2011 

National Transmission Network Development Plan

National Transmission Network Development Plan

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Foreword

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Key Findings

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# introduction

## Introduction to the 2011 NTNDP

The 2011 National Transmission Network Development Plan (NTNDP) is the Australian Energy Market Operator’s (AEMO’s) second NTNDP and has been developed to expand on the 2010 NTNDP, addressing stakeholder feedback on the 2010 NTNDP.

The 2011 NTNDP expands on the 2010 NTNDP in three ways:

* Expanding and updating the 2010 NTNDP results. For example in relation to:
  + the augmentation projects identified, including NEMLink (a high capacity backbone)
  + reviews of Regional Annual Planning Reports (APRs), and
  + Network Support and Control ancillary Services (NSCAS).
* Further development of the inputs and approaches used to develop the 2010 NTNDP results to provide new or improved ways for transmission planners and the industry generally to deal with the issues addressed. For example in relation to:
  + how demand projections are developed, in particular how the impacts of electric vehicles and small-scale generation are addressed, and
  + how the impact of the projected increase in wind generation is addressed.
* To develop inputs for the 2012 NTNDP based on reviewing those used for the 2010 NTNDP.

To maximise the value obtained from the modelling and analysis used to develop the 20-year network development plan, AEMO prepares the transmission network review every other year. Consequently, the 2011 NTNDP is to be considered in conjunction with the 2010 NTNDP.

Responses to emerging planning issues are provided in 2011 for:

* effective integration of wind generation in the NEM
* development of transmission planning criteria and approaches
* considering gas and electricity transmission options, and
* forecasting annual and maximum electricity demand.

Further study results are provided in 2011 for:

* NEMLink, and
* NSCAS.

In response to stakeholder feedback, the 2011 NTNDP also provides:

* scenario sensitivity studies on certain 2010 NTNDP results
* marginal loss factor (MLF) outlooks for key connection points for 2010 NTNDP scenario results, and
* a review of transmission network service provider (TNSP) annual planning reports (APRs) for 2011 to ensure continuing alignment between the NTNDP and APRs.

AEMO has also refreshed the NTNDP data set in 2011 and has made this available to stakeholders.

### Background to the NTNDP

*Describe the objectives of the NTNDP and some history of its development. Briefly summarise how the objectives were met by the 2010 NTNDP.*

The 2010 NTNDP includes a comprehensive review of electricity transmission development needs for the next 20 years for a wide range of industry scenarios.

It also includes information relating to generation clusters, Network Support and Control Ancillary Services (NSCAS) and presents AEMO’s NEMLink study, a high-level study of large, inter-regional interconnection projects.

As a 20-year strategic study, the key value the NTNDP provides is in setting out credible views of the transmission network in 20 years time. If these views were developed again in 2011 they would not differ materially from those developed in 2010, as the inputs used to develop them have not changed materially.

NTNDP users who require the 20-year views are advised to obtain the 2010 NTNDP, supplemented by the additional study results provided in the 2011 NTNDP.

### Responses to the 2010 NTNDP

Describe stakeholder response (consultation, forums…) to the 2010 NTNDP

### Changes since 2010

Describe how the content of the 2011 NTNDP is different from the 2010 NTNDP.

Briefly describe those inputs and results from 2010 that are different for 2011 and refer to the detailed review in Chapter 2.

### Looking forward to the 2012 NTNDP

Indicate that the 2012 NTNDP will be a network review like the 2010 NTNDP.

Describe how the 2011 NTNDP and consultation activities will inform the 2012 NTNDP.

Refer to Chapter 12, which contains the consultation material.

## Content and structure of the 2011 NTNDP

*List and describe the chapters, attachments and appendices. Explain graphically.*

*Inform readers of how they can obtain the report and supporting information.*

The 2011 NTNDP chapters are grouped into four parts that reflect the different purposes of the chapters:

* Part 1 provides updated information that represents latest AEMO’s view of transmission network development.
* Part 2 provides additional information about the 2010 outcomes, relating to the impact of wind generation and marginal loss factors.
* Part 3 provides the results of studies that extend the 2010 NTNDP and provide additional information. These include further studies on NEMLink, sensitivity studies on the 2010 NTNDP scenario results, and a gas and electricity case study for the connection of a major generating unit.
* Part 4 provides information about work to improve transmission planning. This includes approaches to better deal with key issues, including development of planning criteria, the demand forecasting methodology, approaches to integrating wind into NEM planning and inputs and methodologies for the 2012 NTNDP.

Main document and attachments

#### Part 1 – Network development plan for 2011:

**Chapter 2, Network development updates for 2011**, provides information about AEMO’s 2011 view of transmission development. It lists the changes since 2010 and explains how the 2010 NTNDP results still represent AEMO’s view of the 20-year outlook for development. It includes a review of projects from regional Annual Planning Reports (APRs).

**Chapter 3, Network Support and Control Ancillary Services**, provides information about National Electricity Market (NEM) requirements for Network Support and Control Ancillary Services (NSCAS).

#### Part 2 – More information about 2010 outcomes:

**Chapter 4, Wind Impact Simulation Results**, provides information about wind simulation studies that examine the impact of wind generation in 2019/20 for there NTNDP scenarios.

**Chapter 5, NTNDP Outlook Marginal Loss Factors**, provides information about how generation connection marginal loss factors change over time as generation and transmission develop under a number of NTNDP scenarios.

#### Part 3 – Further studies extending the 2010 NTNDP and providing additional information:

**Chapter 6, NEMLink: Further Study Results on a High-capacity Backbone**, provides the results of further studies that refine the scope and impact of a NEMlink-style project to further understand the potential costs and benefits of transmission backbone projects.

**Chapter 7, Generation and Interconnector Development Scenario Sensitivity Studies**, provides information about generation and interconnector development for a range of sensitivities to the 2010 NTNDP scenarios.

**Chapter 8, Gas and Electricity Comparative Case Study**, provides information about a comparative case study into connecting a hypothetical 1,000 MW CCGT, using either significant gas or electricity transmission infrastructure.

