# REGIONAL VICTORIA REACTIVE SUPPORT - PROJECT SPECIFICATION CONSULTATION REPORT

| | |
|---|---|
| PREPARED BY: | AUSTRALIAN ENERGY MARKET OPERATOR |
| DOCUMENT REF: | RVRS RIT-T PSCR |
| VERSION: | 1.0 |
| DATE: | 30 January 2012 |

## Executive Summary

AEMO's 2011 Victorian Annual Planning Report (VAPR) identified the need for additional reactive support in Regional Victoria. 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) to assess the technical and economic viability of increasing reactive support in Regional Victoria.

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 Regional Victoria will require involuntary load reduction to maintain voltage stability.
- The network options that AEMO currently consider may address the identified need, which consist of various combinations of capacitor banks at Bendigo Terminal Station with an estimated cost of between $5 and $10 million and an estimated service date of 2015–16.
- 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 June 2012.

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

# Contents



# Tables



# Figures

# 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 23 April 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 June 2012.

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

David Green
Senior Engineer
Network Planning
AEMO

Phone: (07) 3347 4546
Email: david.green@aemo.com.au

# 2 Identified Need

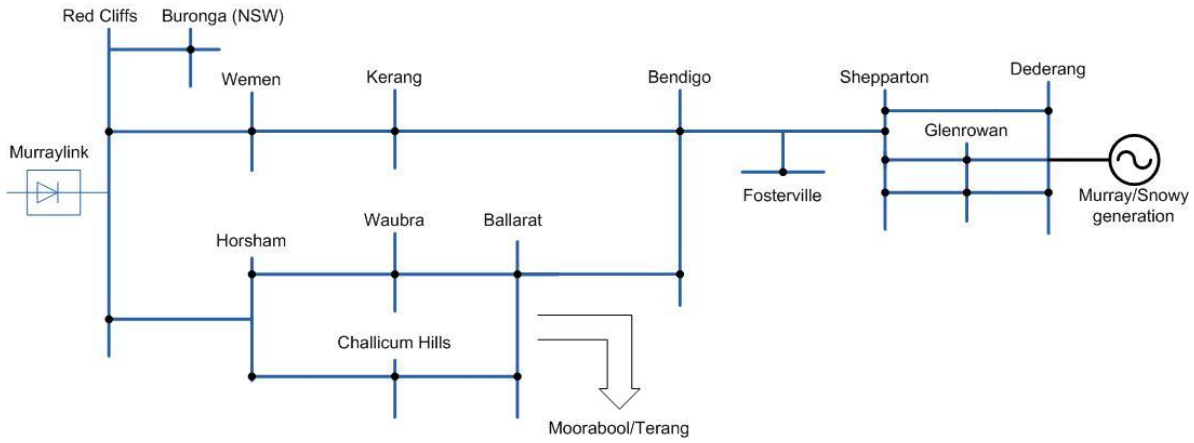
## 2.1 Background

In the 2011 Victorian Annual Planning Report (VAPR), AEMO identified an emerging need for additional reactive support in the vicinity of the Bendigo Terminal Station in Regional Victoria to ensure that stable voltage control is maintained following the most severe credible contingency event.[1]

Bendigo Terminal Station is located 130 km north-west of Melbourne. The terminal station supplies load at 66 kV and 22 kV voltages via two 220/66/22 kV transformers and one 220/66 kV transformer. Two 25 MVAr capacitor banks and two 23 MVAr capacitor banks are currently in service and are connected to the 66 kV buses at Bendigo Terminal Station.

A simplified system diagram of the 220 kV network supplying Bendigo is provided in Figure 1.

*Figure 1 – Simplified system diagram of 220 kV network supplying Bendigo*




## 2.2 Description of the identified need

Demand is forecast to increase steadily in Regional Victoria. Additional reactive power support is required to support this demand, which must be located close to the load growth centres.

