

# **Integrating Wind Farms into the National Electricity Market**

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## **Discussion Paper**

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**Wind Energy Policy Working Group**

**Ministerial Council on Energy Standing Committee of Officials**

March 2005

## **Wind Energy Policy Working Group Consultation Process**

The Ministerial Council on Energy's Standing Committee of Officials (SCO) is seeking specific comments and/or views on the range of issues discussed in the paper to inform the development of policy actions by the MCE. SCO is particularly interested in obtaining the views of energy consumers, consumer advocates, retailers, distributors, and other market participants and institutions.

Accordingly, SCO is seeking written submissions to its Wind Energy Policy Working Group by 6 May 2005.

When making submissions, please include your name, address, organisation, and contact details, including your email address, if applicable. Wherever possible submissions should be provided electronically.

To ensure the Working Group is able to consider all views within the work program timeframe, it is requested that written submissions be limited to five pages. Any supporting documents should be clearly labelled as attachments.

It is intended to make electronic submissions publicly available on the Wind Energy Policy section of the Ministerial Council on Energy website at the end of the process. If you do not want all or part of your submission made publicly available, or you consider any part of your submission to be confidential or commercial-in-confidence, you should make this clear in your submission.

Submissions must be received by 6 May and addressed to:

Wind Energy Policy Working Group  
c/- Office of Energy Planning and Conservation  
GPO Box 936  
HOBART TAS 7001  
Email: [rdgworkgroup@dier.tas.gov.au](mailto:rdgworkgroup@dier.tas.gov.au)

Please direct any enquiries regarding the consultation process to Adam Petersen, on (08) 8204 1701.

## **Integrating Wind Farms into the National Electricity Market (NEM)**

### **Wind Energy Technical Advisory Group (WETAG) Report to the Wind Energy Policy Working Group (WEPWG)**

The WEPWG is pleased to present the WETAG Report on Integrating wind farms into the NEM (Report) for public comment.

The current level of wind farm capacity is relatively small compared to other generation developments in the NEM. Consequently, difficulties that have arisen as a result of their connection to, and their operation in the NEM have been limited in scope to date and been able to be accommodated on a case-by-case basis.

However, a significant number of large-scale wind projects are currently being developed primarily in response to the Commonwealth Government's Mandatory Renewable Energy Target (MRET). As a result, wind generation is emerging as a significant source of both energy and capacity in the National Electricity Market (NEM), particularly in smaller regions such as some areas of South Australia and Tasmania.

At its April 2004 meeting, the Ministerial Council on Energy (MCE) agreed to establish a project to consider issues concerning the entry of renewable energy generation (particularly intermittent and non-scheduled generation such as wind) into the NEM. The Standing Committee of Officials (SCO) established the WEPWG to progress this project. The WEPWG requested that NEMMCO establish the WETAG, consisting of industry participants, to assist the WEPWG with the analysis of technical and policy aspects of wind penetration in the NEM. Industry membership of the WETAG is set out in Appendix C to the Report.

The WEPWG is releasing this Report to obtain the views of stakeholders in respect of the Report as part of its consideration of the policy and technical issues associated with integrating wind farms into the NEM.

WETAG identified the following matters arising from the increasing penetration of wind energy, with a number of these considered urgent:

- An urgent review of the technical standards for connection;
- Managing the impact of intermittent generation on network flows;
- Wind farm modelling in respect of power system operational implications;
- Disclosure of appropriate information; and
- Cost recovery of Regulation Frequency Control Ancillary Services (FCAS) services.

#### ***Technical standards***

WETAG investigations have identified a number of technical difficulties associated with the current technical standards under Schedule S5.2 of the Code. A majority of the standards remain in a form that do not apply or cannot apply to wind generation and in many cases this arises from the use of the technically or commercially specific terms such as 'synchronous' or 'scheduled'. For example, some standards refer to synchronous generating units, whereas wind generators are often non-synchronous. Some provisions may also be overly prescriptive and may result in excessively onerous technical performance requirements.

SCO has agreed to NEMMCO commencing a review of the technical standards for the connection of generators under the Code. The NEMMCO review is being undertaken using a set of guiding principles agreed by WETAG, the details of which are set out in Appendix A of the Report. WETAG has recommended that a review of the technical standards in

accordance with the principles be carried out at intervals of 3-5 years as appropriate. This would aim to avoid further situations where new technologies are not adequately catered for by the standards, and would address any issues arising from the application of the standards.

WEPWG seeks industry feedback on the guiding principles, the need for a regular longer-term review in relation to the technical standards and whether this should be reflected in the Code.

### ***Management of network flows***

Network flows are controlled by NEMMCO to remain within security limits, using the central dispatch process. The current dispatch arrangements require scheduled generators to be dispatched taking into account whatever output non-scheduled generators are producing. Historically, non-scheduled generation was a very small component of the market and was unlikely to impact on security and reliability of the network. However, with large amounts of non-scheduled generation in the market, this assumption is no longer valid.

Situations can arise with significant amounts of non-scheduled generation where the central dispatch process cannot prevent the operational limits of the network becoming infringed by controlling the output of scheduled generators alone. Accordingly, it is considered that the current concept of non-scheduled generation under the Code is not sustainable and that some form of dispatch control of wind farms will be required.

The WETAG Report recommended further investigation by the WEPWG of the cost of control systems and the feasibility of a 'semi dispatch' model for wind farms when network constraints are binding. A potential semi-dispatch approach would be for dispatch targets of maximum generation to be sent to the significant non-scheduled plant when network constraints are binding where the dispatch engine has optimised the wind farm's output utilising an offer price nominated by the wind farm (in a similar way to offer prices submitted by scheduled generators).

WEPWG seeks industry feedback on the management of network flows through mechanisms such as a form of semi-dispatch.

### ***Modelling of power system operation implications***

Studies to determine the sensitivity of the network to increasing amounts of wind generation are yet to be fully carried out. Power system security implications require urgent consideration in respect of areas such as power system stability, plant inertia, overall generation dispatch and ancillary service requirements. NEMMCO and the Electricity Supply Industry Planning Council of South Australia (ESIPC) are currently in the process of acquiring wind farm modelling data to support power system operational studies. NEMMCO intends to carry out the studies, initially in South Australia, to determine system security implications for different levels of wind generation and the need for any special operating arrangements.

Importantly, to ensure that this analysis can be undertaken, WETAG considers that the Code should be clarified to ensure that appropriate dynamic generating plant models are required to be lodged with NEMMCO for all significant generators or generating systems (i.e. >30MW) and that these models should be able to be verified.

WEPWG endorses WETAG's recommendations regarding the provision of dynamic models and the urgent need to undertake power system security evaluations.

***Information disclosure***

As wind energy is becoming a material component of NEM generation, it is important that information regarding wind generation forecasts are made available to market participants to facilitate market transparency and efficient plant commitment outcomes. Appropriate non-scheduled generation data could be released to the market by NEMMCO, however, Code changes would need to be developed to support the release of Predispatch, STPASA, MTPASA and 'next day publication' of non-scheduled generation data. Previous proposed forecasting Code changes that were not progressed, included information disclosure requirements.

NEMMCO have indicated that they are willing to progress the information disclosure provisions as a separate Code change process. WEPWG supports NEMMCO progressing information disclosure Code changes in consultation with industry.

***Regulation FCAS services and cost recovery***

Currently under the Code, wind generation plant that is registered as a non-market generator does not participate in the 'causer pays' arrangements for regulation FCAS services. Wind generators and other market participants that are registered as a market generator participate only if appropriate operational metering is installed.

The WETAG Report notes that the installation of appropriate operational metering is a requirement for generating units or generating systems that are larger than 30MW in size. Obligations to participate in 'causer pays' arrangements may therefore be clearer if the dependency on operational metering were removed and replaced with a clear requirement for all market generators larger than 30MW to participate in 'causer pays' arrangements.

WEPWG seeks industry feedback on the requirement for all market generators larger than 30MW in size to participate in regulation FCAS causer pays arrangements.

***Other Issues***

The Report details a number of matters with varying degrees of urgency and the WEPWG seeks comments on all issues, including those that the Report does not identify as requiring policy consideration at this stage.

# Wind Energy Technical Advisory Group (WETAG)

Report to the Wind Energy Policy Working Group

## Integrating wind farms into the NEM

*Prepared by: Wind Energy Technical  
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*Date: 12 January 2005*

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## 1. Executive Summary

This paper presents the initial findings from technical investigations into issues that need to be addressed to accommodate the emergence of wind generation as a significant generation source in the National Electricity Market (NEM). As a jurisdictional initiative, the Standing Committee of Officials (SCO) established the Wind Energy Policy Working Group (WEPWG) to consider the range of policy level issues associated with wind generation in the Australian context.

The WEPWG requested NEMMCO to establish the Wind Energy Technical Advisory Group (WETAG), to assist their investigations by preparing this paper. The paper aims to articulate the potential range of issues that may need to be addressed in anticipation of large amounts of wind generation in the NEM. Those matters that are likely to require policy level action are then identified for consideration by WEPWG.

WETAG includes input from all industry sectors including wind farm developers, incumbent generators and retailers as well as end users, NSPs and NEMMCO. The investigations by WEPWG have considered the range of technically related issues for wind generation raised in an earlier information paper published by NEMMCO in March 2003 as well as issues identified subsequently.

The following table contains WETAG findings for consideration by WEPWG. WETAG anticipates that WEPWG will use this information to support broader consultation with industry stakeholders prior to recommending policy decisions in regard of wind generation to the SCO.

A number of items have been identified by WETAG as urgent, due the rapid development of significant wind farm projects. This particularly applies to the following items in the table:

- Items 1 and 2 – Recommendation to evaluate the means of managing network flows and the effects of generator short term variability;
- Item 3 – Investigations underway to determine at what stage any special operating arrangements may be necessary;
- Item 8 – technical standards; Some technical standards cannot be applied to wind generation and need to be revised as soon as possible;
- Item 9 – Provision of dynamic plant models; Code obligations for the provision, structure and management of generating plant dynamic models need to be revised so that they apply appropriately to wind generation.

	Potential Issue	Potential Implications of Status Quo	WETAG Proposals
1	<p><b>Management of network flows</b></p> <p>Wind generation is non-scheduled. This gives rise to an increasing number of situations where the optimal dispatch process does not control the dispatch of all significant generating plant that can affect network loadings. Network transfer limits may be affected in some cases.</p> <p>Where multiple non-scheduled generators are each seeking access to a limited network capability, the Code provide no guidance as to which generators should be dispatched and which should be curtailed.</p>	<ul style="list-style-type: none"> <li>- Current provisions assume that scheduled plant loadings will be determined within network capabilities and demand requirements, taking into account the generation levels at which non-scheduled plant is operating;</li> <li>- Small volumes of non-scheduled generation such as wind energy, would not give rise to adverse effects, but larger amounts could give rise to operational issues as scheduled plant is dispatched to accommodate;</li> <li>- When demand is low, or network limits are binding the flexibility of suitably located scheduled plant may be tested. In cases where scheduled plant cannot be dispatched to accommodate wind farm generation, there will be no option but to limit the output of relevant wind farms.</li> <li>- Non-scheduled generators, like other generators will have an impact on network transfer limits. In the case of non-schedule plant however, network limits cannot be optimised;</li> <li>- Some NSPs have required the installation of ‘run-back’ control schemes on wind farms for local reasons. Those schemes are not linked to the central dispatch process, and may not provide for co-ordinated continuous control;</li> <li>- Where power system security or reliability is at issue, NEMMCO can issue “<i>directions</i>” (for market or scheduled generators) or “<i>clause 4.8.9 instructions</i>” (for non-market non-scheduled generators). “<i>Directions</i>” are subject to compensation, while “<i>Clause 4.8.9 instructions</i>” are not. The ability of generators to respond to directions/instructions, and appropriateness of compensation provisions would need to be carefully considered. Routine use of these safety net provisions would test the orderly operation of the market.</li> </ul>	<p>Issues #1 and #2 in this table can be considered together, as they both increase in materiality during constrained network operation, and are both likely to require the installation of a control system to limit wind farm output where the issue becomes material.</p> <p>It is suggested that WEPWG commission an investigation into:</p> <ul style="list-style-type: none"> <li>- The types and cost of control systems available to control wind farm outputs and to smooth sub five-minute variations. Existing systems, and likely evolutionary paths should be considered;</li> <li>- The current and potential future materiality of sub five-minute variations in wind farm output and their effect on network loadings. Work being carried out by ESIPC provides a useful starting point;</li> <li>- Feasibility of a semi-dispatch process for wind farms and other significant non-scheduled generators to assist in the management of network constraints. Such an arrangement would require relevant non-scheduled generators to participate in central dispatch at least when constraints bind;</li> <li>- This should be considered together with feasibility of requiring sub five-minute variations in wind farm outputs to be smoothed either by direct control, or through an ancillary service arrangement;</li> <li>- Feasibility of recognising that counter measures for these issues may not need to be installed until some future time when constraints become an issue. A proposal for a practical trigger should be sought such that adequate notice for implementation can be provided.</li> </ul> <p>WETAG considers that based upon the rapid rise in wind generation foreshadowed for South Australia, this item must be treated as urgent.</p>
2	<p><b>Short term variability</b></p> <p>Unless specifically compensated for, short term variations in the output from wind farms will appear as varying network flows. At the sub five-minute level, variations cannot be controlled through the 5-minute dispatch process.</p>	<ul style="list-style-type: none"> <li>- If variations in wind farm output occur within 5 minute dispatch intervals, then in the first instance this will combine with existing demand variations and other generation variations, and will ultimately appear on the network as variations in line loadings.</li> <li>- If the variations increase the overall materiality of sub five-minute variations, then NEMMCO’s current 5 minute dispatch process may be unable to keep line loadings within limits unless operational safety margins are introduced to allow for variations. The issue therefore has the ultimate potential to result in reduced network limits.</li> </ul>	<p>WETAG considers that this issue has common ground with issue #1 above. Both issues are exacerbated by binding constraints, and mitigation may rely on installation of a form of output control on significant wind farms in some locations.</p> <p>The proposal listed for #1, including the urgent priority, therefore also covers this issue.</p>