#### Part 4 – Development of planning approaches for key issues:

**Chapter 9, Transmission Planning Criteria Development**, provides information about AEMO’s Victorian TNSP planning approach, potential development of the planning criteria applied by the approach, and recommendations for improvements to NTNDP modelling.

**Chapter 10, Demand Forecasting Methodology Development**, provides information about a review of the extent and impact of key new technologies, rooftop solar PV or other distributed generation and electric vehicles, on time-of-day demand.

**Chapter 11, Wind Integration Approach Development**, presents information about reviews into how increasing wind generation can be integrated into the NEM.

#### Part 5 – 2012 NTNDP Consultation:

**Chapter 12, 2012 NTNDP Consultation**, provides details of AEMO’s proposed development of the 2012 NTNDP and describes the modelling inputs and other areas where AEMO is seeking stakeholder feedback.

#### Attachments:

**Attachment 1 etc, As required**, As required.

#### Glossary

This provides a glossary of terms and abbreviations used throughout the NTNDP.

The NTNDP is available as a printed report and can be downloaded from AEMO's website.

Appendices

The appendices are available electronically on the AEMO website only.

#### Appendices:

**Appendix A etc, As required**, As required.

# Network development updates for 2011

Summary

|  |
| --- |
| This chapter provides information about AEMO’s 2011 view of transmission development. It lists the changes since 2010 and explains how the 2010 NTNDP results still represent AEMO’s view of the 20-year outlook for development. It includes a review of projects from regional Annual Planning Reports (APRs).  It presents information about the network developments identified in the 2010 NTNDP and how they have been addressed in the 2011 Transmission Network Service Provider (TNSP) Annual Planning Reports (APRs).  A key element of the NTNDP is the linkage between the shorter-term regional plans and the longer-term national picture. The NTNDP exists in a context where it needs to start from the existing system and have regard to upcoming regional developments, but TNSPs must develop their plans taking account of the national strategies outlined in the NTNDP.  The alignment between APRs and the NTNDP is reflected in this chapter by including tables for each NEM region that show the network developments identified in the 2010 NTNDP with the status of each one in the 2011 TNSP APRs, and additional developments identified in the 2011 TNSP APRs.  The chapter then includes comments on how well the APRs are aligned with the NTNDP and examines how changes foreshadowed in TNSP planning publications (APR and any other planning documents) impact on the conclusions of the NTNDP.  These comments are based on discussions with TNSPs, high level analysis of investment drivers and a selected set of network studies to further investigate key issues. (*Note that any studies may be more qualitative than quantitative – this text may need to change*)  *Provide a summary of how well the 2011 TNSP APRs align with the 2010 NTNDP and highlight any key differences.* |

## 2011 plan and changes since 2010

#### 2011 network development plan

As a 20-year strategic study, the key value the NTNDP provides is in setting out credible views of the transmission network in 20 years time. If these views were developed again in 2011 they would not differ materially from those developed in 2010, as the inputs used to develop them have not changed materially.

Therefore the 2010 NTNDP, supplemented by the additional study results provided in the 2011 NTNDP, represents AEMO’s latest view of network development for the next 20 years.

#### Changes from 2010

Set out those inputs and results from 2010 that are different for 2011.

For example:

* Scenarios
  + Drivers largely unchanged
  + Scenarios adjusted to cover carbon / growth matrix
* Demand forecasts
  + Near-term revisions but long-term consistency
* Technology and costs
  + Some changes - Geothermal, CCS

## Review of projects from regional Annual Planning Reports

AEMO comments for each development

The following tables show the transmission network developments identified in the 2010 NTNDP for a 10-year outlook period under at least one scenario. AEMO categorised these developments on the basis of the timeframe over which the triggers were identified, how sensitive the triggers are to future conditions, and the risk and consequence of not doing preparatory work. In categorising the developments, AEMO applied the following guiding criteria:

Table 2‑1 Network development categories

| Category | Trigger timing | Opportunity cost |
| --- | --- | --- |
| Early attention | Development is triggered  in the first five-year period  under most scenarios and in  the second five-year period in  most of the remaining ones | High opportunity cost if not  done (or have limited or  expensive work-arounds) |
| Preparatory work | Development is generally  triggered in the second  five-year period in most  scenarios but maybe later  in others | High opportunity cost if it turns  out that it is needed  and it requires some long  lead-time works (e.g. easement  acquisition) |
| Monitoring | Development is triggered in  the first or second five-year  period in some scenarios | Likely to have work-arounds if  the triggering conditions unfold  (i.e. relatively low opportunity  cost if the development is  delivered late) |

### Queensland

*See Victoria for model.*

### New South Wales

*See Victoria for model.*

### Victoria

*Include introductory text for each region, if necessary providing a brief overview of general differences between the 2010 NTNDP and the APR. For example, where the NTNDP identified quite different potential development paths, and the APR has followed one of these.*

Table 2‑2 Victoria (NTNDP 2010 developments)