Without the proposed additional reactive support, an unplanned outage of a Ballarat-Bendigo 220 kV circuit during peak demand periods, or another severe network contingency, could cause voltages around Bendigo 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 Ballarat–Bendigo 220 kV circuit, at peak demand times from summer 2013–14 under 10% probability of exceedance (POE) demand conditions.

Table 1 shows that insufficient reactive margin is expected at Bendigo from 2013–14 under 10% POE demand conditions and from 2018–19 under 50% POE demand conditions[2].

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

[2] Note that the identified need was not reported in the 2011 National Transmission Network Development Plan as the trigger timing was assessed to be outside the 5-year assessment period used. The earlier trigger time in this RIT=T is due to the use of updated demand forecasts,

*Table 1 – Forecast reactive margins (MVAr) at Bendigo 220 kV bus*

| Forecast Basis | Target Reactive Margin[3] (MVAr) | Forecast Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 |
| 10% POE | 21 | 19 | 13 | 8 | 2 | -5 | -11 | -18 | -26 |
| 50% POE | 21 | 47 | 42 | 37 | 31 | 25 | 19 | 12 | 5 |

### 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 Bendigo area are:

- **Changes in involuntary load shedding**

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

- **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.

AEMO considers that the following two classes of market benefits may be material in the case of non-network options:

- **Changes in voluntary load shedding**

  There is no expected change to involuntary load shedding as a result of the network option being considered as the Bendigo reactive limitation does not impact wholesale market dispatch or electricity spot prices.

  However 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).

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

  There is no expected change to generation dispatch as a result of the network option being considered as the Bendigo reactive limitation does not impact wholesale market dispatch.

  A non-network option, however, would be expected to lead to differences in fuel consumption by displacing scheduled generation at the time of operation. This may lead to an increase or decrease in market benefits depending on the fuel cost of the non-network option.

[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.

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

  A non-network local generator credible option may reduce the requirement for future remote generation. Additionally, an embedded generator may lead to changes in distribution network investment requirements.

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.

### 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 Bendigo vicinity:

- Characteristics of the load profile.
- Forecast demand growth.
- Planned network projects

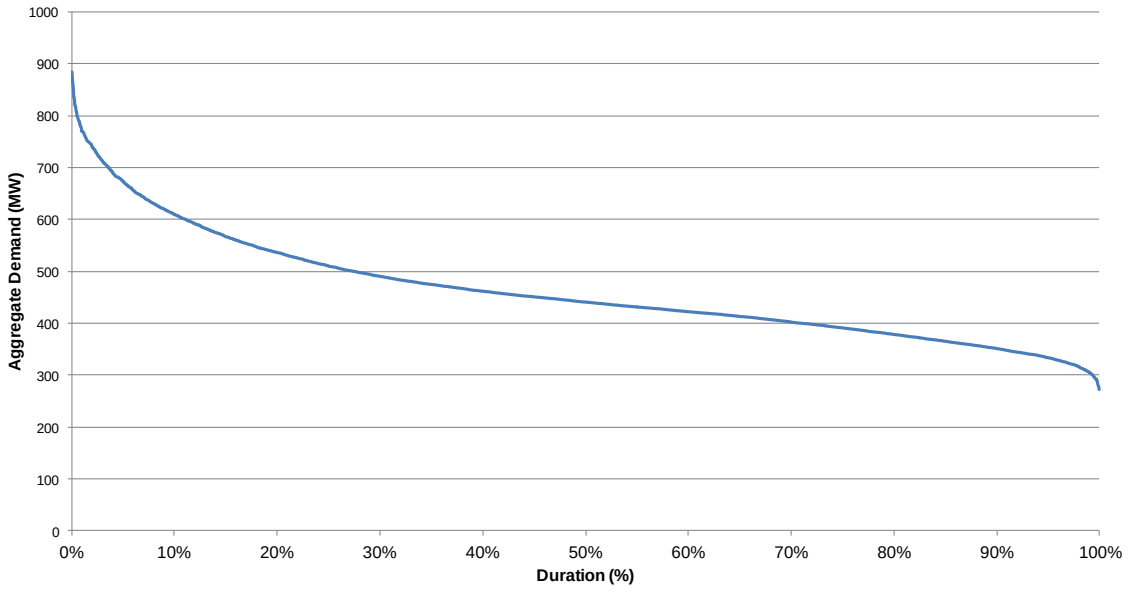
#### Characteristics of the load profile