	<b>Potential Issue</b>	<b>Potential Implications of Status Quo</b>	<b>WETAG Proposals</b>
<b>3</b>	<p><b>Modelling of power system operational implications</b></p> <p>ESIPC has advised that some 1021MW of wind generation projects are in advanced planning phases in South Australia.</p> <p>It is yet to be determined at what stage in this development if at all, some features of wind generation will require the use special operating strategies to allow overall power system security to be maintained.</p> <p>Studies to identify these matters are location specific.</p>	<ul style="list-style-type: none"> <li>- With commitments now being advanced for large amounts of wind generation in South Australia, there is an urgent question as to which, if any, of the operational matters discussed in this report will need to be addressed for power system security in that area.</li> <li>- While NSPs will consider local issues, broader power system security modelling with focus on areas such as power system stability, plant inertia – particularly low demand levels, dispatch implications – particularly where constraints are involved, and ancillary services.</li> <li>- Both developers and system operators need to be aware of any operational implications as early as possible. Otherwise, special requirements may come to light after plant designs are committed, or even later, through operational experience. Both outcomes are undesirable.</li> <li>- Operational studies should inform licensing and connection negotiations. Results of modelling therefore need to be available well in advance of those matters being finalised, and are now urgent for at least South Australia.</li> </ul>	<p>ESIPC has commenced studies on these matters, and NEMMCO is also considering potential scenarios. Proven wind farm technical models are an essential component of some of these studies, but are not yet available. NEMMCO has commenced work in this area independently with a target for initial results in Q1 2005.</p> <p>Wind farm production data is another necessary input to studies. ESIPC has taken steps to derive prospective data for use in South Australian studies.</p> <p>Once the data is available, NEMMCO will carry out operational studies for South Australia. Other areas may follow.</p> <p>ESIPC, NEMMCO and WETAG consider this area of investigation to be very urgent.</p>
<b>4</b>	<p><b>Network connection of large scale wind generation</b></p> <p>Some NSPs and generation developers are finding the Codified arrangements for negotiating connection conditions to be unclear, particularly in respect of achieving a complying connection application and how they should recover the cost of investigating connection options.</p>	<ul style="list-style-type: none"> <li>- This issue does not relate exclusively to wind generation. However, it is particularly relevant to wind generation projects where the project capacity can be readily varied by changing machine numbers, sizes and altering operating parameters.</li> <li>- Groupings of potential projects by different proponents with competitive agendas, and multiple property owners can further complicate the issue;</li> <li>- NSPs may be reluctant to progress analysis of connection options for new developments where there is uncertainty about whether they can recover costs.</li> </ul>	<p>Discussions in WETAG revealed that views on the workability of current code provisions vary between parties, depending on the advice they have received. In view of the uncertainty, WETAG considers there may be a sound case for clarification of the Code connection procedures in the interests of all parties. Specifically, there may be merit in clarifying the enquiry, application and funding arrangements to allow investigation by the NSP of connection options prior to a formal application for connection being made by the developer.</p> <p>As this would effectively constitute a clarification of the Code, the affected participants could propose a change through the Code change process, and prior consideration at policy level may not be necessary.</p> <p>Accordingly, WETAG is not proposing any immediate policy action on this matter.</p>

Potential Issue		Potential Implications of Status Quo	WETAG Proposals
<b>5</b>	<p><b>Islanding</b></p> <p>If an electrical island forms where the generation is only or predominantly from wind farms or other non-scheduled generation, the control of frequency or voltage within the island may be an issue.</p>	<ul style="list-style-type: none"> <li>- Wind farm installations and some other forms of non-scheduled generation are not generally equipped to control the frequency of the power system. Therefore, if an island forms where the generation is only or predominantly wind, frequency will most likely not be directly controlled. This could result in frequency drifting until it exceeds frequency protection settings on plant or customer installations.</li> <li>- Whether or not this issue is material, would need to be determined on a case by case basis as it depends on network topology and the location and technology or relevant generators. The issue is considered here due to the increased incidence of significant wind generators connecting to more remote parts of the transmission and distribution networks.</li> </ul>	<p>There may be merit in providing for NSPs or NEMMCO to require the automatic disconnection of specific generating sources in some network locations. The provision would be applied where the risk of islanding is assessed as material. Due to the case specific nature of this issue, it may be appropriate for the Code to provide for this to be managed through connection agreements.</p>
<b>6</b>	<p><b>Contribution of wind generation to system reserves</b></p> <p>The variability of wind farm generation introduces uncertainty regarding the contribution they will make to meeting the forecast maximum demand over the range of NEM forecasting time horizons.</p> <p>Understanding of the reliable contribution wind farms can make to system reserves, and the impact this has on overall generation investment needs, will need to be kept pace with wind farm establishment.</p>	<ul style="list-style-type: none"> <li>- NEMMCO will need to develop and continually refine routine procedures to estimate the contribution that wind farm sources can make to supply reserves. Contributions could vary with location, and timeframes, and may need to take into account of a number of factors including: <ul style="list-style-type: none"> <li>- Individual wind farm generation patterns;</li> <li>- Impact of geographic diversity; and</li> <li>- Impact on network transfer limits.</li> </ul> </li> <li>- Important decisions such as reliability interventions, and the use of reserve trading powers by NEMMCO will be affected by this issue. The matter is also linked to the forecasting of wind farm outputs, which is discussed elsewhere.</li> <li>- As NEMMCO already has responsibility for monitoring supply reserves, current Code and policy arrangements are considered adequate.</li> <li>- Where relevant, justification of reliability based augmentations to networks will also increasingly need to take a view on the supply contribution non-scheduled generators will make at the time of local peak demand. In a similar vein to the above, proponents of augmentations will need to derive local assumptions.</li> </ul>	<ul style="list-style-type: none"> <li>- The incorporation of wind generation reliability into energy reserve assessments is arguably a task that NEMMCO can undertake on a continual improvement basis. This requires no regulatory or Code changes.</li> <li>- Similarly, the way in which wind generation is considered in reliability network augmentations is a matter for proponents to address and justify on a case by case basis.</li> <li>- WETAG has not identified any policy level changes that need to be addressed on this matter.</li> </ul>

	<b>Potential Issue</b>	<b>Potential Implications of Status Quo</b>	<b>WETAG Proposals</b>
<b>7</b>	<p><b>Optimising shared network connection assets</b></p> <p>Current arrangements may not deliver an optimal design for connection assets to support multiple generation developments. This is because connections are broadly considered in sequence, with little or no potential for possible future generation developments to be catered for and funded prospectively.</p>	<ul style="list-style-type: none"> <li>- Where new connection assets are required to facilitate the connection of several wind farms, the optimal design of those assets would ideally take into account the full amount of generation that is ultimately likely to connect. However, current arrangements tend to support the consideration of each connection in isolation. This is exacerbated by a desire for confidentiality between connecting parties.</li> <li>- Sub-optimal connection of multiple developments can result in increased cost, increased environmental impact, stranded assets from earlier connections, and reduced viability of later connections.</li> <li>- WETAG recognises that this issue affects all generation types, but it has been highlighted by wind generation due to the potential for sequential connections at some network locations</li> <li>- Ultimately, this issue revolves around the design and funding of shared connection assets, and is largely in the NSP domain.</li> </ul>	<ul style="list-style-type: none"> <li>- WETAG recognises that this issue is long standing in the general sense, and discussions revealed the broad range of views across market sectors. Furthermore, the matter is clearly one of policy, particularly in respect of the degree to which potential generation resources are to be harvested, and the role the network is to play in such matters.</li> <li>- In view of the above, WETAG has sought only to articulate the issue in the context of wind generation, to facilitate its further consideration at policy level.</li> </ul>

	Potential Issue	Potential Implications of Status Quo	WETAG Proposals
8	<p><b>Technical Standards</b></p> <p>The Code specifies technical standards which must be satisfied by generating plant wishing to connect to the network. Standards relate to such matters as Voltage control capability; overvoltage tolerance; fault ride-through; stability behaviour and protection; and response to frequency deviations.</p> <p>The drafting of some standards means that they cannot be directly applied to wind generation, or their application is unclear.</p> <p>Some provisions may also be lack flexibility, resulting in excessively onerous requirements.</p> <p>Application of the standards to supply reliability issues is also unclear in some instances.</p>	<p>A number of technical standards are drafted in a way that does not apply or cannot be applied to wind generation. Eg Some codified standards refer to:</p> <ul style="list-style-type: none"> <li>- Synchronous machines, but wind generators are often non-synchronous;</li> <li>- Scheduled plant, but wind generators are non-scheduled;</li> <li>- Transmission connected plant, but wind generators are often distribution connected.</li> </ul> <p>While the amount of wind generation connected to the network is small, the impact of those anomalies is localised or manageable. However, as wind generating systems become larger and greater in number, it is increasingly important that appropriate technical standards are applied at the time of connection.</p> <p>It is important that anomalies in the drafting of technical standards be addressed urgently to avoid issues arising in areas such as the following:</p> <ul style="list-style-type: none"> <li>• System security – eg it is important that all generators are tolerant of certain levels of disturbance on the power system to avoid cascading events;</li> <li>• Supply reliability – eg if the Code contains provisions (such as S5.2.5.12) that aim to ensure that new connections do not reduce supply reliability, it is important that these provisions operate clearly and effectively to all major new plant;</li> <li>• Quality of supply – eg the voltage control capability of plant that has varying output can impact on local supply quality.</li> </ul>	<p>WETAG is of the view that the broad framework in which the current technical standards reside, is appropriate and workable. However, significant issue have been identified with specific provisions within the framework particularly with regard to the applicability of the standards themselves to new technologies, such as wind generation.</p> <p>WETAG suggests that it is important for the technical standards to remain appropriate through time. This requires operational experience to feed back into the standards, and for new technologies to be anticipated and the standards adapted where appropriate to avoid material gaps such as the one that currently exists for wind generation.</p> <p>To achieve this, it is proposed that an appropriate NEM institution be required to review the Conditions for Connection of Generating Plant in the Code. The review should be carried out in consultation with stakeholders, be guided by codified principles, be carried out at intervals of 3-5 years as appropriate, and result in Code change proposals where necessary.</p> <p>Any reviews of the above type needs to consider whether and how any changed standards should apply to existing plant. Such transitional issues point to the need for changes to the standards to be minimised.</p> <p>NEMMCO has separately proposed to NEM jurisdictions that an immediate review of the above nature be undertaken to address pressing issues associated with the technical standards.</p> <p>WETAG considers this matter to be urgent, and supports an immediate review provided all relevant stakeholders are afforded input.</p>

	Potential Issue	Potential Implications of Status Quo	WETAG Proposals
9	<p><b>Provision of Dynamic Generating Plant Models</b></p> <p>NEMMCO, NSPs and other parties require robust dynamic generating plant models to support operational and planning functions.</p> <p>The Code (clause S5.2.4(b)) currently requires dynamic generating plant models to be provided to NEMMCO for all scheduled generating plant. Applicability of this provision to non-scheduled wind generation is unclear.</p> <p>The Code also requires NEMMCO to make dynamic plant models publicly available (clause 8.6.2(m)). As wind generation is a developing technology, this gives rise to manufacturers resisting the provision of their models due to intellectual property concerns.</p>	<p>Delays in the provision of suitable dynamic plant models for use by NEMMCO and NSPs stem from a range of issues including the following:</p> <ul style="list-style-type: none"> <li>• Ineffective Code obligations for the provision of models;</li> <li>• Lack of guidelines for the form of model to be provided;</li> <li>• Lack of obligations for the verification and testing of models;</li> <li>• Serious concerns about confidentiality of models.</li> </ul> <p>In the event that NEMMCO and NSPs are unable to access suitably verified models for all significant generating plant, the following concerns would emerge:</p> <ul style="list-style-type: none"> <li>• NEMMCO's uses generator dynamic models for on-line security assessment and for security planning. Lack of verified models may result in risks to power system security;</li> <li>• NSPs use dynamic models for operational planning purposes such as the determination of protection settings. Poor models may pose risks to plant or network security;</li> <li>• The design of new connections by developers, and processing of new connection applications by NSPs and NEMMCO rely on the availability of accurate models;</li> </ul>	<p>WETAG suggests the following potential measures to ensure adequate availability of dynamic generating plant models:</p> <ul style="list-style-type: none"> <li>• <b>Provision of models</b> – the Code should be clarified to ensure that dynamic models are required of be lodged for all significant generators or generating systems – eg those larger than 30MW.</li> <li>• <b>Guidelines</b> – an obligation could be placed on NEMMCO and/or NSPs to specify information to be included in models and the form in which it is to be provided. This could be reviewed periodically based on experience and technology developments, and could be linked to technical standards reviews;</li> <li>• <b>Verification of models</b> – Both NEMMCO and NSPs should have the authority to require testing to confirm the accuracy of models that have been provided. Such testing might best be achieved through the relevant NSP, which will have a formal relationship with the connecting party. Testing should be passive where possible to minimise costs and operational impacts;</li> <li>• <b>Generator model confidentiality</b> – WETAG favours maintaining the status quo in this area, i.e. keeping models non confidential. This would encourage manufacturers to find ways to represent the dynamics of the wind farm as a whole, while preserving the confidentiality of commercially sensitive material.</li> </ul> <p>WETAG considers this matter to be urgent.</p>
10	<p><b>Contingency FCAS Services and Cost Recovery</b></p> <p>There is a question as to whether the variability and low inertia of wind farms could lead to increased contingency FCAS requirements.</p> <p>There is an additional question of whether the current funding arrangements apply appropriately to wind farms.</p>	<p>NEMMCO has adequate existing powers to procure Contingency FCAS to meet frequency control standards. The need for increased contingency FCAS procurement is yet to be determined through operational modelling. Wind farm variability and geographic diversity are key considerations. Preliminary studies by ESIPC are attached. The low inertia of wind farms may also lead to increased procurement needs.</p> <p>Contingency FCAS is funded by market generators (raise services) and market customers (lower services), with those arrangements representing inherent cross subsidies. NECA recently conducted a review of FCAS arrangements, which is understood to have explored the potential for improvements to contingency FCAS funding arrangements.</p>	<p>WETAG considers that NEMMCO already has adequate powers to determine and procure contingency FCAS requirements.</p> <p>Cross subsidies are inherent in the current funding arrangements for contingency FCAS, and their refinement should be guided by NECA's recent FCAS review, rather than being specific to wind generation.</p> <p>Accordingly, WETAG does not propose that any specific actions are required at policy level from this item other than to recognise that further consideration may be subject to the findings of NECA's review.</p>