| Development No. | Transmission development | Rating | NTNDP 2010 Status | Victorian 2011 APR Status | AEMO Comments |
| --- | --- | --- | --- | --- | --- |
| V1 | A new 500 kV Loy Yang-Hazelwood line | Monitoring | Victorian 2010 APR, Section 9.3.1 |  |  |
| V5 | A new 500/220 kV 1,000 MVA transformer at Ringwood, Rowville, or Cranbourne | Early attention | AEMO is undertaking an assessment of the available network and non-network options as part of the 2011 APR (Victorian 2010 APR, Section 9.3.4) |  |  |
| V6 | An additional 500/220 kV 1,000 MVA transformer at Ringwood, Rowville, or Cranbourne | Preparatory work | AEMO is undertaking an assessment of the available network and non-network options as part of the 2011 APR (Victorian 2010 APR, Section 9.3.4) |  |  |
| V7 | Re-conductor the 220 kV Rowville-Springvale line | Preparatory work | This limitation is observed beyond the first 5-year period. AEMO will monitor the load at the Springvale and/or Heatherton terminal stations and identify available network and non-network options including necessary lead-times (Victorian 2010 APR, Section 9.3.4) |  |  |
| V8 | A new 500 kV Moorabool-Mortlake/Heywood line (third line) | Monitoring | This augmentation is triggered by new generation connections to the 500 kV Moorabool-Mortlake/Heywood line. AEMO will consider its as part of new generation connection enquiries on the line (Victorian 2010 APR, Section 9.3.2) |  |  |
| V9 | A new 330/220 kV 700 MVA transformer at South Morang (third transformer), and a cut-in of the 220 kV Rowville-Thomastown circuit at South Morang to form a third 220 kV South Morang-Thomastown line | Preparatory work | AEMO is undertaking an assessment of the available network and non-network options as part of the 2011 APR (Victorian 2010 APR, Section 9.3.4) |  |  |
| V15 | An additional 500/220 kV 1,000 MVA transformer in the western part of the Greater Melbourne Metropolitan Area | Monitoring | This augmentation is triggered in the first 10 years by the combination of high demand growth and lack of new generation south of Geelong. AEMO will monitor the progress of these factors. |  |  |
| NV2 | A Victoria-New South Wales interconnector upgrade | Preparatory work | AEMO and TransGrid are intending to investigate the benefits of upgrading the Vic-NSW interconnector |  |  |
| V16 | Cut-in on the 220 kV Eildon-Thomastown line at South Morang | Monitoring | This augmentation is triggered in the first 10 years by the combination of high demand growth and increased imports from New South Wales as a result of an interconnector upgrade. AEMO will consider the need for this augmentation as part of investigations into an upgrade of the Victoria-New South Wales capability (Victorian 2010 APR, Sections 9.3.4, Section 9.3.3) |  |  |
| V22 | A new 330/220 kV Dederang transformer (fourth) | Monitoring | This augmentation is triggered in the first 10 years by the combination of high demand growth and increased imports from New South Wales as a result of an interconnector upgrade. AEMO will consider the need for this augmentation as part of investigations into an upgrade of the Victoria-New South Wales capability (Victorian 2010 APR, Sections 9.3.4, Section 9.3.3) |  |  |
| V28 | A new 220 kV Ballarat-Moorabool line (third line) | Early attention | AEMO is undertaking a detailed assessment as part of the 2011 APR of the constraint that triggers this augmentation (Victorian 2010 APR, Section 9.3.5) |  |  |
| NV1 | A new 220 kV, 250 MVA phase angle regulator on the 220 kV Buronga-Red Cliffs interconnection | Early attention | AEMO and ElectraNet are intending to investigate the ongoing requirements for South Australian imports over Murraylink, and options to support load growth in the Riverland and other areas. AEMO and TransGrid are intending to investigate the impacts for the New South Wales system from high Murraylink power transfers at time of peak demand. |  |  |
| V29 | Replace the existing, single circuit 220 kV Ballarat-Bendigo line with a 220 kV double circuit line | Early attention | These limitations are triggered by demand growth in CVIC and high power transfers to South Australia via Murraylink. AEMO is intending to undertake an assessment of these limitations (Victorian 2010 APR, Section 9.3.5) |  |  |
| V31 | Uprate the existing 220 kV Ballarat-Bendigo line | Early attention | These limitations are triggered by demand growth in CVIC and high power transfers to South Australia via Murraylink. AEMO is intending to undertake an assessment of these limitations (Victorian 2010 APR, Section 9.3.5) |  |  |
| V32 | Replace the existing, single circuit 220 kV Bendigo-Kerang line with a new 220 kV double circuit line | Monitoring | These limitations are triggered by demand growth in CVIC and high power transfers to South Australia via Murraylink. AEMO is intending to undertake an assessment of these limitations (Victorian 2010 APR, Section 9.3.5) |  |  |
| V34 | Replace the existing 220 kV Kerang-Wemen-Red Cliffs single circuit line with a new 220 kV double circuit line | Monitoring | These limitations are triggered by demand growth in CVIC and high power transfers to South Australia via Murraylink. AEMO is intending to undertake an assessment of these limitations (Victorian 2010 APR, Section 9.3.5) |  |  |
| V30 | Uprate the existing 220 kV Geelong-Moorabool lines | Early attention | AEMO is currently undertaking a detailed assessment of this limitation and options to address it (Victorian 2010 APR, Section 9.3.5) |  |  |

Table 2‑3 Victoria (APR 2011 developments)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Development No. | Transmission development | Rating | NTNDP 2010 Status | APR 2011 Status Update | AEMO Comments |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

*Table to be restructured as there are no 2010 NTNDP projects matching these*

*Comment on how the APR projects align with the 2010 NTNDP. Discuss any differences.*

*Comments are to be qualitative. If there are mutually exclusive projects identified then comments on each one may need to refer to the other.*

*Comment on the impact of new TNSP proposals for Victoria, and timing variations, and how they might impact the timing or validity of projects identified in the 2010 NTNDP.*

*These comments will be based on discussions with TNSPs, high level analysis of investment drivers and a limited number of studies.*

*Provide similar tables and text for the other regions.*

### South Australia

*See Victoria for model.*

### Tasmania

*See Victoria for model.*

# network support and control ancillary services

Summary

|  |
| --- |
| This chapter provides information about National Electricity Market (NEM) requirements for Network Support and Control Ancillary Services (NSCAS). NSCAS is an ancillary service for controlling active and reactive power flows, which assists with maintaining the power system in a secure operating state, and maintaining (or increasing) power transfer capabilities.  AEMO has looked at potential national and regional NSCAS requirements for the next five years to provide the market with sufficient notice for these requirements to be met through orderly investment. Transmission network service providers (TNSPs) are expected to procure NSCAS, and AEMO only procures NSCAS itself as a last resort to ensure system security.  Regional assessments show that there are no NSCAS requirements for system security other than already proposed by the TNSPs, except in the following areas:  *Bullet point list of requirements*  The regional assessments are intended to indicate the approximate extent, duration, and location of NSCAS requirements, enabling TNSPs and other market participants to make investment proposals or establish operating arrangements to deliver services efficiently, and in a manner consistent with the Regulatory Investment Test for Transmission (RIT T).  In the absence of this investment, AEMO can contract for services if they are available, or constrain power flows to maintain secure power system operations.  *2011 NTNDP will not include market analysis. Instead it will include up to 4 examples of market-based NSCAS.*  *The 2011 NTNDP will assess NSCAS against existing capability and committed projects only. Any gap identified will be related to proposed projects from APRs.* |

## Reporting on future NSCAS requirements

Explain that the 2011 NTNDP reporting does not attempt to meet the new NSCAS rules. 2012 NTNDP NSCAS reporting will meet the new rules.

