analysis in the RIT-T would require a significant modelling assessment, which would be disproportionate to any additional option value benefit that may be identified for this specific RIT-T assessment. AEMO does not therefore propose to estimate any additional option value market benefit for this RIT-T assessment.

- **Competition benefits**

  Competition benefits are not expected to be material to the outcome of this RIT-T assessment. The reactive support limitation is localised in nature and has a limited impact on spot market outcomes. The estimation of any competition benefit in this RIT-T assessment would require a significant modelling assessment which would be disproportionate to any competition benefits arising from any of the credible options in this RIT-T.

[12] AER. "Regulatory investment test for transmission application guidelines". Final version, June 2010.

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