	<b>Potential Issue</b>	<b>Potential Implications of Status Quo</b>	<b>WETAG Proposals</b>
<b>11</b>	<p><b>Regulation FCAS Services and Cost Recovery</b></p> <p>There is a question as to whether the short term variability of wind farms could lead to increased regulation FCAS requirements</p> <p>There is a further question of whether current 'causer pays' funding arrangements apply appropriately to wind farms.</p>	<p>NEMMCO currently has obligations and powers to procure the necessary amount of regulation FCAS to meet frequency control standards. Operational modelling and continual monitoring by NEMMCO will reveal any necessary changes to requirements.</p> <p>'Causer pays' funding arrangements currently apply only to Market Generators that have appropriate metering (i.e. real time operational metering) installed. This arrangement is vague, and could lead to resistance from some market generators to the installation of real time operational metering.</p>	<p>WETAG has not identified any need for policy level changes to the procurement of regulation FCAS, as current Code provisions allow NEMMCO to procure adequate services.</p> <p>It is suggested that 'causer pays' funding arrangements be clarified to require that all significant Market Generators (eg those &gt;30MW in total capability) participate in the causer pays process. This would remove the uncertainty about participation stemming from the reference to appropriate metering in the current Code provisions.</p>
<b>12</b>	<p><b>Information Disclosure</b></p> <p>Current generation information disclosure provisions relate primarily to scheduled plant. With the likely increase of non-scheduled plant there may be merit in the disclosure of additional information to facilitate the market.</p>	<p>The increasing incidence of non-scheduled generators raises the question of whether specific forecast and operational information should be published for those plants, similar to the information disclosed for scheduled generators.</p> <p>Additional information would increase the ability of scheduled plant operators to adapt to the operation of non-scheduled plant. If semi-dispatch arrangements are adopted for constrained operation, then it will be imperative for similar information to be disclosed for all plant that is involved in the dispatch process.</p>	<p>WETAG suggests that there may be merit in providing for the disclosure of additional information along the following lines for significant non-scheduled generating plant. This matter may need to be given further consideration when the functionality of the wind farm forecasting facility planned by AGO become clear. Further, some WETAG members consider that additional information regarding non-scheduled generation should be released as soon as possible as interim measures.</p> <ul style="list-style-type: none"> <li>- predispatch and ST PASA: Forecast aggregate non-scheduled generation for each region for each trading interval;</li> <li>- MT PASA: Forecast aggregate non-scheduled generation for each region;</li> <li>- After the event: Actual generation, dispatch targets and offers where relevant.</li> </ul>
<b>13</b>	<p><b>Forecasting wind generation</b></p> <p>Forecasts of the generation expected to be available from wind farms and other non-scheduled plant will be an essential input to demand forecasts used in dispatch, predispatch, and PASA.. Such forecasts are not yet available.</p> <p>This matter is being progressed outside of WETAG by Australian Greenhouse Office (AGO).</p>	<p>Forecasts of wind farm generation levels are important for the operation of the power system, for the management of supply reserves, and also for the market, to support the accuracy of forward spot market information.</p>	<p>AGO is administering a federally funded initiative for the development of a centralised wind generation forecasting capability that will service Australian electricity markets. This initiative is being managed outside the WEPWG / WETAG process.</p> <p>WETAG noted that pending delivery of the AGO's forecasting system, NEMMCO is undertaking interim measures to derive forecasts of wind generation for some critical market processes. These interim processes will necessarily be simple in nature.</p>

## **2. Introduction**

The Standing Committee of Officials established the Wind Energy Policy Working Group (WEPWG) in mid 2004 to consider the range of policy level issues associated with the anticipated entry of large amounts of wind generation into the NEM in the coming years.

Many of the issues that need to be considered have their roots in technical matters relating to the emergence of large-scale wind technology, as outlined in an earlier paper published by NEMMCO in March 2003. Accordingly, the WEPWG requested NEMMCO to establish the Wind Energy Technical Advisory Group (WETAG), to undertake fact finding and analysis on their behalf. The WETAG, which has representation from all industry sectors including wind farm developers, has prepared this paper at the request of WEPWG to assist in their efforts to identify and address relevant issues. A full list of WETAG members, and the industry sector they represent appears in Appendix B.

Large amounts of wind generation have not been considered in the current National Electricity Code. Code provisions, including those relating to central dispatch, and those that guide the technical attributes of generating plant, effectively assume that only very small amounts of wind generation would be present, and that such small amounts could be largely ignored. That assumption has remained valid until recently, however, it is now evident that significant amounts of wind generation are about to be seeking connection to the NEM network in the very near future. In particular, 400MW is currently under construction in South Australia and likely to be fully operational before the end of 2005<sup>1</sup>, and approximately 200MW in Victoria is in a similar state of preparedness. A future 600MW in SA is likely to be seeking generation licences in the very near future.

This rapid increase in wind generation projects highlights the need to review some market arrangements with the aim of integrating the new technology and ensuring the Code is appropriately adapted to the changed circumstances. Developing a detailed understanding of the impact of wind energy on the market and its implications for network management and generation patterns is imperative. Such an understanding can then form the basis of any necessary financial arrangements and preparing amendments to current operating procedures and the Code as soon as possible to facilitate future integration.

## **3. Purpose and Structure of this Paper**

The primary purpose of this paper is to provide the scope and groundwork for WEPWG's consideration of policy level matters that need to be addressed to integrate potentially significant amounts of wind generation in future years. It is anticipated that the paper will form the basis for WEPWG's review of technical matters and to carry out industry consultation of wind related issues.

Section 5 of the paper describes each of the potential issues considered by WETAG. In each case, the nature and scope of the potential issue is described, including where possible, a qualitative description of the materiality of the issue. Likely consequences of not addressing the issue, are then discussed, followed by a high level discussion of possible options to progress the matter. In the case of some issues, WETAG has proposed a specific set of policy options for WEPWG to consider following broader industry consultation. In other cases, measures are suggested to allow future remedial action to be taken on a case by case basis if issues are demonstrated as material. Matters have also been identified where WETAG does not currently consider any change to be warranted.

It should be noted that the discussion in this paper is largely qualitative. This has been intentional, due to the early stages of wind development in Australia, the short period of time

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<sup>1</sup> See ESIPC status report (December 2004) in Appendix B.

during which this material has been assembled, and the high level policy focus of the exercise. It is recognised that a degree of specific modeling or research may be needed in some areas in order to identify or refine some of the policy directions that emerge as this work progresses. It is intended that this paper should provide a useful focal point for identifying and structuring such future work. It is also recognised that the operational implementation of any changes that emerge will require detailed development once broad policy directions are clarified.

#### **4. Forecasting**

The matter of wind generation forecasting is important to the operation of both the power system (for the management of supply reserves) and the market (to support the accuracy of spot market forward information). Initiatives in this area are being managed by the Australian Greenhouse office (AGO), outside the WEPWG / WETAG process, and AGO has supplied the following information in that regard.

The Australian Government recognises that increasing the penetration of wind energy poses challenges in managing the balance between supply and demand in the electricity markets. To facilitate the increasing use of wind power, the Wind Energy Forecasting Capability (WEFC) initiative was announced in the Australian Government's Energy White Paper "Securing Australia's Energy Future" in June 2004. Under this initiative, up to \$14 million will be provided to assist the development and installation of a wind generation forecasting capability for Australian electricity markets.

The Australian Government considers that there are significant benefits for both wind industry development and electricity market management in adopting a centralised forecasting model. A centralised model will enable more accurate forecasting without unnecessary cost duplication and is expected to increase the value of wind energy to customers.

The Australian Greenhouse Office, within the Department of the Environment and Heritage, is administering this initiative in conjunction with the Department of Industry, Tourism and Resources (DITR). Development and implementation of the wind energy forecasting capability, as an Australian Government initiative, is separate from Ministerial Council on Energy processes including the Wind Energy Policy Working Group (WEPWG). However, in light of their complementary nature, the WEFC and WEPWG initiatives will regularly share information during their parallel development.

WETAG noted that pending delivery of the AGO's forecasting system, NEMMCO is undertaking interim measures to derive forecasts of wind generation for some critical market processes. These interim processes will necessarily be simple in nature and are being implemented within NEMMCO's operational role.

#### **5. Technical Issues Considered by WETAG**

This section discusses potential technical or commercial issues related to the integration of wind energy into the NEM.

Each section below describes a particular technical or commercial issue that may possibly become material if significant amounts of wind generation emerge in the NEM. Each section also considers the potential implications of leaving current market arrangements in place as wind generation increases, and identifies possible way(s) of averting the issue, or addressing it at an appropriate time and in an appropriate way. Where relevant, various options are presented for consideration.

Following on from the description of the technical issues and potential ways forward in section 5, section 6 then distils the policy considerations that WETAG has identified for

consideration by WEPWG. While it is anticipated that WEPWG will use the issues and options identified in this paper as a basis for consultation with industry stakeholders before committing to any proposals going forward, the amount of wind generation planned for some parts of the NEM necessitates urgent action in respect of some issues. WETAG has identified issues as urgent where appropriate.

## 5.1 Network Management issues

Network constraint equations are employed in the central dispatch process to control the dispatch targets for scheduled generation so that network loadings remain within operational limits. Wind generation is generally registered as non-scheduled. In such cases, current Code provisions do not require it to participate in the central dispatch process, so that it is not required to control its output to assist in the control of network flows. If the central dispatch process does not manage all significant generating plant that can affect network loadings and transfer limits then the network may become overloaded or its technical limits infringed.

Current Code provisions assume that the level of non-scheduled generation is minimal and that the network can be managed through adjusting scheduled plant loadings to control the network flows to within operational capabilities. It is quite plausible for there to be parts of the network that may contain only non-scheduled wind farms. In a network area with an over supply of generation from wind farms, there would be no control of excessive network flows by controlling scheduled generation under the current arrangements - e.g. the development of the Eyre Peninsula in South Australia. In this case, the non-scheduled plant would have to operate at a reduced output to avoid network overload. This process cannot be managed through the central dispatch process unless some dispatch obligations are placed on non-scheduled plant.

A related issue is that of “excess generation”. At times when the demand for electricity is very low, such as in the early hours of the morning, excess generation situations may arise where the output of non-scheduled generating plant combined with the minimum economic generation levels of scheduled plant is in excess of demand. The minimum economic generation levels for base load thermal generators is often around 30-60% of capacity unless expensive auxiliary fuels are used to stabilise their boiler operation. When encountered in some European countries with high percentages of wind generation, this issue has resulted in high electricity exports from the country (e.g. Denmark). In the NEM context, exports from one region to another are possible, but only up to the capability of the interconnector between the regions. Once interconnector limits are reached, generation levels in the exporting region(s) must be reduced.

When network limits are reached, it is possible that, over a number of dispatch intervals, the ramp rate capability of the scheduled generation in the area is insufficient and cannot balance the changes in supply or demand of a network area. This may be possible if there is a large increase or decrease in non-scheduled generation in a network area with limited scheduled generation. ESIPC has carried out some preliminary studies to better understand the potential variability of wind generation outputs in South Australia. That work appears in Appendix B, and very significant generation variations can occur.

A common aspect of this group of issues is that if wind farms are required to reduce their output or limit their rate of increase or decrease to control network flows, then the technical ability to provide continuous control should be included in each wind farm design.

### Potential implications of the status quo

There are no adverse consequences with small volumes of non-scheduled generation however, as volumes of wind generation increase, the ability to control the network to within its operational limits is likely to diminish to some extent. The resultant impact on spot prices would be dependent upon whether non-scheduled generators displace high or low cost

generation plant. In most cases, high cost generation plant would be displaced (when the network is unconstrained), but under some network configurations, it may be possible that low cost plant is displaced.

When the network is operating within flow constraints, output from non-scheduled generation is accommodated by changing the loadings of scheduled generators. This is achieved through the central dispatch process over successive 5-minute dispatch intervals and by ancillary services within a 5-minute dispatch interval.

When network constraints are binding, or when scheduled generation is not able to accommodate the variations from non-scheduled generation, NEMMCO would need to control the output from the non-scheduled generation to manage power system security.

Where power system security or reliability is at issue, NEMMCO can issue “directions” (for market or scheduled generators); or, “clause 4.8.9 instructions” (for non-market non-scheduled generators). In the absence of remotely enabled plant control facilities that allow the wind farm output to be limited in real time, there may be uncertainty about the ability of wind generators to appropriately respond to directions / instructions from NEMMCO. The appropriateness of compensation provisions are doubtful as compensation only applies to directions for market or scheduled generators and not to clause 4.8.9 instructions. With directions and clause 4.8.9 instructions intended as safety net mechanisms only, rather than routine operational activities, their regular use for the dispatch of non-scheduled generation would not constitute an orderly or viable long term solution to the issue. In particular, aspects of dispatch would become manual, with attendant issues for consistency and manageability. Commercial out-workings would be lengthy and onerous.

Under existing arrangements, some NSPs are requiring the installation of generation control solutions through connection agreement conditions for wind farms. For example, there are cases where wind farms have been required to install the capability to limit their output on request from the NSP to manage local network flows. Clearly, such arrangements are not required by the Code, nor co-ordinated with the central dispatch process and will therefore not be reflected in market forecast processes managed by NEMMCO. The means of deciding which generators are required to reduce output levels is outside the central dispatch process and may be on the basis of such mechanisms as “first in”, proportional to nameplate rating, or perhaps some other method. These arrangements deliver an ability to manage network flows for the NSPs, however, introduce complexity for wind developers through potentially different approaches being adopted by each NSP. Some WETAG members expressed the view that rationing of network capacity should be undertaken on a common basis across the NEM. It is desirable to have NEM wide common arrangements for the dispatch of plant rather than different arrangements being possible at different locations in the NEM.

Uncertainty may also be an issue as additional wind farms connect to local network areas. Unless these decentralised processes are linked in some way to NEMMCO’s central dispatch process, the dispatch of scheduled generating plant, and the forecasting or setting of spot market prices cannot take the local control actions into account.

If the main transmission system is involved, NEMMCO can issue directions / instructions as described above, including to NSPs, but again the effectiveness would be dependent upon the non-scheduled generation being able to respond to the directions or instructions through the installation and operation of appropriate control facilities with a short response time. Such an arrangement would also be difficult to manage as discussed above, and thus increase risks for all parties. This contrasts with the central dispatch process being used to co-ordinate other significant generation sources on a 5 minute basis.

Resolution of the above issues is important to ensure effective management of power system security. Australia is not alone in consideration of network management issues related to the emergence of significant wind generation. ESIPC is finalising for release a draft version of an

international benchmarking report prepared by Garrad Hassan detailing the status of wind generation related issues in six countries<sup>1</sup>.

### **Possible Way Forward**

When network constraints are not binding, these issues do not arise, and no countermeasures are required. It may therefore be reasonable for any proposed solutions to be applicable only at times of binding network constraints.

In this context WETAG considers it inevitable that significant non-scheduled generation plant will need to be controlled to reduced outputs in cases where network loading constraints become binding. There is merit in determining the acceptable loading level limits of non-scheduled generating plant using the central dispatch engine, particularly for any plant that is greater than 30MW in size.

This approach would determine the maximum output of the relevant non-scheduled generation for the next dispatch interval using the central dispatch process, as is the case for scheduled plant, using constraint equations to keep network flows within limits. Dispatch targets of maximum generation would be sent to wind farms when network constraints are binding. This option may be characterised as a form of “semi-dispatch”:

- This option may require the submission of dispatch offer prices for relevant non-scheduled plant so that the dispatch engine has a basis for co-ordinating plant loadings. The use of default or deemed submission prices may be an option;
- For this approach to be effective, constraint equations would model the relevant generating systems as controllable – i.e. on the “left hand side” of constraint equations;
- Communication and control facilities would need to be installed and operated to ensure that the dispatch instructions can be implemented. Obligations to install such facilities may be best managed through Code obligations such as technical standards (see section 5.8), but installation may not be necessary until some future time as discussed in section 6.1.