Regional Victoria predominantly supplies residential loads. The annual peak demand for regional Victoria occurs generally on hot summer afternoons due to increased residential air conditioner load. The loads that impact the reactive margin at Bendigo include those at Bendigo, Fosterville, Glenrowan, Kerang, Red Cliffs, Shepparton and Wemen.

Figure 2 shows the load duration curve for the critical regional Victoria loads for summer 2009-10. 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.

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

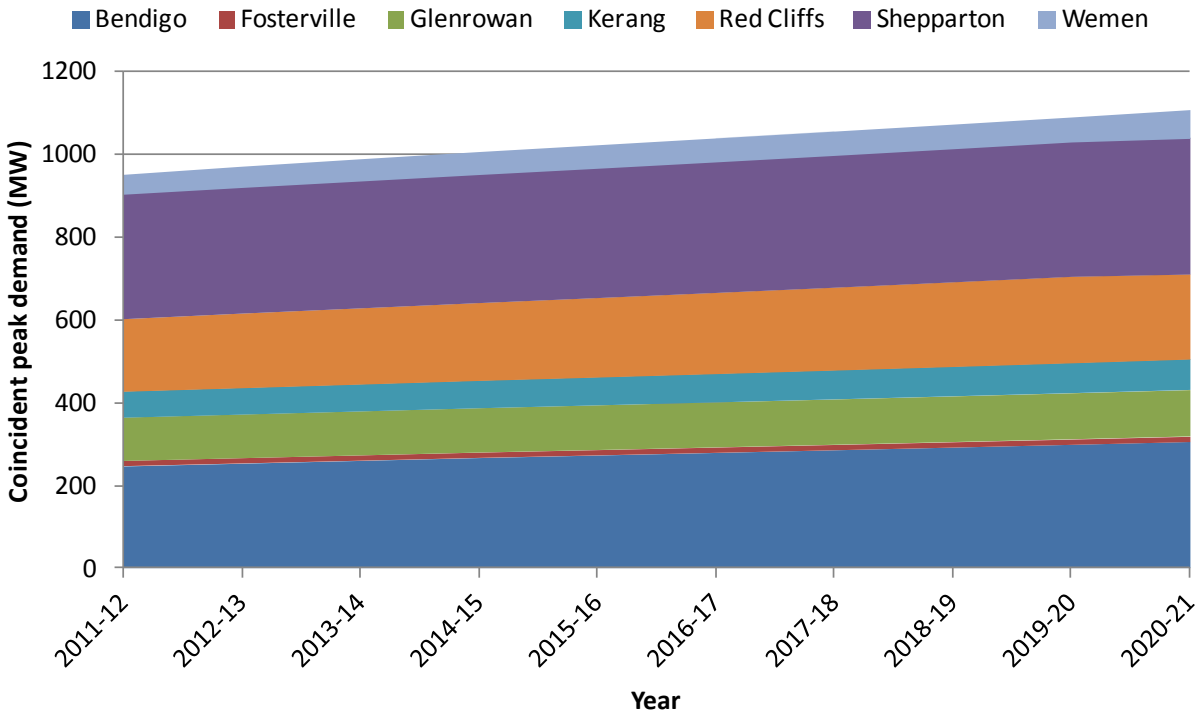


## Forecast demand growth

Figure 3 shows that the forecast maximum demand growth for the critical regional Victoria loads (Bendigo, Fosterville, Glenrowan, Kerang, Red Cliffs, Shepparton and Wemen) is about 2% per year. These forecasts are based on the 2011 Terminal Station Demand Forecasts and represent the 10% probability of exceedance (POE) demand levels.[6]

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 Regional Victorian loads over 10% POE 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.