State that changes were made to the NER in April 2011 (applying from April 2012) that require AEMO to identify NSCAS requirements in the NEM, assess the quantities of NSCAS needed and need dates, assess the benefits of procuring of NSCAS and to publish this information in the NTNDP.

Describe requirement to assess the market benefits of procuring NSCAS for meeting an identified NSCAS need and reporting the benefits in the NTNDP.

State that 2011 NTNDP does not include this information, but future NTNDPs will.

Summarise the procedure for assessing NSCAS market benefits from the NSCAS Quantity Procedure

Provide as a market benefits example, the benefits of the existing NLCAS between NSW and Vic.

Mention NSCAS Description and NSCAS Quantity Procedure and how they are used. State that further details on each provided in Sections 3.2 and 3.3 respectively. Brief mention of consultation on NSCAS Description and NSCAS Quantity Procedure and highlight any key items from the consultation that provide required context for final positions reached.

## Types of Network Support and Control Ancillary Services

Define NSCAS.

Provide an overview of what NSCAS is, what it does and how it is provided and by whom.

Provide details of each type of NSCAS and give examples of each.

Relate to NSCAS Description

## Assessing future NSCAS requirements

*Provide a high-level description of the methodology (approach and models) for assessing future NSCAS requirements.*

*Explain how the 2011 assessments are being carried out. Mention that this differs from the 2012 approach that is being developed with stakeholders during 2011.*

*Relate to NSCAS Quantity Procedure*

NSCAS needs of the NEM for system security will be assessed in detail for 10% POE demand levels and a likely generation development scenario (based on committed and advanced generation projects from the ESOO). The needs for other scenarios will be surmised and reported in high-level. The proposed planning horizon is 5 years (2012 - 2017)

System security NSCAS needs will be Identified using previous AEMO planning documents (e.g. the 2010 NTNDP), AEMO operation documents (e.g. PSA) and operation experiences, TNSP Publications (e.g. APR) and discussions with TNSPs.

The assessment of this NSCAS need will use the assumptions and follow the current AEMO procedure outlined in the document "NSCAS Quantity Procedure".

Inputs to NSCAS assessment include:

* network models including committed network augmentations for next five years
* network models populated with 10% POE MW load and estimated MVAr loads for the five years
* network models populated with the estimated light load (MW and MVAr) for the five years
* market models and modelling inputs as required for estimating market benefit of NSCAS (as necessary for investigating a methodology for the market benefit assessment)

## Common assessment assumptions

This section lists the common assumptions applied to each regional assessment. Region-specific assumptions are listed with the relevant regional assessment..

## Queensland assessment

Highlight that assessments are based on current approach: 2012 may be different as new approach.

Summary of NSCAS issues and requirements for the region.

Include a table of requirements where applicable.

List any assumptions that are specific to that region.

List any projects in APRs that are not yet committed but may address some of the requirements.

| Type of NSCAS | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 |
| --- | --- | --- | --- | --- | --- |
| NLCAS | MW | MW | MW | MW | MW |
| Supplying RPAS | MVAr | MVAr | MVAr | MVAr | MVAr |
| Absorbing RPAS | MVAr | MVAr | MVAr | MVAr | MVAr |

## New South Wales assessment

Content as Queensland assessment section

## Victoria assessment

Content as Queensland assessment section

## South Australia assessment

Content as Queensland assessment section

## Tasmania assessment

Content as Queensland assessment section

# wind Generation Variability and Network Congestion

Summary

|  |
| --- |
| *This chapter presents information about market-related issues related to integration of large amount of wind generation forecast in the 2010 NTNDP. This will include intermittency issues related to the high levels of wind power based on wind measurements, and use these measurements and result s support more thorough market simulation congestion studies and reporting that were carried out in the 2010 NTNDP.*  *Results from the variability work will provide new traces for the congestion studies.*  The 2010 NTNDP simulated the operation of wind generation using time sequential Monte Carlo techniques and one year (2005/06) of historical wind data derived from CSIRO data. The 2011 NTNDP extends this by using a a number of years of wind measurements to (i) assess intermittency issues, and (ii) use those measurements and results to examine the potential impact of wind generation in 10 years time for three NTNDP scenarios. The simulations are for 2019/20, as this is the closest year that was fully developed in the 2010 NTNDP. List the scenarios and explain why they were chosen.  Eight years of historical wind data, from South Australia, are used for the 2011 NTNDP simulations. This is a significant increase on the single year used for 2010, and is intended to provide a more reliable basis for an analysis on the impact of variability and congestion.  This chapter summarises the results of the simulations and full results are provided in Appendix XXX. |

## Background from 2010 NTNDP

Describe the outcomes from the 2010 NTNDP and the reasons for carrying out this, more thorough review. This will include:

* amount of wind power proposed from the various scenarios used in the 2010 NTNDP
* how this chapter will review these outcomes more thoroughly

## Variability

Wind data available and how wind intermittency will be reviewed, including diversity, output step changes, ramp rates, impact on other generation, etc. Check the variability for each bubble, to see if we need to split bubbles down.

### Diversity

Diversity across the locations where wind generation is modelled. Contribution at peak.

### Rates of change of wind generation output

Maximum step changes (+ and -) in wind output for the historic dataset and ramp rates (minimum hourly resolution)

## Congestion studies

This study identifies locations where congestion occurs and the extent of this congestion. It:

* reports on the degree to which each local wind generation area is constrained to some degree
* reports on the value of that congestion (compare with an unconstrained run)
* determines the relativity of the congestion between local (e.g. where the farm(s) are essentially radial from the backbone transmission system) and backbone network constraints, and
* considers the capacity increase and potential benefits of operating the local transmission assets above their secure operational ratings (i.e. at 'n' capacity) using wide-area control schemes to maintain security.