The above approach would also allow pre-dispatch forecasts to foreshadow the operational requirements of the generating systems concerned, and to reflect it in associated forecasts for both scheduled and significant non-scheduled plant. This is an important consideration for effective operation of the market as a whole.

Information is yet to be gathered on the incremental cost and capability of suitable control systems, but it is important to note that this will vary, and most likely reduce through time. A focussed investigation of this type may be warranted as a next step if WEPWG chooses to progress the ‘semi-dispatch’ concept approach further.

WETAG members support an approach where significant non-scheduled generators would only be required to install appropriate control facilities<sup>2</sup> at the time when the network loading issues become material in their network area. With an appropriate notice period, non-scheduled generators would have to comply with an obligation to install control facilities and participate in the semi-dispatch arrangement described above. This would allow non-scheduled generators to consider the technology of control facilities and the time of installation commercially. It would also allow technical design considerations to be included in initial feasibility assessments by wind developers and appropriate technologies could be assessed at the outset of wind generation projects.

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<sup>2</sup> Such control facilities would allow wind generators to automatically receive and respond to dispatch targets from NEMMCO.

Any obligations in relation to control schemes required to address this issue would need to be accompanied by appropriate provisions for existing plant, which may not have been designed or committed with such obligations in mind. In some cases, existing control arrangements may also be in place as a result of connection agreements with NSPs.

In order to address the management of network loading issues, WETAG members consider that the current NEM arrangements are inadequate to cater for the management of network congestion as the amount of non-scheduled wind generation increases. In particular, reliance on the market provisions of last resort, such as directions, are considered to be inappropriate for what may become a routine market situation.

The introduction of new dispatch obligations for non-scheduled plant would represent a change to the market, and would change the risk profile for those investing in wind farms and other generation. Accordingly, any changes of this type would require policy support.

### **Potential Interaction with the proposed CSP/CSC Mechanisms<sup>3</sup>**

In considering this issue, it is noted that recommendations currently being considered in respect of the MCE's Region Boundary Review could have implications for wind generation.

In particular, proposals involving the CSP/CSC mechanism appear to rely upon the allocation of financial network rights to market participants likely to have their dispatch impacted by a network constraint. In further investigating those mechanisms, it will be important for jurisdictions to also consider the interaction of the proposed CSP/CSC mechanism with non-scheduled generation, particularly wind generators and the fairness and impact on NEM investment of any allocation process.

## **5.2 Short term variability**

This section focuses on the impact that sub five minute variations in wind farm output may have on network loadings. Sub five minute variations currently occur in network flows due to variations in large loads, and due to unexpected variations in other generating plant outputs. NEMMCO's 5-minute dispatch process cannot control sub 5-minute variations on the power system. Network constraint equations currently make allowance for these variations by inclusion of an operating margin in the calculation of a network constraint limit.

Variations in the output from wind farms at the sub 5-minute dispatch interval level will also appear as variations in the flow of electricity on transmission or distribution lines combining with other power flow variations. Sometimes this will add to and sometimes it will subtract from the general load variation, however if the overall amount of variation increases such that it is significant, then the amount of operational margin included in the definition of a network limit may need to increase.

The issue of wind farm short term variations only has the potential to be material to network flow management when constraints due to network transfer limits are binding or close to binding. At other times, the issue is not material to network flow management, so that net variations would manifest as frequency deviations and be addressed through the regulation of power system frequency – see section 5.11.

A better understanding of materiality of this issue will emerge with experience as wind farm developments are installed and through the power system operational modelling being carried out by ESIPC to extend the modelling presented in Appendix B to shorter timeframes and by NEMMCO (see section 5.3). Furthermore, short term variations on the power system that occur due to other causes such as the natural variation of system load may also need to

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<sup>3</sup> "Constraint Support Pricing / Constraint Support Contracts - See SCO consultation paper on Region Boundaries at: [www.mce.gov.au](http://www.mce.gov.au).

be monitored to ensure that variability outcomes are not automatically fully assigned to wind energy.

It has been suggested that the potential for this issue may reduce if automatic advanced control systems were required for wind farms as a solution option to address other issues such as network constraints – see section 5.1.

### **Potential implications of the status quo**

In the event that variability becomes material, then it is likely that NEMMCO and NSPs may need to reduce network transfer limits for affected areas of the network or introduce a new ancillary service. This would in turn reduce the utility of existing network assets, and would give rise to a potential trade off between introduction of reduced network limits, and controlling the output of wind farms to reduce their variability.

### **Possible Way Forward**

Perhaps the most important step going forward with this potential issue will be to collect data to better understand its likely future materiality. Such a study would need to be carefully specified to take account of the limited data currently available from wind farms, in better informing likely future implications of variability. Key areas of focus would include an understanding of the extent to which statistical diversity affects the issue, and the likely materiality of wind farm variations compared with demand variations. Work here undertaken by ESIPC (see Appendix B) is being extended to shorter timeframes with this aim.

Another factor that will affect variability will be the type of wind turbines that form the majority of wind generation on the system. Newer wind turbines that employ more advanced technology in their control systems can maintain a more constant power generation for a wider range of wind speeds. This will translate to more wind energy with greater constancy. However, studies are required to establish the affect of sub-five minute variations in power flows.

Two potential approaches have been identified to address this issue. The broad decision of which option would be used in the event of a material issue emerging may be one of policy. Early knowledge of the option, and of the circumstances in which it would be used, is crucial for investors as it informs their investment decision. The broad options are outlined below. The group anticipates that it would be necessary to invoke countermeasures of this type only if the impact of variability during constrained operation became material:

- **Ancillary service** - Introduce a new ancillary service to offset variations from significant wind farms. This option could introduce complexity into the market and may be viable in some network areas where other facilities, such as regulating generation capable of compensating the variations are available. NEMMCO would need to carry out further detailed analysis to better understand whether this option can be effective in practice for resolving short term variations on network loadings. Effectiveness of the ancillary service would be influenced by the distance between the wind farms and the scheduled generation required to provide the compensation. Funding of the ancillary service would need to be carefully considered.
- **Regulation of net impact** – An approach that would require significant wind farms to reduce or remove the effect of short term variations once the variations reached a materiality threshold. The method of reducing variations would be left to the wind farm generators to determine and implement under commercial considerations. This could entail either modifications to the plant design through new or modified control systems, contracting other generating units to provide compensating output, or other means.

Note that if the wind farm chose to contract other generating units for a compensating service, such arrangements would amount to a local implementation of the ancillary service option considered immediately above. WETAG members support an appropriate notice period would apply for the realisation of countermeasures.

WETAG also discussed the potential for targeted R&D incentives. Whilst this would not address short term management issues for the integration of wind farms, it would foster further developments and encourage leading edge technologies associated with wind farms such as control systems or energy storage to manage output variability. These would be outside the NEM arrangements and would not require any changes to the Code or NEMMCO procedures.

WETAG considers that the above options should be considered by WEPWG to identify a way forward.

### **5.3 Modelling of Power System Operational Implications**

Rapidly increasing amounts of wind generation capacity are already being connected to some parts of the Australian power system. For example, the greater than 400MW of wind generation expected to be operational in South Australia by late 2005 represents approximately one third of the region's minimum demand. A further 600MW of proposed wind farm developments is understood to be in the advanced planning stages – see Appendix B.

It is yet to be determined at what stage of investment particular features of wind generation discussed in this report will introduce the need for special operating strategies to maintain overall power system security. For example, variability, non-scheduled status in conjunction with network constraints or low demand periods, or particular technical characteristics may be of little consequence when small amounts of wind generation are present, but may need to be actively managed at higher levels of wind generation.

Studies to determine the sensitivity of the network to increasing amounts of wind generation have not yet been carried out. While NSPs must consider the connection and local implications of wind farms, the broader power system security implications require urgent consideration in the context of such matters as power system stability, plant inertia, overall generation dispatch and ancillary service requirements.

Studies to better understand these issues should reveal the level of wind generation at which special operating conditions, such as reduced transfer limits, or long periods of operation at reduced generation levels, may become necessary and for what reason. Studies and outcomes are likely to be location specific, so that studies relating to South Australia are unlikely to be applicable to other locations such as Tasmania or Victoria. It is therefore important that any such studies are prioritised. It will also be important to ascertain from such studies whether plant inertia is likely to become a critical factor, and if so, under what circumstances.

Initial studies of this type are now urgent. NEMMCO has commenced work in this area independently with a target for initial results in Q1 2005. Any special operational or plant related arrangements must be identified with adequate advance notice to allow the findings to be taken into account in investors' decisions. South Australia and Tasmania in particular are locations that are likely to warrant priority attention in this area. However, some studies rely upon the availability of robust generating plant models of the type discussed in section 5.9 of this report.

#### **Potential Implications of the Status Quo**

It is very important for both power system operators and generation developers to be aware of any special connection or operational arrangements prior to committing to firm

agreements. If this is not the case, the need for special arrangements could become apparent after designs are finalised, or even later through operational experience. Both outcomes are undesirable, as they can result in unforeseen expenditure or power system operational implications.

Prospective power system operational studies would inform licensing and connection negotiations so that outcomes of those processes are robust. As licensing and connection negotiations can take place a year or more in advance of construction, the timing of any power system operational studies will need to be further advanced again – perhaps of the order of two years in advance of potential wind farm construction. It is this element of timing that renders studies of this type to be urgent at this time, at least for South Australia and possibly for Tasmania.

### **Possible Way Forward**

NEMMCO and ESIPC are currently endeavouring to obtain suitable wind farm modelling data to support operational studies of the type described in this section. Proven wind farm technical models will be a necessary input to studies relating to power system stability, but are not yet available for the reasons discussed in section 5.9. NEMMCO is currently seeking technical advice on the derivation of a suitable model structure pending resolution of these issues at policy level. Wind farm production data is another necessary input, including data reflecting realistic production variability across potential future wind farms and across the frequency spectrum from a few seconds to the daily cycle. ESIPC is currently taking steps to derive variability data for use in South Australian studies.

Once the required data is available, NEMMCO intends to carry out operational studies initially for South Australia, to determine what level of wind generation is likely to introduce the need for special operating arrangements. A target for completion of initial NEMMCO results in this area is Q1 2005.

NEMMCO and WETAG consider this area of investigation to be urgent and the potential for operational implications to emerge should be noted and foreshadowed by WEPWG.

## **5.4 Network connection of large scale wind farms**

The network connection process and procedures are detailed in clause 5.3 of the Code and define a sequence of enquiry, response, application, offer to connect and finally a connection agreement. The Code identifies specific requirements with each step with a focus on information to be provided by proponents and network operators, response times and commitments, allowable fees and the lodgement of a connection application. The Code then requires an offer to connect to be made in response to a submitted application.

The changeable nature of wind farm projects in their design specification and feasibility stages has highlighted difficulties with the above Code arrangements. The key issue at hand is that some NSPs and generation developers are finding that some aspects of the existing network connection arrangements in the Code to be unclear, particularly in respect of how a final project proposal for the submission of a complying “application to connect” is derived and how the NSP should recover the cost of investigation of various connection options for potential developers.

Depending on the advice NSPs receive in respect of the current provisions, it appears that they may or may not consider it legitimate to charge for investigations that take place prior to a formal connection application being finalised and lodged. This has the potential to hinder the progress and effectiveness of connection studies.

## Potential implications of the status quo

Whilst the Code clause above presents a logical procedural sequence of steps, application of the Code to project developments has illustrated a number of compliance issues in attempting to match the project's requirements and options to a reasonable connection arrangement in terms of technical, financial and timing issues. This is particularly so for wind generation projects where the project capacity can be readily varied by adding or subtracting generating units, changing the nominated individual machine sizes and characteristics and redefining proposed operating parameters.

The likely grouping of projects by different proponents with different and competitive agendas, the need to construct new connection assets involving multiple property owners and the various approval obligations can further complicate this issue for NSPs.

The above issues result in some NSPs being reluctant to progress the analysis of connection options for new developments due to uncertainty as to whether they can recover the costs concerned. This can act to delay or prevent the progression of connection investigations, or alternatively result in inefficient management of analyses.

## Possible Way Forward

It has been suggested by WETAG NSP members that the Code should be changed to focus on the enquiry stage of the process rather than the application stage to avoid the above problems. This approach would clarify the connection procedures by encouraging development of an initial project and connection concept to a firm proposal for a connection application. This often requires an iterative approach with initial network studies to indicate constraints and options. An offer to connect and connection agreement should then be able to be readily finalised for a project.

The following variations to the network connection procedure for new generation plant have been suggested as a means of addressing this issue:

- Preliminary enquiry: The proponent advises the NSP of a project interest and discusses connection feasibility;
- Formal enquiry: The proponent confirms an indicative project proposal and the NSP responds to confirm connection option/s, general study requirements and associated fees to develop a preferred project option;
- Connection application: The proponent submits the preferred project for connection and completes detailed connection studies;
- Connection offer: The NSP confirms a connection proposal and terms for the agreed project;
- Connection agreement: The parties finalise and sign the agreed connection document.

As this proposal effectively amounts to clarification of the current Code provisions to make them clearer in their effect, and more efficient in their application, it may be appropriate for the affected participants to propose a clarifying Code change to address the issue. There may be little or no need for policy level endorsement prior to initiation of such an initiative.

## 5.5 Islanding

It may be possible that following certain network or generation contingencies, parts of the network may be separated from the remainder of the network. At the largest level, NEM regions may be separated from the rest of the NEM, whilst at a smaller scale, some radial areas of the network could be separated. In the event that the separated areas have roughly balanced generation and load, functioning "islands" can arise in the power system.

It may not be possible for NEMMCO to manage the system frequency through the central dispatch process and voltage in islands if non-scheduled generation or generation with limited frequency control capability forms the major or only generation supply for an island. It is the increasing potential for islands of predominantly non-scheduled generation that makes this issue relevant to this paper.

### **Potential implications of the status quo**

The management of power system frequency is achieved by market frequency control ancillary services (FCAS) provided by scheduled generation. Power system security can not be managed by NEMMCO or NSPs for those island network areas where insufficient FCAS is available or for which NEMMCO has not established a specific frequency control system in advance.

If islands are permitted to operate with inadequate frequency control, the frequency of the islanded area may drift away from its nominal value until generation or plant trips off in an uncontrolled manner and the quality of electricity supply to customers being indeterminate.

### **Resolution**

WETAG members consider the management of power system security to be paramount for all market participants. It is considered appropriate that generation, including wind farms, should be disconnected from the system in islanded areas of the network where NEMMCO is unable to manage power system security.

The introduction of a requirement to disconnect generation sources from islanded areas of the network where NEMMCO is not able to manage power system frequency or voltage may be best managed through the connection agreement with the NSP as the NSP will identify appropriate network areas and disconnection arrangements. It may be necessary to amend the Code technical requirements to allow generating systems to be disconnected when islanded.