## Network developments

Powercor Australia published an application notice in June 2009 for two new 230/22 kV transformers to be installed at Bendigo Terminal Station by late 2013.[7]

In identifying the need, AEMO assumed that these two transformers will be installed as scheduled and operational prior to summer 2013–14.

[6] AEMO. "Victorian Terminal Station Demand Forecasts 2011/12-2021/22". Available at http://www.aemo.com.au/planning/transmission.html Viewed 22 November 2011

[7] Joint Victorian Electricity Distribution Businesses, "Transmission Connection Planning Report 2011". Available http://www.powercor.com.au/Electricity_Networks/Powercor_Network/Powercor_-_Network_Planning/. Accessed November 2011.

### 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 entirely at Bendigo.

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 the energy at risk weighted for the 10% POE and 50% POE demand forecasts.
- Limitation cost, which is the cost of the expected unserved energy, obtained by multiplying the expected unserved energy by the VCR.

Table 2 shows the growing impact of the voltage stability limitation from 2013–14.

*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 | 2 | 1 | 0.3 | 0.02 |
| 2014-15 | 9 | 11 | 3 | 0.2 |
| 2015-16 | 15 | 30 | 9 | 0.5 |
| 2016-17 | 22 | 67 | 20 | 1.2 |
| 2017-18 | 30 | 118 | 36 | 2.1 |
| 2018-19 | 38 | 185 | 57 | 3.3 |
| 2019-20 | 46 | 290 | 98 | 5.7 |
| 2020-21 | 55 | 440 | 166 | 9.6 |

Under the RIT-T, the preferred option is the solution and timing which leads to the greatest net present market benefits. The optimal timing for investment occurs when the annual benefits of the solution are greater than the annualised cost of the solution. The following gives an indication of the optimal timing for the options considered in this RIT-T using the limitation cost shown in Table 2[8]:

- For a network option with a capital cost of $5 million and an annualised cost of $0.5 million (assuming a 10% discount rate and a 40 year asset life) the optimal timing for the solution is 2015–16.

[8] Example assumes that the market benefits of the solution arise only from reductions in involuntary load shedding and that each solution removes all involuntary load shedding. Full market benefit assessment will be presented in the PADR.

- For a network option with a capital cost of $10 million and an annualised cost of $1.0 million (assuming a 10% discount rate and a 40 year asset life) the optimal timing for the solution is 2016–17.
- A non-network option will be the most efficient solution if its total annual cost (availability and running cost) is less than the limitation cost shown in Table 2 and less than the annualised cost of the most efficient network option.

## 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 combined pre-contingent 22 kV and 66 kV load reduction, or 220 kV reactive support required, at Bendigo Terminal Station and the number of hours in each year that it would likely be required during summer 10% and 50% POE demands.

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.

*Table 3 – Estimated load reduction or 220 kV reactive support required at Bendigo Terminal Station*

| Year | 10% POE Demand | | | 50% POE Demand | | |
|---|---|---|---|---|---|---|
| | Load Reduction (MW) | Reactive Support (MVAr) | Anticipated Utilisation (hours) | Load Reduction (MW) | Reactive Support (MVAr) | Anticipated Utilisation (hours) |
| 2011-12 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012-13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013-14 | 2 | 2 | 1 | 0 | 0 | 0 |
| 2014-15 | 9 | 8 | 3 | 0 | 0 | 0 |
| 2015-16 | 15 | 13 | 5 | 0 | 0 | 0 |
| 2016-17 | 22 | 19 | 6 | 0 | 0 | 0 |
| 2017-18 | 30 | 26 | 9 | 0 | 0 | 0 |
| 2018-19 | 38 | 32 | 10 | 2 | 2 | 1 |
| 2019-20 | 46 | 39 | 16 | 10 | 9 | 3 |
| 2020-21 | 55 | 47 | 21 | 19 | 16 | 5 |

The required support shown in Table 3 above is an indication of the support required at the optimal location, which is Bendigo. Non-network support could also be supplied at other regional Victorian locations but larger quantities would be required.