### Location and extent of congestion

Reports on the degree to which each local wind generation area is constrained to some degree

Reports on the value of that congestion (compare with an unconstrained run)

Determines the relativity of the congestion between local (e.g. where the farm(s) are essentially radial from the backbone transmission system) and backbone network constraints

Considers the capacity increase and potential benefits of operating the local transmission assets above their secure operational ratings (i.e. at 'n' capacity) using wide-area control schemes to maintain security

Link to further information in Appendix.

### Generator utilisation

An assessment of how other generation patterns in the NEM change in response to variations in wind output

### Price impacts

Wholesale energy market price outcomes would also be available from these studies. These may illustrate depressed or negative prices at low load / high wind periods. These results should be considered for publication if there is sufficient value.

## Current and future modelling of wind generation

Establish how reliably the existing NTNDP market simulation models represent wind generation and, therefore, how good is the optimisation of network and generation investment is in this regard (results would feed into NTNDP2012).

Describe proposed changes to market simulation studies for the 2012 NTNDP and how congestion will be reported.

Link to further information in Appendix.

# ntndp outlook marginal loss factors

Summary

|  |
| --- |
| This chapter presents information about how generation connection marginal loss factors change over time as generation and transmission develop under a number of NTNDP scenarios.  It provides indicative MLFs for 2020 and 2030, for three scenarios, for generation connection points where there is greater than 1,000MW of new entry generation.  Key findings from the studies include:   * Factors identified as affecting MLFs   + Describe the factors and their impact * Connection points with significant changes in MLF over time   + List the connection points and the MLF changes * Little change in MLF despite large generation changes   + List the connection points and the generation and MLF changes |

## Background and objectives

This chapter presents information about how generation connection marginal loss factors change over time as generation and transmission develop under a number of NTNDP scenarios.

It provides indicative MLFs for 2020 and 2030, for three scenarios, for generation connection points where there is greater than 1,000MW of new entry generation. MLFs for 2011/12, as published by ESOPP, are provided as a reference point.

This piece of work has been driven by comments made by investors at the Network Planning Forum that MLFs can tip a project business case one way or another and, in particular, uncertainty and volatility related to MLFs is a specific investment risk.

The 2010 NTNDP generation expansion incorporated the MLFs that were current last year but, because of computational complexity, did not adjust these with changes in generation or transmission.

## Inputs and methodologies

A methodology that approximates the ESOPP operational loss factor model has been used to derive indicative MLFs for 2020 and 2030 from a small number of cases. This is appropriate given the indicative nature of the results and the resource intensity of using the full ESOPP operational loss factor model. The 2011/12 MLFs that are provided as a reference point have been published by ESOPP, and reflect use of the full ESOPP operational loss factor model.

XXX cases were considered. This is considered to provide sufficient samples for calculation of a representative loss factor.

A base case load flow file was developed for each scenario and year required, with generation and interconnector output information extracted from the 2010 NTNDP time sequential market simulation results.

Although these calculated MLFs might have changed the results of the least cost generation expansion, this project will not provide that feedback and the least cost expansion will not be re-evaluated.

## Factors identified as affecting MLFs

Describe the factors identified in the studies as having impact on MLFs

## Key connection point results

### Significant changes in MLF over time

List the connection points and the MLF changes

Explain the drivers behind the MLF changes observed

MLFs for all generation connection points are available from the AEMO website.

### Little change in MLF despite large generation changes

List the connection points and the generation and MLF changes

Explain the drivers behind the MLF changes observed, and how the generation has been accommodated without significant impact on MLFs

MLFs for all generation connection points are available from the AEMO website.

# NEMLink: further study results on a High-Capacity Backbone

Summary

|  |
| --- |
| *This chapter presents information about…..Summary of chapter with focus on key results and context material required to understand those results*  The 2010 NTNDP included a high-level study into the potential benefits of significantly increasing the power transfer capabilities in the NEM. Core to this study was a conceptual project called NEMLink that represented significant transmission investment in a high-capacity backbone between the NEM regions.  The NEMLink assessment provided information about the technical characteristics, estimated costs, and potential market benefits such a project might carry. These benefits were significant and, under an optimistic set of assumptions, approached breakeven against the project costs.  The results generated considerable stakeholder interest, and further analysis has been carried out for the 2011 NTNDP. In particular, by refining the scope and impact of a NEMLink-style project, positive net market benefits may become achievable, or the project may become viable under a broader range of scenarios.  The results are summarised in this chapter and detailed cost benefit data are available electronically on the AEMO website. |

## 2010 NTNDP NEMLink results

Summarise the 2010 conclusions, market benefits and the 2010 NEMLink technical features and methodology. To provide context for the 2011 study results.

## Methodology

High level description of the methodology used to reach the conclusions. Include key high level assumptions. State how changed / unchanged from 2010.

The 2011 NTNDP will expand on the NEMLink studies conducted in 2010, by exploring the results of three revised NEMLink-syle projects. The three projects (in priority order) include:

* Removal of the VIC-TAS component. This element carried the greatest individual cost and therefore is likely to have the largest impact on the cost-benefit ratio (currently the only committed study).
* Removal of the VIC-SA component (in scope only if resources allow).
* Removal of the VIC-NSW component (in scope only if resources allow).

For each studied project, a set of potential market benefits will be calculated under two scenarios (the FC-High and UW-Low scenarios, as used for the 2010 NEMLink analysis). The study is likely to focus on FC-High. These market benefits will include changes arising in:

* Generation capital costs and avoided fixed costs;
* Transmission capital costs;
* Transmission system losses;
* Operating costs; and
* Changes in system reliability.

The calculated benefits will be compared against estimated costs for each project, and a cost benefit ratio will be calculated.

Describe the technical characteristics (voltages, AC or DC etc), pathways, timings etc of the NEMLink variations studied for 2011. Explain how relate to 2010 concept. (Likely to be very brief).