## **5.6 Contribution of wind energy to system reserves**

The variability and non-scheduled nature of wind farms introduces uncertainty regarding the contribution they may make to meeting the forecast maximum demand over the range of NEM forecasting time horizons.

The reliable contribution to system reserves, and the impact this has on overall generation investment needs is still to be modelled in detail for operational and planning timeframes. Operational modelling carried out by ESIPC and NEMMCO (see section 5.3) will assist in this regard, but has an operational rather than forecasting focus.

Two key considerations emerge in determining the contribution to reserves made by wind generation. Firstly, in the long term planning sense, the NEM relies on transparent assessment of the supply demand balance to induce appropriate investment in generation. This depends on appropriate plant (peak/intermediate or base load duty) being enticed to the market in pursuit of commercial opportunities at a time the market is in need of additional supply to meet reserves. Secondly, the Code provides for a “reserve trader” function whereby NEMMCO is able to contract for reserve plant in the event that medium term (up to 6 months ahead) system reserves are insufficient. This has occurred for example in respect of forecast low system reserves for summer 2004/05 in Victoria / South Australia. An understanding of the contribution of wind generation towards meeting system reserves will be pivotal in both these assessments in the future.

In the longer forecasting time frames (greater than a week) expected generation from wind farms can be undertaken through statistical analysis of historical generation data. This type of data analysis generally produces probabilistic assessments of average wind farm

generation or energy production which are useful in answering the following critical power system reserve related questions:

- “How much wind generation (MW) will be produced in a region at the time of peak demand in summer and winter (for the next 10 years)?”. This corresponds to assessments made in the annual NEM Statement of System Opportunities (SOO) ; and,
- “How much wind generation (MW) will be produced in a region at the time of peak demand each day (for the next 2 years)”. This corresponds to the timeframe applicable to MTPASA.

When reliability based network augmentations are considered by proponents, a view will need to be taken on the contribution to local supply from non-scheduled generation at the time of local peak demand. This assessment will become increasingly important for proponent’s commercial assessments as the volume of non-scheduled generation in an area increases.

### **The way forward**

The materiality of this issue is under active investigation in Australia where early indications have shown an expectation that 15%<sup>4</sup> of the installed capacity of a wind farm in South Australia can be relied upon to contribute to meeting peak demand in a planning sense.

NEMMCO has also made allowances for wind generation in its SOO but the manner in which this allowance is made will need to evolve as additional data becomes available.

The incorporation of wind generation reliability into energy reserve assessments is arguably a task that NEMMCO can undertake within its existing powers under the code and NEMMCO internal procedures on a continual improvement basis. This requires no code or policy changes, but may result in the disclosure of additional information to ensure transparency. The development of wind forecasting is discussed in section 4.

NEMMCO will develop and continually refine routine procedures to estimate the reliability of wind farm sources in meeting demand for various geographic areas and timeframes, taking account of a number of factors including: Individual wind farm generation patterns; Impact of geographic diversity for wind farms; and, the impact on network transfer limits.

The way in which wind generation is considered in reliability based network augmentations will be a matter for proponents to consider.

## **5.7 Optimising shared network assets at the design stage**

The nature of wind as a potential major renewable electricity generation resource means that viable wind farm sites are likely to be clustered in rural regions that have limited local electricity network service assets. As such, significant network extensions are sometimes required to link the potential wind farm site/s to the existing distribution or transmission networks which in turn may require augmentation to provide the needed grid connection transfer capacity.

Current arrangements tend to support the development of connection assets for each particular generation development individually, so that after a period of time, the end result may be quite different from a design that considered the collection of likely generation developments the eventually emerged. Achieving an optimal engineering design for new and existing network assets to facilitate the connection of significant amounts of wind generation can be a major challenge where multiple proponents are involved. While this is not

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<sup>4</sup> See ESIPC status report contained in Appendix B.

specifically a wind issue, and would apply to any network with clustered generation projects, it is likely to be more evident for wind farm connections which are likely to be clustered in areas of good wind resources.

Discussions in WETAG revealed a broad range of views on this issue, which links to core issues of network funding, and augmentation arrangements. Furthermore, any consideration of a way forward on this issue will inevitably encounter matters of policy in respect of the degree to which potential generation resources are to be harvested. In view of this, and the clear policy implications, WETAG seeks only to articulate the issue in the context of wind generation, to facilitate its further consideration at policy level. Issues identified by WETAG include the following:

- There is no regulated or Codified methodology by which an NSP can seek to optimise connection solutions for a group of applicants.
- There is no low risk methodology available to an NSP where it can fund initial excess capacity that has the potential to provide a more appropriate and cheaper solution for a number of connection applicants. The risk for an NSP of adopting such an approach, combined with the lack of potential commercial upside, make it unlikely that an NSP would be willing to undertake such investments.
- Existing processes to deliver network assets in order to connect new generating systems (including wind farms) are generally designed around a single applicant and the provision of a specifically designed single applicant connection solution.
- There are no regulatory barriers preventing a number of project proponents forming a consortium proposal to develop shared network assets. Some WETAG members have indicated that this option may not work due to commercial, project timing and legal drafting issues.

Precedents for the wider transmission investment environment may need to be considered by policy makers in relation to any changes in this area specifically to facilitate wind energy development.

### **Potential implications of the status quo**

If the wind generation resource in some geographic areas is to be developed, then network augmentation for connection of the new developments is often a key part of the process. Clearly, the design of any necessary network connection assets would have the best chance of being optimal if all of the ultimate generation was catered for in the design, rather than augmenting the network for each subsequent generation development.

There is a question however, of whether such an optimal network design for multiple generation developments is the objective, or whether each generation development should assess the full implications of construction. This is a general question for policy makers to consider.

In terms of the status quo, unless specific measures are put in place there is likely to be a tendency for connection augmentations to be considered sequentially. The following considerations may be relevant:

- Facilitating consultation and cooperation between the involved parties (developers and NSPs) is difficult where commercial confidentiality constraints apply, project timings may differ and developers are focused on protecting their opportunities and potential liabilities;
- Environmental impacts of network connections can be significant and increased by a non-optimal arrangement. Public interest and reaction can high in such cases;

- Electricity network service providers are constrained by Code, regulator and shareholder requirements. Although it may be possible for an NSP to ‘underwrite’ a prospective connection development, such action would contain elevated levels of commercial risk for the NSP, such as the potential of stranded assets and raises the question of NSP roles;
- Facilitation of optimal connection designs may require development of an “ultimate” network development plan that could accommodate the likely level of generation with reasonable staging and designated responsibilities. Defining such a plan would require specific centralised planning or appropriate regulatory regimes to allow NSPs to take commercial risk in exchange for potential reward. The appropriateness of such an approach is clearly a matter for consideration at policy level;
- While the status quo may not lead to an optimum network design, the costs of any network augmentation are borne in the first instance by wind farm developers with no risk of stranded network assets.

Some measures are understood to have been progressed in Victoria to facilitate new network connections. There may be merit in considering those measures to assess their relevance to this matter.

### **Possible Way Forward**

Discussion within WETAG indicated a broad range of strongly held views on this matter, ranging from concern about any form of central optimisation as it would represent an intervention in the market process, through to support for prospective regulated funding of anticipated optimal shared connection assets.

WETAG suggests that this issue be further developed. Clearly such work would need to take into account other policy issues such as wind energy targets in each state and the role of NSPs.

## **5.8 Technical Standards**

The Code specifies technical attributes of generating plant that must be satisfied before approval will be given for the plant to be connected to the network. Standards are in general laid out in schedule 5.2 of the Code, and relate to matters such as:

- Voltage control capability; (Code clauses S5.2.5.1 and S5.2.5.13);
- Disturbance ride through; (Code clauses S5.2.5.3 and S5.2.5.4);
- Stability behaviour and protection; (Code clause S5.2.5.10, S5.2.5.8, and S5.2.5.9);
- Response to frequency deviations (Code clause S5.2.5.11); and,
- Reliability impacts of new connections (Code clause S5.2.5.12).

WETAG is of the view that the broad framework within which the current technical standards provisions reside, is appropriate and workable for the NEM, and can be applied to emerging technologies. That framework is based upon the use of minimum, automatic and negotiated standards that provide bounded flexibility to accommodate the varying connection conditions that need to be applied at different network locations. Significant issues were identified however, with specific provisions of the framework, the consistency with which the framework

is used in the Code, and applicability of the standards to new technologies such as wind generation.

Many of the technical standards have been reviewed since market start, but their application to wind generation is inappropriate, unclear or absent in a significant number of cases. Clarification of the Code can address a range of uncertainties presented by wind generation. These uncertainties arise from a range of issues, including the following:

- Some standards refer to synchronous machines, whereas wind generating units are often non-synchronous;
- Some standards refer to scheduled generators, whereas wind generating units are often non-scheduled;
- Some standards refer to transmission connected generators, whereas wind generating units are often distribution connected.

Some provisions of the technical standards may also be overly prescriptive, and may therefore result in excessively onerous technical performance requirements, for example the requirements for overvoltage tolerance in clause S5.2.5.3 of the Code makes no provision for a negotiated standard for situations where the default requirements may not be necessary.

An over-arching structural issue has also become apparent with the technical standards provisions of the Code, where Clause 5.3.4A provides NEMMCO and NSPs with a power to reject applications for connection that do not satisfy standards relating to power system security or quality of supply. One standard in particular however, appearing in clause S5.2.5.12 of the Code, arguably seeks to ensure that new generation connections “do no harm” to the reliability of a region. Clause 5.3.4A may therefore need to be broadened to also cover reliability.

Although there is a “do no harm” concept for the connection of new generating units in the Code in relation to network transfer limits based on power system stability (Code clause S5.2.5.12), there is no similar provision for network transfer limits based on other security criteria such as thermal ratings or power system inertia. This is a general issue for new connections, and is not specific to wind generation.

Resolution of these matters will require the involvement of policy makers as it encounters areas of technology neutrality, equity for incumbents and new entrants, and clarification of the ultimate objectives of the technical standards.

### **Potential implications of the status quo**

A number of technical standards are drafted in a way that does not apply or cannot be applied to wind generation. While the amount of wind generation connected to the network is small, the impact of those anomalies is localised or manageable. However, as wind generating systems become larger and greater in number, it is increasingly important that appropriate technical standards are applied at the time of connection.

Failure to apply robust technical standards could result in the emergence of issues in areas such as the following:

System security – eg it is important that all generating systems are tolerant of certain levels of disturbance on the power system to avoid cascading events;

Supply reliability – eg if the Code provisions (such as S5.2.5.12) aim to ensure that new connections do not reduce supply reliability, it is important that these provisions operate clearly and effectively to all major new plant (Clause 5.3.4A);

Quality of supply – eg the voltage control capability of plant that has varying output can impact on local supply quality.

### **Possible Way Forward**

Preliminary industry discussions on this topic, carried out through the WETAG, indicated a high level of industry support for the issue of technical standards to be addressed urgently in the first instance, and subsequently in an ongoing evolutionary way.

The need for urgent action arises from the uncertainty currently being faced by wind farm developers, network service providers and NEMMCO, for wind farm connections that are currently taking place, or are about to occur.

The inevitable future emergence of other technologies, and the difficulty of ensuring that the standards cover all possibilities, has led to the suggestion of an additional ongoing review process that aims to keep the standards relevant.

WETAG has identified the following proposal to address the technical standards issue in the immediate and ongoing timeframes:

### **Ensuring appropriate Code technical standards**

- The Code could be changed to require an appropriate NEM institution to routinely review the relevance and effectiveness of the technical standards that appear in schedule 5.2 and Chapter 5 of the Code:
- The party would be required to carry out the review in consultation with all industry stakeholders, including developers or manufacturers of potential new technologies;
- A set of principles would be established to guide the review. Suggested principles have been developed by WETAG for consideration and are set out in Appendix A;
- The party undertaking the review would be required to report to an appropriate NEM institution on the outcome of the review, which may include proposals to change standards where a deficiency or potential deficiency has been identified.
- Do no harm: Generalise the minimum requirements of Code S5.2.5.12 to require that any new connections will cause no net reduction in transfer limits into the importing region as a result of other power system security criteria such as thermal constraints or power system inertia (in addition to stability constraints). Existing Code arrangements considering impacts of new connections transfer limits only consider exports from the region in which the generator is located. This approach would address the current lack of symmetry when considering the impact of new generation connections on transfer limits.

### **Clear requirement for immediate review of technical standards**

Due to the urgency of progressing this issue, and the high level of stakeholder support that has been identified within the WETAG membership to date, Jurisdictions (via WEPWG) may initiate an immediate detailed review of relevant Code provisions with the objectives along the lines of those listed below;

- To recommend detailed changes to the Code so that appropriate technical standards can be applied clearly to wind generation;
- To rectify any other issues with the application of technical standards that have arisen in their application;

- The review would be carried out in consultation with all relevant industry sectors, including wind generation developers;
- Outcomes of the review would be guided by the principles listed in Appendix A;
- The party or parties nominated to undertake this immediate review by jurisdictions should report outcomes and recommendations arising from the review as soon as possible.

WETAG understands that NEMMCO has separately raised this suggestion of an immediate review with SCO, and endorses such a measure.

In taking these matters forward, WETAG has further identified the need to ensure that processes for dealing with existing plant are clear. Specifically, if the technical standards are modified at any point in time, then there is a chance that some existing generating plant may not conform to the changed standards even though it did comply with previous standards. The relevance of this matter goes beyond technical standards, and it is dealt with in the general sense in section 6.1.

## 5.9 Provision of Dynamic Generating Plant Models

Accurate technical models of generation plant are essential for the management of power system security, and for analysis in the planning timeframe.

NEMMCO must have accurate dynamic plant models to support its real time security assessment processes, and to allow the technical implications of new connections to be assessed as part of registration processes.

NSPs use dynamic plant models in network augmentation analyses, in determining accurate network limits that are ultimately advised to NEMMCO for use in the generation dispatch process, and in the assessment of new connection applications.

Network users, including generation plant developers, need generation plant models to undertake feasibility studies prior to developing an application to connect, to perform initial designs for a connection application and to finalise the detailed design of their plant after a connection agreement has been signed. Additionally, the availability of generation plant models fosters transparency of technical assessments, negotiated access requirements and operational requirements by NSPs or NEMMCO, by enabling scrutiny of the assessment or requirements by connection applicants or third parties.

NEMMCO and NSPs are currently facing difficulties in obtaining appropriate models for existing wind farms and wind farm developments because the relevant Code provisions fall short of applying clearly to wind generators. As a result, there is a lack of clarity in the expectations and obligations of NEM participants in dealing with the introduction of significant wind farms (Code clause 5.3.3) and in particular, the provision and usage of appropriate models. Issues include the following:

- **Requirement to provide models is unclear** - the Code does not have general requirements for provision of models for all significant generating systems but rather only requires models for scheduled generating units<sup>5</sup>;
- **No guidance on details to be provided in models** – wind farm technology is an emerging technology. “Standardised” industry model types and model requirements for wind farms are not established – in some cases they comprise very detailed individual wind turbine models, while in others they are aggregated wind farm models.