Table 4 shows the support required at the other critical regional Victorian locations for each 1 MW or 1 MVA support supplied at Bendigo 220 kV. For example, if non-network support was located at Fosterville, then approximately 1.8 MW of support would be required for each 1 MW required at Bendigo 220 kV.

*Table 4 – Non-network support required relative to 1 MW at combined Bendigo 22/66 kV load*

| Fosterville | Glenrowan | Kerang | Red Cliffs | Shepparton | Wemen |
|---|---|---|---|---|---|
| 1.8 | 4.9 | 1.7 | 5.2 | 3.2 | 3.8 |

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.

# 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 at Bendigo Terminal Station, connected at the 220 kV, 66 kV or 22 kV bus.

As indicated in Table 3, about 20 MVAr of additional reactive support at Bendigo is forecast to be required to maintain voltage stability in summer 2016–17, and about 50 MVAr in summer 2020–21.

This reactive support could be supplied using one of the following:

- One 50 MVAr 220 kV capacitor bank.
- Three 15 MVAr 22 kV capacitor banks.
- Two 25 MVAr 66 kV capacitor banks.

The estimated cost of each of these options is between $5 million and $10 million.

AEMO considers that this project may be provided as a contestable service if combined with the procurement process for other reactive plant.

## 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 option.

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 close to Bendigo 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 at Bendigo Terminal Station. Table 4 shows the estimated relative load curtailment and reactive support required at neighbouring 220 kV buses. Note that this estimated level of support would be required during high demand periods in preparation for an unplanned network outage. This type of pre-contingent support is required to be operational within a fifteen minute response time.

### 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.

### 3.2.2 Options considered but not progressed

The following network options were considered but not included in this RIT-T:

- **Capacitor banks at other Regional Victorian locations.**

  Capacitor banks at other locations, including Fosterville, Glenrowan, Kerang, Red Cliffs, Shepparton and Wemen terminal stations were considered. However these locations are some distance from Bendigo and are less effective at supplying reactive support to Bendigo than Bendigo itself. Hence additional capacity would be required at a greater cost with no additional benefits.

# 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".[9]

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

- **Differences in the timing of transmission investment**

The power factor correction provided by new capacitor banks at Bendigo Terminal Station is insufficient to defer any of the planned transmission circuit upgrades required to address thermal limitations in the region.

- **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.

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

## Disclaimer

(a) Purpose - This Project Specification Consultation Report has been prepared by the Australian Energy Market Operator (AEMO) in accordance with clause 5.6.6 of the National Electricity Rules.

(b) No reliance or warranty - This document contains data provided by third parties and might contain conclusions or forecasts and the like that rely on that data. This data is included “as is” and might not be free from errors or omissions. While AEMO has used due care and skill, it does not warrant or represent that the data, conclusions, forecasts or other information in this document are accurate, reliable, complete or current or that they are suitable for particular purposes.

(c) Limitation of liability - To the extent permitted by law, AEMO and its advisers, consultants and other contributors to this report (or their respective associated companies, businesses, partners, directors, officers or employees) shall not be liable for any errors, omissions, defects or misrepresentations in the information contained in this report, or for any loss or damage suffered by persons who use or rely on such information (including by reason of negligence, negligent misstatement or otherwise). If any law prohibits the exclusion of such liability, AEMO’s liability is limited, at its option, to the re-supply of the information, provided that this limitation is permitted by law and is fair and reasonable.