Include table showing characteristics for each variation studied. Include map figure showing NEMLink concept and variations. Consider whether more than one map is needed.

### Market modelling for NEMLink

Provide market modelling assumptions including which scenarios are used for the assessment and why. Explain any changes from 2010.

The 2010 studies discounted costs using the generator Weighted Average Cost of Capital (WACC), which differed between scenarios. The 2011 studies will apply the transmission WACC described by the AER, and comment on the impact this would have on the 2010 results.

AEMO will not seek to quantify other market benefits that may exist, such as competition benefits and option values. However, AEMO may comment on the potential size of these benefits based on references to other studies.

## Generation and transmission development

### Generation expansion

Provide key aspects of generation expansion and impact of the NEMLink variations on the generation pattern. E.g. locations of increased and reduced generation, for different variations. Explain any differences to 2010.

### NEMLink impacts on other transmission developments

Impact on network of generation expansion changes from NEMLink variations. Any impact on regional network development. E.g. augmentations avoided or additional ones needed or changes of augmentation location.

## Market benefits

Describe sources of market benefits and key assumptions. Provide table(s) of benefits for the variations. Explain differences from benefits presented in 2010. Relate benefit results to characteristics and impacts of each variation.

Consider graph figures showing benefits over time for all or key variations only.

Comment on impact of use of transmission WACC.

Comment on the potential size of competition benefits, option values etc. (Results may limit what can be said here – comments can be based on other studies).

## Conclusions

Rank the stages (cannot rank if only 1 stage done), drawing together benefits and technical considerations and indicate next steps. Draw conclusions on possible benefits of components.

# generation and interconnector development scenario sensitivity studies

Summary

|  |
| --- |
| This chapter presents information about generation and interconnector development for a range of sensitivities to the 2010 NTNDP scenarios.  The sensitivities chosen reflect the requirement to provide GPG data for the 2011 GSOO and a focus on the potential impact of changes to cost and availability assumptions for some emerging technologies, including geothermal and CCS, and of changes to carbon target and price assumptions.  Based on least-cost models, rather than time-sequential or network studies, the results comprise generation expansion and retirement, transmission impacts and data for GPG and carbon emissions.  The results show:   * Key impacts from changes to technology costs and availability assumptions   + Differences from 2010 generation development (scale and locational)   + Any trends, knee points observed * Key impacts from changes to carbon approach assumptions   + Differences from 2010 generation development (scale and locational)   + Any trends, knee points observed   GSOO GPG data – changes from 2010 |

## Technology costs and availability

### Sensitivities selected

Describe the sensitivities selected and the reasons for the selection

### First sensitivity

#### Generation development

Describe the development (expansion and retirement) and how it is different to the 2010 base scenario and sensitivity

#### Transmission development

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### GPG utilisation

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Carbon emissions

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Sensitivity results summary

Describe any patterns, trends, knee-points etc observed in the results and how the different results fit together, and differ from the 2010 results

### Second sensitivity

#### Generation development

Describe the development (expansion and retirement) and how it is different to the 2010 base scenario and sensitivity

#### Transmission development

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### GPG utilisation

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Carbon emissions

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Sensitivity results summary

Describe any patterns, trends, knee-points etc observed in the results and how the different results fit together, and differ from the 2010 results

## Carbon approaches

### Sensitivities selected

Describe the sensitivities selected and the reasons for the selection

### First sensitivity

#### Generation development

Describe the development (expansion and retirement) and how it is different to the 2010 base scenario and sensitivity

#### Transmission development

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### GPG utilisation

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Carbon emissions

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Sensitivity results summary

Describe any patterns, trends, knee-points etc observed in the results and how the different results fit together, and differ from the 2010 results

### Second sensitivity

#### Generation development

Describe the development (expansion and retirement) and how it is different to the 2010 base scenario and sensitivity

#### Transmission development

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### GPG utilisation

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Carbon emissions

Describe the development and how it is different to the 2010 base scenario and sensitivity

#### Sensitivity results summary

Describe any patterns, trends, knee-points etc observed in the results and how the different results fit together, and differ from the 2010 results

## GPG utilisation for the 2011 GSOO (Delete if published in GSOO)

Three sets of GPG utilisation data have been developed for use in the 2011 GSOO. They are for:

* the 2011 'Independent Action' scenario
* the 2010 'Uncertain World' scenario, and
* a sensitivity to the 2010 'Fast Change' scenario that delays the availability of Geothermal and CCS.

*Provide the reasons for the scenario selection.*

### GPG utilisation

#### 2011 Independent Action scenario

Brief scenario description

Describe the GPG utilisation under this scenario / sensitivity. Provide a table.

#### 2010 Uncertain World scenario

Brief scenario description

Describe the GPG utilisation under this scenario / sensitivity. Provide a table.

#### 2010 Fast Change sensitivity: geothermal and CCS availability delay

Brief sensitivity description

Describe the GPG utilisation under this scenario / sensitivity. Provide a table.

### Differences from the 2010 GSOO GPG utilisation

Describe how the range of scenarios addressed and the utilisation results obtained are different from those addressed in 2010

# gas and electricity transmission comparative case study

Summary

|  |
| --- |
| This chapter presents information about a comparative case study into connecting a hypothetical 1,000 MW CCGT, using either significant gas or electricity transmission infrastructure.  The 2010 NTNDP identified gas generation development as an important theme in the transition to a lower carbon energy environment. The prominence of gas as a fuel source in all of the NTNDP scenarios raises some important issues related to the interaction between the gas and electricity systems.  This case study is a general comparison of the two systems: it compares the characteristics of each of the electricity and gas approaches and issues relating to them, including access, costs and benefits. |

## Background and objective

The 2010 NTNDP identified gas generation development as an important theme in the transition to a lower carbon energy environment. The prominence of gas as a fuel source in all of the NTNDP scenarios raises some important issues related to the interaction between the gas and electricity systems.

The objective is to provide information about how gas transmission can act as an alternative to electricity transmission and to derive an understanding of their comparative economic ranking and the parameters affecting this.