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<sup>5</sup> See Clause S5.2.4 of the National Electricity Code

It is essential that aggregated generation plant models are available in a suitable structure and of sufficient accuracy to enable power system modelling and analysis by NSPs and NEMMCO.

- **Verification of models** – where a new technology, such as wind generation, is being modelled it is important that models can be verified or tested against the actual power plant to ensure their level of accuracy is adequate, or at least known. There are currently no Code provisions providing NEMMCO the ability to require verification of models, whether through the relevant NSP or directly with the connecting party.
- **Confidentiality** - Generating unit models are defined as non-confidential in the Code: This is understood to have been a deliberate arrangement, to allow prospective investors to carry out investigations as to the detailed design requirements of their plant in the context of the power system to which they propose to connect. In the case of a new technology however, manufacturers have a desire to treat models as confidential so as to protect their intellectual property rights. NEMMCO is currently having difficulty obtaining appropriate models for wind farms due to confidentiality concerns. Note that NEMMCO cannot sign a confidentiality agreement in respect of the generation plant models due to current Code provisions that require publication of the models by NEMMCO.

### **Potential implications of the status quo**

In order to assess new wind farm connection applications and manage online power system security effectively, NEMMCO has required appropriate generation plant models to be developed by proponents as a condition of registration and where necessary has registered significant wind farms on the undertaking that appropriate models are developed and provided to NEMMCO.

The delay in obtaining suitable models is primarily due to the reluctance by wind generation manufacturers to supply non-confidential models to wind farm developers and in turn to NEMMCO and NSPs. In addition, existing wind generation models have been developed at an individual turbine level rather than an aggregate wind farm level. The availability of aggregate wind farm dynamic models from manufacturers is a problem also faced by overseas market operators and NSPs.

In the event that models are not adequately tested to verify that they are a true representation of the physical plant, the power system may respond to events in a way that is unexpected.

These issues can have the following implications:

- NEMMCO uses dynamic models of generating units for on-line security assessment and for security planning. Incorrect or inaccurate models may result in risks to power system security;
- NSPs require accurate models for their own operational planning purposes – for example, for the planning of network maintenance outages or for the determination of settings of protection equipment. Poor models may result in risks of damage to their own plant or that of other network users;
- NSPs and NEMMCO use the models for assessment of connection applications, and NEMMCO uses the information for registration purposes. Poor models may result in incorrect assessments in the connection agreement and registration processes;
- New and existing network users (not just wind farm developers) require models for their own design and operational purposes. Incorrect or inaccurate models may cause another network user to incorrectly design its plant or its protection equipment.

## Possible Way Forward

There would be benefit for all parties in resolving the issues relating to the provision models for generating plant, particularly new technologies that are still to develop standard approaches for such activities. As these matters relate to equity between parties, and the establishment of clear high level principles, the involvement of policy makers is a key ingredient to a concise resolution. WETAG proposes that WEPWG considers the following potential way forward:

Provision of models – the Code should be clarified to ensure that all generators with generating units or generating systems above a certain capacity (e.g. greater than 30MW) are required to provide models as a mandatory condition of an offer to connect from a NSP. This would be a change from the current arrangements where only scheduled generators are required to provide models, but is arguably consistent with the original intent of the current provision. This outcome would place an obligation on all significant generators, regardless of registration category, to provide generation plant models. Accurate plant models are essential to ensuring that:

- power system security can be monitored and maintained;
- power system planning can be adequately undertaken; and,
- adequate modelling can be undertaken for connection design work.

Defining the information required in generation plant models – There appears to be a need for a mechanism that provides detailed guidelines on the information to be provided in models, and the way in which it is to be provided. Enhancement of the guidelines for anticipated new technologies, or for identified deficiencies may need to be carried out routinely, perhaps in a similar way to the regular review of technical standards. Whether the guidelines should ultimately reside inside or outside of the Code would require consideration from a legal perspective, in the context of the new NEM Rules arrangements. Where requirements change at any point in time, workable and equitable transition arrangements would need to be made as discussed in section 6.2.

This would be a new activity, and would need to link effectively to any clarification of the obligation for provision of models. An obligation could be placed on NEMMCO and/or NSPs to specify information to be included in generation plant models, and to review the outcomes to ensure that the plant models remain appropriate for their intended purposes. To ensure their continued relevance, the guidelines could be reviewed periodically, and there may be merit in linking such reviews to any ongoing reviews of technical standards.

Testing to confirm accuracy of plant models – Under current arrangements, NSPs have the ability to require testing of generating plant models to confirm their accuracy. It is suggested that Code clauses requiring a Generator to test its generation plant<sup>6</sup> be modified to also provide NEMMCO with the ability to require testing to confirm that the provided models are suitable for their intended purposes and of sufficient accuracy. Any requirement of NEMMCO's may best be achieved through the relevant NSP, which will have an existing relationship with the connecting party. It may also be appropriate for an on-going requirement to confirm the model either through test or performance during a disturbance. In defining testing of generation plant, the cost of the testing should be minimised, preferably through the use of passive tests where possible.

Confidentiality of plant models – The status quo clearly provides for generation plant models to be non-confidential, however concerns with this have been raised by wind generation manufacturers. Any change to the status quo would have flow on effects, and would need careful consideration particularly from the perspective of potential barriers to entry for new

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<sup>6</sup> See clause 5.7.6 of the Code.

investment due to reduced transparency of the power system design. The broad options for confidentiality are as follows:

- Status quo – models are non-confidential. This is the option generally preferred by WETAG. It provides for potential new entrants to carry out design feasibility studies on their proposed plant, using an accurate model of the power system. The provision of generation plant models raises issues for manufacturers in respect of keeping their specific technology designs confidential, however, this should preferably be mitigated by allowing models to be provided for the new generation plant connection as an aggregated response at the point of connection that do not disclose commercially sensitive information. Some wind farm developers for example, are currently developing appropriate aggregated models based on wind farm models rather than scaled-up wind turbine models;
- Make models confidential – this would allow NEMMCO and NSPs to use the models, but would prevent their broader distribution. It would be a fundamental change from the status quo, and would probably require that all modelling for prospective new connections would have to be done by either NEMMCO or NSPs with reduced transparency for the market;
- Allow limited use under confidentiality agreements – this approach is also a change from the status quo. It would aim to preserve the confidentiality of model data through contractual arrangements, but would allow investors or their consultants to access the models for specific purposes. It would need to be confirmed whether this approach would afford sufficient comfort to manufacturers. WETAG considers this option to be impractical as it would involve significant overheads in managing confidentiality agreements by NSPs or NEMMCO with any party(s) requiring access to model information. The concern to manufacturers of this option is illustrated by an example where some enquiring parties may also include direct competitors who manufacture competing technology.

## 5.10 Contingency Services and cost recovery

NEMMCO procures contingency frequency control ancillary services (FCAS) to ensure that power system frequency meets the Frequency Operating Standards set by the Reliability Panel. At present, the amount of contingency raise service procured by NEMMCO is mainly determined by the largest generating unit present on the power system and similarly, contingency lower service by the largest load. It is considered unlikely that wind farms will impact these requirements directly, however some potential has been identified for additional contingency services to be needed due to the low inertia of wind generators in some parts of the network as wind generation displaces higher inertia generation plant, such as Tasmania. Further modelling studies are required to better understand the materiality of inertia as discussed in section 5.3.

NEMMCO has existing powers to procure Market Ancillary Services, including contingency services under the Code<sup>7</sup> that allow the amount of service procured to be varied to match the need. On that basis, there is no apparent need for change to the current arrangements for contingency FCAS procurement to accommodate wind generation.

Under existing Code arrangements, the registration of wind generators as either market or non-market generator determines liability for making contingency frequency control ancillary service payments. Market generators reimburse the cost of raise services and market customers reimburse the cost of lower services. In some cases, such as the one described above involving low inertia plant, non-market wind generation may also contribute to the requirement for contingency frequency control ancillary services, but would not have a

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<sup>7</sup> See clause 3.8.11 of the Code.

liability towards the cost. Under current arrangements, their contribution is implicitly covered by market generators. There is therefore some chance of potential cross subsidies if the cost implications change to be significant. The current funding arrangements for contingency FCAS are generally considered to be very coarse however, resulting in WETAG calling into question the merit of making fine adjustments to a process that arguably has inherent cross subsidies at its base level.

Of note, NECA has recently conducted a review of ancillary services arrangements, and is understood to have considered options for improving the funding arrangements for contingency FCAS services, although their final report has not yet been published. Given the background to this matter, and its low level of materiality in the context of current FCAS funding arrangements, WETAG considers that no action is necessary at this stage. It may be appropriate to consider the matter further however, in the context of any changes that are made arising from NECA's FCAS review.

### **Potential implications of the status quo, and possible way forward**

No compelling or material reasons have been identified to make changes to the existing mechanisms for procurement and funding of contingency FCAS services as greater amounts of wind generation emerge in the NEM.

WETAG does not propose any changes in this area, but it is recognised that further consideration may be given to this matter subject to the findings of NECA's FCAS review.

## **5.11 Regulation frequency control ancillary services and cost recovery**

### **Regulation frequency control ancillary service requirements**

Variations in the output of generating units and loads disturb the supply/demand balance and routinely cause power system frequency to move away from the nominal value of 50 Hz. NEMMCO procures regulation FCAS through a spot market to counteract these variations in order to keep power system frequency within acceptable operating limits determined by NECA's Reliability Panel.

WETAG has not performed analysis to quantify the degree to which whether or not additional amounts of regulation service may be required due to the increased emergence of wind farms at some time in the future. Such analysis is likely to be dependent upon availability of operational data from a number of wind farms, and may have merit for consideration in the future to inform the ultimate materiality of this issue. It is expected that materiality would be moderated by geographic diversity as the number of wind farms increases.

At the current time, NEMMCO has made no special arrangements to procure additional regulation FCAS specifically due to wind farm operation, and has actually reduced the amount of regulation FCAS procured over the past two years. If this issue increases in materiality, requiring NEMMCO to procure more regulation FCAS to manage power system frequency as a result of the emergence of wind farms, NEMMCO's existing powers under the National Electricity Code are considered sufficient for that purpose. In particular, NEMMCO already has obligations to procure the necessary amounts of FCAS to control frequency to standards set by the Reliability Panel.

There is no apparent need for any change to current regulatory provisions in relation to regulation FCAS procurement at this time. However, the working group anticipates that NEMMCO would monitor the situation and inform the market if it considers that additional regulating frequency control ancillary service FCAS is needed to manage any frequency impacts of wind generation. As discussed in section 5.10 however, increases in FCAS requirements can be for reasons other than wind energy, and it may be beneficial to ensure that any observed outcomes are not automatically assumed to be solely wind related.

## Regulation frequency control ancillary service cost recovery

A “causer pays” cost recovery mechanism is defined in the Code<sup>8</sup> (clause 3.15.6A) for market generating units that have appropriate operational metering in place. Appropriate metering in this case refers to real time operational metering that records short-term variations in plant output. Operational metering is key to NEMMCO’s ability to manage power system security, as it is the means by which the status of the power system is tracked in real time. NEMMCO consulted with the industry in 2002 to determine transparent guidelines as to what generating plant is required to provide operational metering to NEMMCO. Broadly, the outcome of that consultation was that any generating unit or generating system with a nameplate rating exceeding 30MW will be required to provide metering to NEMMCO. NEMMCO also indicated that it may require some smaller generating units or generating systems to provide the data where it was found to be necessary for the management of power system security.

The ‘causer pays’ mechanism identifies relevant generators that are causers of frequency variations and allocates a causer pays factor to each. The remaining cause of frequency deviations is allocated to market customers, shared on a pro-rated basis. The causer pays factors are then used in market settlements to recover the procurement costs for regulation FCAS.

Under the current Code provisions, wind generating plant that is registered as non-market, does not participate in the causer pays process. On the other hand wind generators and other market generators that are registered as a market generator, will participate in causer pays arrangements only if appropriate operational metering is installed.

### Potential implications of the status quo

WETAG identified the following potential implications of the current Code arrangements:

- Dependency of participation in ‘causer pays’ arrangements upon the availability of operational metering is not desirable, as it may lead parties to resist the installation of appropriate metering. Such an outcome would have potential flow on effects for management of the power system. WETAG is of the view that there is merit in making these provisions more specific.
- There is potential for a cross subsidy to emerge depending on whether a wind generator (or any generator for that matter) registers as market or non-market. In the former case, the generator will be assessed for ‘causer pays’ factors, and will bear the resulting costs. In the latter case, the generator’s contribution will default to market customers in proportion to their energy. A cross–subsidy will therefore emerge from the generator to market customers as a group. As the non-market generator will most likely have a financial arrangement with a particular market customer, there will also be a cross subsidy between that market customer and remaining market customers in the same region. It should be noted that as wind farms become larger in size, many will be registered as market generating units because the generator will either not have a Power Purchase Agreement (PPA), or because their PPA will be with a retailer other than the local retailer.
- If the wind generator registers as a market generator, but does not install appropriate operational metering (for whatever reason), then the generator will not be allocated a ‘causer pays’ factor, and the factors allocated to other market customers will be affected by corresponding small amounts. The contribution of the subject generating system will therefore be picked up by other market generators, resulting in a cross subsidy.

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<sup>8</sup> See clause 3.15.6A(h) of the National Electricity Code.

WETAG members generally agreed that there is merit in clarifying the obligations of parties to participate in causer pays arrangements. This would increase the certainty for developers, and avoid tension between the power system security drivers for installation of SCADA metering and obligations to participate in causer pays arrangements.

### **Possible way forward**

During the assessment of potential regulation ancillary service funding issues, WETAG members identified the following options for consideration if cross subsidies were to be addressed, namely:

- The Code causer pays arrangements could be restricted to market scheduled generators.

This option modifies the status quo by removing the obligation for market non-scheduled generators with appropriate metering to participate in causer pays processes.

- All significant market generating systems (>30MW) be included in Code causer pays arrangements.

This option is the closest to the status quo which requires all market generators to participate in causer pays arrangements if they have appropriate metering (Clause 3.15.6A(h) ).

- All significant generating systems (>30MW) be included in Code causer pays arrangements, regardless of their registration category. In addition, non-market generators would be exempted from inclusion until a materiality threshold had been reached.

This option would not be generally supported by wind generation proponents as non-market generators may be required at some future stage to establish and manage settlement accounts with NEMMCO. Wind generation proponents argue that this would incur unnecessary costs.

Investigations would be required to establish appropriate materiality thresholds to underpin this option.

In order to clarify the obligations regarding involvement in FCAS causer pays arrangements, WETAG generally preferred the second option (All significant market generating systems greater than 30MW be included). This position is relatively simple, and requires minimum changes from the current arrangements, and arguably clarifies the intent of the current Code provisions. It also avoids the potential for cross-subsidies to the extent that wind farms register as market generators, and avoids unnecessary cost overheads if a generator is registered as non-market. End users in particular expressed concern with any additional process cost being imposed unless there is a clear net benefit.

With regard to non-market generators, no compelling case emerged from the group for the potential cross subsidies associated with non-market generating units described above to be addressed unless it becomes clear at some future time that they are material.

## **5.12 Information Disclosure**

NEMMCO routinely publishes a range of information in accordance with Code clauses 3.7, 3.8 and 3.13. As wind energy becomes a material component of NEM generation supply, it is important that information regarding wind energy forecasts and production is made available to market participants to facilitate market transparency.

Code changes (such as those contained in NEMMCO's intermittent generation forecasting Code change proposal to NECA in June 2004) would be required to clarify publication obligations.

The future availability of wind farm forecast data will be enhanced by the AGO wind forecasting project as described in section 4. Consequently, there may be merit in co-ordinating enhancements to the release of information for significant wind farms with the AGO forecasting project.

Nevertheless, some WETAG members support a more urgent approach that recognises the importance of the market transparency, and timeliness of releasing significant non-scheduled generation data to the market. To facilitate this approach, those WETAG members consider that appropriate non-scheduled generation data should be released as soon as possible<sup>9</sup>. Additional information incorporating wind generation forecast information arising from the AGO forecasting project, should then be made available to the market at some later date when it becomes available to NEMMCO.

Additionally, any semi-dispatch arrangements (such as those described in section 5.1) may give rise to new offer and target generation data that should be published in a similar manner to scheduled generating units if such an arrangement proceeds.

Information along the following lines may be appropriate for future publication by NEMMCO:

- Predispatch: forecast aggregate non-scheduled generation for each region for each trading interval. This would include the expected aggregate plant capability and expected aggregate sent out generation for each region;
- STPASA: physical plant capability and expected sent-out generation for non-scheduled generation >30MW for each trading interval;
- MTPASA: expected physical plant capability and expected sent-out generation for each day for a time nominated by NEMMCO (representing the expected time of maximum demand);
- Next day publication: Actual plant generation snapshots on a 5 minute basis similar to current processes for scheduled generating units.

## 6. Policy Implications

This section distils the policy matters arising from the issues discussed earlier in the report.

Sections 6.1 and 6.2 describe two areas of overarching consideration that need to be clarified at policy level and relate to the range of potential issues discussed in this report.

Regulatory certainty is critical to developers, particularly of new technology, and it is essential that the appropriate signals be sent to developers to ensure that they will bring forward the most efficient investments. Issues such as those discussed in 6.1 and 6.2 have the potential to significantly impact on the regulatory risk perceived by developers and therefore need consideration by policy makers.

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<sup>9</sup> Non-scheduled generation data that could be released to the market by NEMMCO (subject to Code and IT development times) may include regional operational metering data and any regional aggregate wind generation forecasts derived by NEMMCO under interim operational arrangements until more appropriate aggregate wind generation becomes available from the AGO forecasting project. Code changes would be required to be developed to support the release of the information described above for non-scheduled generation (including wind farms).

Section 6.3 notes that ESIPC and NEMMCO are urgently modelling the implications of potentially rapid developments in wind investment in South Australia. Results of this modelling could relate to a number of the issues discussed in this report.

Sections 6.4 to 6.11 describe areas where WETAG considers that policy action is required.

WETAG members also note that regulatory changes may impose costs on existing wind farms as well as those at various stages of development. Costs associated with complying with changed Code requirements may jeopardise some existing plant and proposed projects and impact the volume of wind energy ultimately installed in the NEM. The influence of any additional costs discussed in this paper should be carefully considered.

Section 6.12 considers other areas discussed by WETAG, but where no policy action has been identified.

## 6.1 Materiality

In many cases, the potential technical issues examined in this paper are not material at this point in time due to the low levels of wind generation currently in place. However, it is essential that the industry achieves a good understanding of whether, when and where the issues will become material. It is acknowledged as important to developers that solutions do not necessitate the mandatory installation of physical mechanisms until the need is clearly evident. On the other hand, it is imperative that all parties be aware as early as possible of any measures that may be imposed on them in the future.

Thus, it is desirable for a decision to be made now, as to the nature of the issues that may be of concern in the future, and the triggers that could indicate that action needs to be taken. Requirement for a solution to be implemented would be triggered on the basis of actual measurements taken from the power system and detailed modelling. It would then be possible to give participants a period of time to realise the solution if and when they are notified.

This approach is thought to have a number of benefits above mandated installation of solutions as follows:

- This approach may reduce expenditure by developers that may later prove to have been unnecessary;
- Subject to resolution of the matters raised in section 5.1, developers can invest with knowledge of whether they will be involved in a response should a particular potential issue become material in the future. This gives relevant developers an incentive to not exacerbate the issue;
- Actions required on the part of the developer once the issue becomes material, will be undertaken with a minimum notice period. This allows the developer to seek out the lowest cost means of compliance, at the latest possible time. Opportunities for technology development and outsourcing of solutions to other participants are therefore maximised.

On the other hand, this approach requires the materiality of issues to be derived in advance against a clear threshold or trigger. Such a regulatory process would need to be carefully designed to ensure robust response to triggers. Given the lead time for some wind farm developments, these studies may need to be carried out well in advance. This process is put forward for consideration at policy level in respect of issues discussed in this paper that may require special action from wind farm generators.

## 6.2 Transitional Issues and dealing with existing plant

Project developers invest significant effort and funds in determining project commercial feasibility and technical design specifications for wind farms to suit the market and comply with Code requirements. Changes to the Code or other regulatory arrangements such as technical standards during the project feasibility, design or construction stages introduce regulatory risk and may result in project plans or assets that are incompatible with the new arrangements.

Appropriate processes are required in the Code to manage any transitional issues arising from changes in Code requirements or obligation on market participants. Options available to manage transitional issues may vary according to the particular issue. These could include a requirement to comply with the new requirement, grandfathering arrangements or Code derogations depending upon circumstances.

In respect of issues such as the ones covered in this paper, it is important that timely changes to Code arrangements are made before significant wind generation capacity enters the market. It should be noted that increased regulatory risk brought about by changes to the Code and specifically the requirements or obligations on wind farms, and their associated costs, may act as a significant deterrent to investment in new generation plant, reducing actual investment.

In regard to Code technical standards, WETAG noted the approach that was taken with changes to technical standards that came into effect in November 2003. Transitional arrangements<sup>10</sup> provided for existing obligations of generators in respect of the technical performance of the plant to be effectively grandfathered as “performance standards” as the basis for ongoing compliance. These initial performance standards were based on derogations, connection agreements and design performance and allowed some degree of negotiation, particularly for new requirements. As a consequence of this process, technical derogation obligations were included in the performance standards and most derogations have now lapsed. Performance standards are required to be included in new connection agreements and can be changed by amending the connection agreement.

With the above in mind, it is suggested that policy level consideration of the issues covered in this paper should generally include a means of dealing with existing plant.

## 6.3 Modelling of Power System Operational Implications

There is an urgent need to progress modelling studies to better understand operational implications of the connection of increasing volumes of wind farms, particularly in South Australia and Tasmania. Studies to determine the capability of the transmission system to carry increasing amounts of wind generation have not yet been completed. While NSPs must undertake modelling studies to consider the connection and local implications of wind farms, the broader power system security implications also require urgent consideration in the context of such matters as power system stability, plant inertia, dispatch and ancillary services.

NEMMCO and ESIPC are currently endeavouring to obtain suitable wind farm modelling data to support the required operational modelling studies. NEMMCO is also seeking technical advice on the derivation of a suitable model structure pending resolution of these issues at policy level. Wind farm production data is another necessary input, including data reflecting realistic production variability across potential future wind farms and across the frequency spectrum from a few seconds to the daily cycle. ESIPC is currently taking steps to derive variability data for use in South Australian studies.

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<sup>10</sup> See Code clauses 4.13 and 4.14.

Once the required data is available, NEMMCO intends to carry out operational studies for South Australia to determine what level of wind generation is likely to introduce the need for special operating arrangements.

NEMMCO and WETAG consider this area of investigation to be urgent. The potential for the studies to reveal the need for new operational arrangements should be noted and foreshadowed by WEPWG.

#### **6.4 Network Loading Control and Short Term Variations**

WETAG's consideration of the Network Loading Control (sections 5.1) and Short Term Variability (section 5.2) has indicated that the issues are related to each other at least the extent of the following:

- Both issues arise only when network flows approach their limits;
- Physical countermeasures to address the issues involves the potential installation and operation of a control capability to limit the output of relevant wind farms. In one case the output would be limited for longer timeframes exceeding five minutes, while in the other case sub five minute variations in wind farm output would be smoothed;
- Depending on the type of control system installed, and the obligations imposed, it may be possible to address both issues with some specific types of control systems and a well considered obligation.

Accordingly, WETAG has sought to preserve any common ground between the network loading issues, and short term variation issue in proposing a way forward. In this case, more detailed investigations are required to collect information on the cost of appropriate control systems, and to define a practical and fully developed way forward.

Furthermore, the rapidly increasing investment in wind farm generation, particularly in South Australia, points to a need for this issue to be progressed urgently.

It is therefore proposed that WEPWG commission an urgent focussed investigation with the following key objectives:

- To identify the types of control systems currently available for the control of wind farm outputs in the general sense, and to smooth sub five minute outputs. The cost of such systems would be a key deliverable, together with likely future evolution of such systems. Consideration should be given to existing control arrangements for wind farms required by some NSPs;
- To report on the current and potential future materiality of sub five minute variations in wind farm output, in respect of their impact on network loadings. ESIPC is currently progressing work of this nature for South Australia – preliminary results are set out in Appendix B, with more detailed results are expected during the first half of 2005;
- To assess and report on the likely feasibility and effectiveness of a semi-dispatch process for the management of network constraints as described in section 5.1 above. This should be considered together with the feasibility and effectiveness of requiring sub five minute variations in wind farm output to be smoothed as described in the 'regulation' and 'ancillary service' options in section 5.2 above. The pros and cons of combining the solution to both issues should be considered;
- Recognising that countermeasures for these issues may not need to be installed until some future time when constraints become an issue, a proposal for a practical trigger should be sought. Such a trigger should ideally provide for adequate notice for

implementation of any necessary control systems as discussed in sections 5.1 and 5.2.

WETAG considers that based on the forecasts in Appendix B, there is a high likelihood of some countermeasures of the type described above being required, in which case there would be benefit in WEPWG foreshadowing that outcome as soon as possible. WETAG recommends that this item be progressed as a matter of priority.

## **6.5 Islanding**

It is recommended that WEPWG consider the introduction of a requirement to disconnect generation sources from islanded areas of the network where NEMMCO or the NSP is not able to manage power system frequency and/or voltage. This may be managed through the connection agreement with the NSP, who in the best position to identify appropriate network areas and disconnection arrangements. It may be necessary to consider specific technical requirements to allow generating systems to be disconnected when islanded. Any relationship with registration arrangements should also be considered.

Changes to the Code would be required if WEPWG decides to progress this recommendation.

## **6.6 Technical Standards**

It is proposed that jurisdictions require an appropriate NEM institution to routinely review the Conditions for Connection of Generation Plant appearing in schedule 5.2 of the Code. The obligation to carry out such a review should ideally include guidelines along the following lines:

- The review should be carried out in consultation with all industry stakeholders, including developers of potential new technologies;
- A set of principles should be established to guide the review. Suggested principles have been developed by WETAG for consideration and are set out in Appendix A;
- The party undertaking the review should be required to report and propose any necessary changes to standards to the AEMC for consideration in the context of the Code Change Process;
- The review should be carried out at intervals of approximately 3 to 5 years or some other time period;
- Consideration should be given to appropriate transition arrangements for application to wind farm proposals at various stages of the developmental, design, specification and construction phases and existing wind farms. Such plant may not be capable of meeting revised technical standards under their original technical designs.

WETAG understands that NEMMCO has approached NEM jurisdictions proposing that an immediate review of the above nature be undertaken to address pressing issues with the Conditions for Connection of Generating Plant and some other specific issues associated with the technical standards provisions of the Code. WETAG supports an immediate review of this nature provided all relevant stakeholders are afforded input.

## **6.7 Provision of generation plant models**

The options identified in the potential way forward section for provision of generation dynamic plant models (section 5.9) are primarily independent policy decisions that do not

have significant impacts on other issues discussed in this paper. There would be benefit for all parties in resolving the issues relating to the provision models for generating plant, particularly new technologies, such as aggregate models of wind farms, that are still to develop standard approaches for such activities. As these matters relate to equity between parties, and the establishment of clear high level principles, the involvement of policy makers is a key ingredient for resolution of the following issues. WETAG proposes that WEPWG considers the following:

- The Code should be clarified to ensure that all generating units or generating systems above a certain capacity (e.g. greater than 30MW) require models as a mandatory condition of an offer to connect from a NSP;
- The definition of information required in generation plant models requires clarification. An appropriate NEM institution is required to oversee a mechanism that provides detailed guidelines on the information to be provided in generation plant models, and the way in which it is to be provided;
- Code clauses requiring a Generator to test its generation plant<sup>11</sup> should be modified to provide NEMMCO with the ability to require testing to confirm that the provided models are suitable for their intended purposes and of sufficient accuracy;
- Confidentiality issues surrounding generation plant models requires clarification. The status quo provides for generation plant models to be non-confidential, however concerns with this have been raised by wind generation manufacturers. WETAG has identified a number of options for WEPWG to consider regarding the confidentiality of generator models (see section 5.9).

## **6.8 Regulation frequency control ancillary services**

WETAG considered potential regulation ancillary service funding issues that may emerge for wind generation. Of note, cross subsidies may arise if significant wind farms are developed and regulation FCAS requirements increase as a result of the variability of generation output from wind farms. Uncertainty in Code obligations regarding participation in the causer pays arrangements was seen as an important issue in this regard.

WETAG considers that there would be benefit in clarifying the obligations of parties to participate in causer pays arrangements. It is recommended that Code clause 3.15.6A(h) be modified to require that all market generators with generating systems greater than some threshold (such as 30MW) participate in causer pays arrangements.

## **6.9 Optimising shared network assets at the design stage**

Clarification is required by policy makers in the area of network investment in connection assets and network augmentations.

This issue is applicable to the connection of all generation, but has been particularly highlighted by connection applications for wind farms due to their often remote network locations, and the potential for multiple wind farm proponents seeking network connection in similar areas of the network. The following issues have been discussed by WETAG:

- There is no regulated or codified methodology by which an NSP can seek to optimise connection solutions for a group of applicants;

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<sup>11</sup> See clause 5.7.6 of the Code.