## Electricity transmission approach

### Planning criteria

Describe the planning criteria

### Case studies

Document the case studies

### Design of electricity transmission network approach

1000 MW CCGT near the source of gas but 500km away from the grid connection requiring 500 km of electricity connection.

Description of needs to meet. E.g 500 km length

High level design

### Indicative cost estimates of electricity transmission network approach

Characteristics and cost estimate including access and commercial issues

## Gas pipeline approach

### Planning criteria

Describe the planning criteria

### Case studies

Document the case studies

### Design of gas pipeline approach

1000 MW CCGT near the electricity grid connection but requiring 500km of gas pipeline.

Description of needs to meet. E.g 500 km length

High level design

### Indicative cost estimates of gas pipeline approach

Characteristics and cost estimate including access and commercial issues

## Other considerations

### Environmental

#### Electricity transmission network

Electricity issues.

#### Gas transmission pipeline

Gas issues.

### Reliability and access to new generations

#### Electricity transmission network

Electricity issues.

#### Gas transmission pipeline

Gas issues.

### Operation and maintenance

#### Electricity transmission network

Electricity issues.

#### Gas transmission pipeline

Gas issues.

### Regulatory approval process and commercial arrangements

#### Electricity transmission network

Electricity issues.

#### Gas transmission pipeline

Gas issues.

## Differences between electricity and gas approaches

Provide a table comparing (side by side) the different characteristics of the two approaches

Include open access / firm access issues

Not appropriate to conclude that one is better than the other

# Economic transmission planning Approach

Summary

|  |
| --- |
| This chapter presents information about an economic approach to transmission planning.  It also includes the results of key findings of development studies (looking to improve how competition benefits, HILP and option value are dealt with)  Provide key elements of an economic approach.  Describe key findings of development studies (competition benefits, HILP and option value)  Explain what an economic approach is.  Explain how economic planning is an appropriate way of applying consumers’ transmission charges |

## Economic planning and investment approach

### Probabilistic planning approach

Description of the probabilistic planning approach

How it accounts for power system requirements

VCR - explanation of what it is and how it is used in probabilistic planning

More high-level than the Victorian approach: provide room for other ways of applying the economic planning approach

### Investment process

Set out the different stages of project approval and the different techniques used at each stage, including when economic assessment is applied

Option development and screening

Non-network option development (including demand side management), how they are established, assessed and issues such as where an economically efficient alternative exists for which there is no proponent, when to screen options without proponents out of the regulatory test process

Regulatory Investment Test for Investment (RIT-T) application process

Description of RIT-T process

Scenarios - how these are designed, weighted and applied

## Planning approach development

### Competition benefits

Description of competition benefits

Competition benefits versus wealth transfers

How these could be calculated

Details of further work AEMO may undertake

Link to full report

### HILP assessments

Description of HILP events

How these are dealt with in other industries

How these could be included in AEMO's planning process

Details of further work AEMO may undertake

Link to full report

### Option value

Description of option value and measures of the resilience of solutions to alternative futures

How this can be included in RIT-Ts, including using the NTNDP

Link to full report on AEMO website

# demand forecasting methodology development

Summary

|  |
| --- |
| This chapter presents information about a review of the extent and impact of key new technologies, rooftop solar PV or other distributed generation and electric vehicles (EV) on time-of-day demand.  *To be updated to reflect new scope.*  *Should reflect stakeholder interest: in rooftop PV and EV at least.*  *A lot of work needs to be done on load shape for rooftop PV and EVs. More than just a MW issue.*  It includes demand forecasting methodologies for addressing these impacts, and proposals for how these may be used in transmission planning studies. |

## Small, distributed generation and storage impacts

Provide information about the impacts on future load shape from small distributed generation and storage (PVs, CHP, fuel cells)

Review range of possibilities for future small distributed generation & storage

Investigate the impacts on future time-of-day load shape from small distributed generation and storage

Provide models and rules for developing future load traces for electricity market modelling, to account for particular assumptions about distributed generation & storage

## Electric vehicle impacts

Provide information about the impacts on future load shape from EVs

Review range of possibilities for future EV penetration and smart / dumb EV charging

Investigate the impacts on future time-of-day load shape from electric vehicles

Provide models and rules for developing future load traces for electricity market modelling, to account for particular assumptions about EVs

## Load traces

Approaches to growing future load traces from historical data

Review existing process for developing future load traces and currently available alternative approaches

Develop view of load growth algorithm best practice for 2012 NTNDP

Provide load growth tools to be used when developing future traces for the 2012 NTNDP

# wind integration Review

Summary

|  |
| --- |
| This chapter presents information about reviews (from a predominantly technical perspective, rather than a market perspective) into how increasing wind generation can be integrated into the NEM. This will include key results from reviews of international practice, grid code (in comparison with the National Electricity Rules) and analytical studies. These key results and those key findings from Chapter 4 will be used to recommend the next steps in integrating high levels of installation of wind generation.  Recommendations may include (for example):   * what changes to the National Electricity Rules might be required (e.g. regulatory and generator performance standards) * what additional studies might be required to establish the materiality of issues application to the NEM context * how the levels of wind generation from the 2010/21 simulations can be efficiently accommodated in the NEM while ensuring system security is maintained; and * how future planning should model and incorporate wind generation.   The 2010 NTNDP shows that in some scenarios between 7000 and 8000 MW of new wind generation is added to the NEM's existing 2000 MW.  There are potential integration issues associated with this extent of wind entry into the NEM. These issues can arise in a number of areas including:   * The technical performance of the power systems under various operating conditions with relative high concentration of wind energy; * The efficient operation of the market and utilisation of the wind generation within the overall generation portfolio; and * The regulatory and policy settings required to support the expansion and augmentation of the network to efficiently and effectively accommodate high penetrations of wind generation.   These issues are addressed in this chapter, through reviews of international practice, grid codes, operational impacts of increased simulated wind generation and congestion. |

## International practice

Summarises international practice in dealing with high levels of wind penetration in power systems

What has been observed internationally with respect to wind

How other networks approach standards for wind

Lists the types of issues that may arise and how these are dealt with.

Applicability to the NEM

Link to report on website.

## Review of grid codes

Transmission operators are relying more heavily on grid codes to specify the technical and performance requirements of wind generators and wind farms. The objective is to protect the service levels of other transmission customers when a new generator connects to the transmission system.

Lists and comments on recent changes to, and developments of, international codes that specify technical requirements for new wind generation.

Identifies code issues (technical and operational requirements) that may be relevant to the NEM and explains the rationale for each one.

Link to report on website.

## Review of wind impact studies

High level review of technical issues identified internationally, including a review of international studies international grid codes in comparison with the National Electricity Rules.

There are technical issues that are likely to emerge as more wind enters the NEM and conventional plant is displaced. Some of these issues are addressed in this section.

What results have been generated internationally? Lots of market studies are available, few technical.

Link to report on website.

*(The following describe notional issues that might be reported, subject to the outcomes of the consultants’ reviews.)*

### Voltage control and stability

Sets out the reactive requirements to support the modelled wind generation

* Issue
* Drivers
* Potential responses

### Inertia

Provides results of an investigation into whether there is a requirement to maintain a minimum level of inertia within the power system (locally) and, if so, what are the drivers for this requirement.

* Issue
* Drivers
* Potential responses

### Frequency control

Provides results of an investigation into whether there are localised issues for frequency control and required FCAS services.

* Issue
* Drivers
* Potential responses

### Minimum generation

Provides results of an investigation into whether there are minimum generation levels in parts of the network (such as the extremities - Tasmania and South Australia) and what the drivers are for this requirement.

* Issue
* Drivers
* Potential responses

### Volatility

Provides results of an investigation into whether the levels of volatility established in the 2020/21 wind simulations create requirements for ancillary services or other support services to maintain secure operation of the power system for the 2020/21 power system.

* Issue
* Drivers
* Potential responses

### Power electronic device technology issues

Related to the installation of significant amounts of power electronic devices in the NEM.

Assesses the particular issues with these devices and control systems associated with wind technology. This includes the operation of these devices during and after faults - e.g. wind turbine "fault ride-through control schemes".

Provides results of an investigation into whether there are any particular risks to the NEM where these control systems perform in an unexpected manner for unbalanced faults (while the Rules mandate certain performance, our analysis tools are currently unable to predict this behaviour).

* Issue
* Drivers
* Potential responses

### Sub-synchronous resonance

* Issue
* Drivers
* Potential responses

## Next steps

Summarises the next steps from the separate sections. Brings them together to show how they form a coherent approach. What AEMO is going to do next.

For example, technical standards changing, Rule changes and further NEM studies.

# 2012 NTNDP Consultation (Consider making a standalone paper)

Summary

|  |
| --- |
| *This chapter presents information about…..Summary of chapter with focus on key results and context material required to understand those results*  *Indicate that the 2012 NTNDP will be a network review like the 2010 NTNDP.*  *Describe how the 2011 NTNDP and consultation activities will inform the 2012 NTNDP.*  *For example:*  *The NTNDP dataset also includes the maps and single line diagrams of the existing system that are usually published.*  *For each scenario, the database reflects the non-confidential data for existing participants, accepted future technology and fuel costs. This may not be identical to that used in the 2012 NTNDP but reflects its fundamental relationships. The data will be provided both in data spreadsheets and in a Prophet database.*  *Updated single line diagrams and wall map of the NEM electricity system*  *The input data spreadsheets and Prophet database to be published in the 2011 NTNDP and will form part of the formal consultation required before the data is used in the modelling for the 2012 NTNDP.*  *State that these planning assumtions will be used for ESOO, GSOO, VAPR , as appropriate. Include a table showing how the different inputs are used in each document.*  *Input data will be reviewed with stakeholders, including:*   * *Capital costs* * *Operating and Maintenance costs* * *Efficiency* * *Emissions intensity* * *Date the technology is commercially available* * *Fuel costs*   The NTNDP provides an independent, strategic view of the efficient development of the National Electricity Market (NEM) national transmission network over the next 20 years. As a key part of AEMO’s suite of planning documents, the NTNDP aims to facilitate effective transmission network development by providing a nationally-consistent view of investment requirements to support growing demand for energy.  This chapter provides details of AEMO’s proposed development of the 2012 NTNDP, and seeks stakeholder feedback on:   * The 2011 NTNDP * The proposed development areas for the 2012 NTNDP:   + 2012 scenarios   + Least-cost expansion modelling   + Major transmission option cost-benefit analysis (NEMLink)   + Other market benefit assessments * Proposed modelling methodology and data inputs * Strategic long-term direction   Next steps in the consultation |

## The 2011 NTNDP

Describe briefly the high-level intent of the 2011 NTNDP and suggest areas for stakeholder feedback.

## 2012 NTNDP scope and presentation

Include options, such as whether more NEMLInk studies are included, whether material is presented in spreadsheets or written form.

## 2012 scenarios

Describe the 2012 scenarios and suggest areas for stakeholder feedback.

## Least-cost expansion modelling

Describe the approach proposed for the 2012 NTNDP and suggest areas for stakeholder feedback.

## Wind studies

Describe wind studies proposed for 2012 NTNDP.

## Other market benefit assessments

Describe the approach proposed for the 2012 NTNDP and suggest areas for stakeholder feedback.

## Proposed modelling methodology and data inputs

Stakeholder feedback is sought on the proposed methodology and input data. In this respect, this chapter references a number of more detailed attachments describing the modelling that will be conducted and the associated input data. In addition, the AEMO website contains the following spreadsheets:

* 2012 NTNDP Supply Input Spreadsheets.zip
* 2012 NTNDP Consultation Report Input Tables.xls
* 2012 Fuel Cost Review.xlsx
* 2012 Demand and energy forecasts.xlsx

These include the numerical market simulation inputs, such as physical parameters for modelling generation, generation costs and assumed lead times.

## Strategic long-term direction

Describe AEMO’s plan for development of the NTNDP and suggest areas for stakeholder feedback.

## Next steps

List and describe the next steps in the consultation