- There is no low risk methodology available to an NSP where it can fund initial excess capacity that has the potential to provide a more appropriate and cheaper solution for a number of connection applicants. The risk for an NSP of adopting such an approach, combined with the lack of potential commercial upside, make it unlikely that an NSP would be willing to undertake such investments;
- Existing processes to deliver network assets in order to connect new generators are generally designed around a single applicant and the provision of a specifically designed single applicant connection solution;
- There are no regulatory barriers preventing a number of project proponents forming a consortium proposal to develop shared network assets.

Discussion within WETAG indicated a broad range of strongly held views on this matter, ranging from concern about any form of central optimisation as it would represent an intervention in the market process, through to support for prospective regulated funding of anticipated optimal shared connection assets.

WETAG suggests that this issue be further developed. Clearly such work would need to take into account other policy issues such as wind energy targets in each state and the role of NSPs.

## 6.10 Information disclosure

It is suggested that consideration be given to Code provisions of additional information by NEMMCO in respect of non-scheduled generation – see section 5.12. Such information should ideally bring the transparency level of non-scheduled generation to a level that is comparable with the current provisions for scheduled generation where reasonably practicable.

Progression of this issue would most readily be carried out in co-ordination with other issues such as forecasting and any semi-dispatch, in order to account adequately for the outcomes in those matters. Some WETAG members consider that further information regarding non-scheduled generation should be released as soon as possible as interim measures.

## 6.11 Items Where No Action Is Proposed

A number of the issues considered in this paper have not led WETAG to identify a material case for immediate action at policy level. In some cases, this has been because existing Code or regulatory arrangements appear to be adequate for the issues to be resolved when necessary. In others, WETAG has not considered the issues to be material enough to warrant countermeasures. In both cases, WETAG recognises that broader consultation with industry stakeholders has the potential to bring forward other perspectives that could be considered.

WETAG considered that the following items do not warrant immediate action to be taken by policy makers:

**Contribution of Wind Energy to System Reserves** (see section 5.6) – NEMMCO is considered to have adequate obligations and powers under the Code at present to continually refine the value of wind generation supply reserve forecasts. While NEMMCO should continually refine this process in a manner that is transparent to stakeholders, no need for policy action has been identified, however additional information disclosure may become desirable to ensure transparency (see section 5.12);

**Network Connection of Large Scale Wind Farms** (see section 5.4) – in this case, WETAG considers that NSPs may have a sound case for clarification of the current Code provisions

for assessment of connection options for new generating systems. In particular, there may be merit in clarifying funding arrangements for assessment of options prior to a formal application for connection being made by a developer. As such changes would effectively constitute a clarification or adaptation of current Code provisions however, NSPs could propose changes to clarify the Code at any time. Prior consideration at policy level may not be necessary in this case;

**Contingency FCAS** (see section 5.10) – Both the FCAS contingency requirements and FCAS contingency cost recovery issues are considered not to be material in nature to policy decisions at this stage due to any impacts associated with the expansion of wind energy in the NEM. It is recognised however, that further consideration may be given to this matter subject to the findings of NECA's FCAS review;

Further, should this issue become material at a future date, additional FCAS contingency requirements can be procured by NEMMCO under existing NEM arrangements.<sup>12</sup> In the event of a material increase in the procurement costs being accrued due the impact of wind energy, which is not foreshadowed at this stage, it is proposed that contingency FCAS cost recovery mechanisms be reviewed at that time.

## 7. SUMMARY

This report has been prepared by WETAG and submitted to WEPWG to assist it in developing policy recommendations for SCO through the provision of technical consideration of identified issues. It is anticipated that the report will be used by WEPWG as a basis for consultation with broader industry parties prior to forming final policy positions.

The WETAG process raised a number of issues and options relevant for policy makers, including a number where differing industry views were identified. This paper has sought to present many of those viewpoints in its discussion of issues and options.

It should be noted that individual submissions to WEPWG's consultation process from interested parties are to be expected from stakeholders, including industry sectors and individual companies, and NEM institutions represented on WETAG.

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<sup>12</sup> FCAS contingency requirement arrangements are established by NECA's reliability panel.

## Appendix A: Principles of NEM Technical Standards

### Principles to be adopted for Technical Standards Code changes

Following is a list of draft Technical Standards Principles that are intended to guide the development of any changes to technical standards provisions. The headings are provided only for indication, and should be read only in conjunction with associated descriptions.

#### Principle 1:

**The technical standard must provide for adequate security, quality of supply and reliability.**

The technical standards are intended to specify performance of plant such that:

- Power system security;
- Quality of supply; and,
- Reliability of supply<sup>13</sup>

are maintained at satisfactory levels into the future.

The Code specifically requires that NEMMCO and the NSP to take into account security and quality of supply in their negotiations. Consideration of impacts on reliability of supply should extend only to generating units or systems, and not impacts from customers.

#### Principle 2:

**Minimum, automatic and mandatory standards should be defined so that performance requirements are consistent with the potential impact of generating plant on the power system.**

This principle provides for the negotiated standard to be no more onerous on the generator seeking connection than is necessary.

The technical standards cover two sets of standards – “system standards” and “access standards”. System standards are defined to set a target performance level for the power system overall<sup>14</sup>.

Consistent with achieving the required system standards, the Code allows for developers, NSPs and NEMMCO to negotiate a suitable level of technical performance for new connecting plant. In NECA’s Review of Technical Standards (Dec 2001), NECA stated:

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<sup>13</sup> Chapter 5 refers specifically to security and quality of supply, but at least one technical standard addresses reliability of supply (see clause S5.2.5.12).

<sup>14</sup> Ref. ACCC final determination on technical standards – February 2003.

“The range for those parts of the standards that can be negotiated should be defined between the automatic access standards and the lowest capability that is acceptable, called the minimum access standard. The lowest acceptable standard should normally be related to the level at which a risk to system security or of harm to other connected parties may arise.”

In a few instances, mandatory requirements have been placed on connecting parties, without scope for negotiation

As a principle, the technical standards should be formulated in terms that provide for an automatic access standard and a minimum access standard. A review of the technical standards should determine whether:

- the minimum access standards are reasonable minima, considering the location and potential impact of the generating system within the network;
- the mandatory requirements can be re-cast in terms of minimum and automatic standards without contravening Principle 1; and,
- automatic access standards are set at appropriate levels.

### **Principle 3:**

**Terminology used in the technical standards should support their appropriate application. Where technically appropriate, performance of generating plant should be measured at the connection point.**

Most of the technical standards are applied to generating units, but for distributed generating systems, such as wind farms, which are comprised of numerous small units, it is appropriate to consider performance requirements in terms of “generating systems”, or the performance of the plant on the power system as measured at its connection point.

Depending on the way the plant is controlled and the configuration of its connection, performance can be considered in some cases a function of the generating system<sup>15</sup>, and in others a characteristic of the generating unit. The terminology used in the technical standards should therefore be specific, and appropriately support the standard’s application, allowing flexibility to define combined performance in terms of generating systems, and take effect at the connection point where appropriate.

The impact of a generating system on the power system security or quality of supply is generally governed by the laws of physics and not influenced by whether it is scheduled or non-scheduled, except through application of certain market rules (such as dispatch rules). Inappropriate use of the term “scheduled” in technical standards can have the consequence of excluding significant intermittent generation projects from the requirement to comply with some technical standards. When the technical standards are reviewed inappropriate use of the term “scheduled” should be avoided.

### **Principle 4:**

**Where reasonable, the technical standards should be written so that they are applicable to all technologies. Technology-specific terms should be used only where necessary to clarify requirements for particular technologies.**

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<sup>15</sup> The Code defines a generating system to be “a system comprising one or more generating units”.

The technical standards must adequately cover all types of generator technologies. To the extent reasonably possible the technical standards should not treat one technology more favourably than another. While the technical standards might recognise the differences between technologies, the standards should aim to achieve an equivalent performance outcome.

As new technologies may emerge over time, technical standards should be written, where possible, in a form that can be applied to all technologies. It is recognised that there may be some exceptions to this principle, for example, where a technology has established methods of specifying technical capability that simplify performance assessment or where the technical parameters for a technology are significantly different from those of other technologies.

**Principle 5:**

**Where possible, the technical standards should provide clear guidance on the basis for negotiating access standards for each requirement.**

To provide a fair and consistent basis for negotiation on a particular technical standard requirement, there should be no ambiguity in the intent of the clause or the factors that impact the level of acceptable performance. This can be achieved by the provision of clear guidance.

Greater clarity on the intent of clauses and the basis for negotiation between automatic and minimum access standards will assist both NSPs and Generators in their negotiations, and will enhance the consistency of negotiated outcomes for technical standards.

**Principle 6:**

**Changes to the technical standards must include appropriate transitional arrangements.**

Consideration must be given to how the changes will apply to:

- (i) Registered generators (as at the date of commencement of the amendments);
- (ii) Plant not registered, but with Connection Agreements pre-dating the commencement date of amendments;
- (iii) Plant registered prior to the amendments coming into effect, but modified after this date (including whether the plant must comply with all new requirements or only those related to the modifications made);
- (iv) Non-committed projects that are in the process of negotiating connection agreements.

In developing these transitional arrangements consideration must be given to the possible economic impact on all parties affected by the transitional arrangements, and in any case, the requirements of Principle 1 must not be compromised.

**Principle 7: Changes to technical standards are to be technically justified**

To provide adequate certainty to generators and intending generators the technical standards should only be changed if an appropriate industry body can demonstrate an adequate technical requirement for the change. The justification for this could include the need to correct an error or omission or to incorporate a new technology.

In general, when changes are required to incorporate a new technology into the technical standards, contributions to the technical standards review should be sought from both power system experts and specialists from the new technology.

## **Appendix B: ESIPC Report - Wind Farm Status Briefing**

This report was prepared by The South Australian Electricity Supply Industry Planning Council (ESIPC) and was provided to NEMMCO in December 2004. It provides a status report for South Australian wind farm developments, and demonstrates the need for a sense of urgency in progressing some of the issues discussed in this WETAG report.

This Appendix B report does not necessarily represent the views of other groups represented on WETAG, or is it endorsed by WETAG.

## Update on Wind Farm Development in South Australia

As you are aware, the Planning Council is currently investigating the impact of wind generation in South Australia. The following is a brief update of the Planning Council's current understanding of wind generation proposals in South Australia and some preliminary results from our analysis of their expected impact.

### Current Status

Table 1 - Projects already in operation or being commissioned:

Wind farm	Units and Name-plate Rating (MW)	Station Capacity (MW)	Developer	Target Completion Date / Comments
Starfish Hill	23 x 1.5	34.5	Tarong Energy	Operational
Lake Bonney Stage 1	46 x 1.75	80.5	Babcock and Brown	Some wind turbines operating, construction due for completion in early 2005
Canunda	23 x 2	46	International Power	April 2005
<b>TOTAL</b>		<b>161.0</b>		

Table 2 – Wind Farm Projects Under Construction

Wind Farm	Units and Name-plate Rating (MW)	Station Capacity (MW)	Developer	Target Completion Date
Cathedral Rocks	33 x 2	66	Hydro Tasmania	June 2005
Mt Millar	35 x 2	70	Tarong Energy	January 2006
Wattle Point	59 x 1.75	101	Meridian Energy	June 2005
<b>TOTAL</b>		<b>237</b>		
<b>TOTAL (existing or under construction)</b>		<b>398</b>		

The above projects represent the wind energy capacity we expect to have operating in South Australia during 2005. In the section of preliminary results below, these constitute case 1. I understand that none of that information is confidential and has been otherwise released publicly. Based on our most recent analysis, wind energy will constitute 10.7% of sales in South Australia when these are all operational.

There are a large number of projects which are very well advanced in the planning and project development phase and on which proponents have and are making substantial commitments. As I am unsure of the status of public information on these projects I have not listed them individually. In total they add 623 MW to the projects above, taking the probable wind generation in South Australia to 1021 MW. In the section of preliminary results below, these constitute case 2.

One of those probable projects, Clements Gap, is expected to receive a generation licence soon. Clements gap is a 58 MW project proposed by Pacific Hydro with a target completion date of late 2005. The rest of the probable projects are expected to formally seek generation licences soon having fulfilled most other approvals. (As of Wednesday, ESCOSA have applications for one wind-farm of 200 MW and another of 170 MW capacity).

### **Analysis of expected wind energy generation**

The next stage of analysis is premised on a thorough understanding of the individual output of each proposed wind farm and the aggregate output of all wind farms in South Australia with various scenarios as to the wind-farms which proceed. The level, predictability and variability in various time frames drives the impacts on the power system and the market. Attachments show:

- a fortnight of simulated wind-farm output;
- average simulated wind-farm output for each of the last 7 years;
- the variability in wind output from half-hour to half-hour.

Further information is available if it would assist. The variability of wind generation in other time periods is being analysed with assistance from the University of South Australia.

Average capacity factors for proposed wind farms are slightly higher than previously expected and for the existing wind-farms and those under construction the overall capacity factor is now predicted to be 37.3%. The output which can be considered "firm" for the purposes of reliability assessment has risen to 15% of installed wind capacity as a result of this work.

### **Market modelling**

The data produced, synthesising some seven years of half-hourly wind generation in South Australia, is being used in the Planning Council's market model to estimate the likely impacts of various levels of wind generation on:

- the dispatch of other generators in the market;
- generation dispatch patterns and hence the capability of the power system to remain secure against variations in wind generation;
- volatility in gas consumption;

- spot price and spot price volatility; and
- greenhouse gas emissions.

The results from this analysis to date are based on bidding according to short run marginal costs and do not reflect the five minute variability in wind energy generation and is being progressively developed.

### **Technical issues**

Many of the technical issues associated with wind generation are dealt with between the proponent, NEMMCO and ElectraNet through the negotiation of a connection agreement

The WETAG is proposing a review of the current technical standards to ensure appropriate standards for future wind-farms. Whilst a review of standards is worthwhile, it will be too late to influence outcomes for the projects currently under consideration and probably for any wind-farms to be constructed under MRET. A real sense of urgency is required

#### For case1; 398 MW installed in SA (plus other wind energy in Victoria):

The variability of output and impacts on the market in this case are significant but unlikely to be a real problem under most operating conditions. The Planning Council remains concerned that there has not been a thorough analysis of the potential impacts on system stability with various scenarios, especially under unusual conditions, to determine the secure technical envelope. It is expected that some potential security risks will not be able to be optimally managed without some rule changes. We also consider that efficient market operations and efficient pricing at this level will probably require some rule changes.

#### For case2; 1,021 MW installed in SA (plus other wind energy in Victoria):

The information available on this case demonstrates much higher fluctuations in wind output than could be easily managed under current arrangements. More extensive changes to national market arrangements are expected to be required to allow 1,021 MW of wind generation in South Australia whilst maintaining the security of the power system and market efficiency.

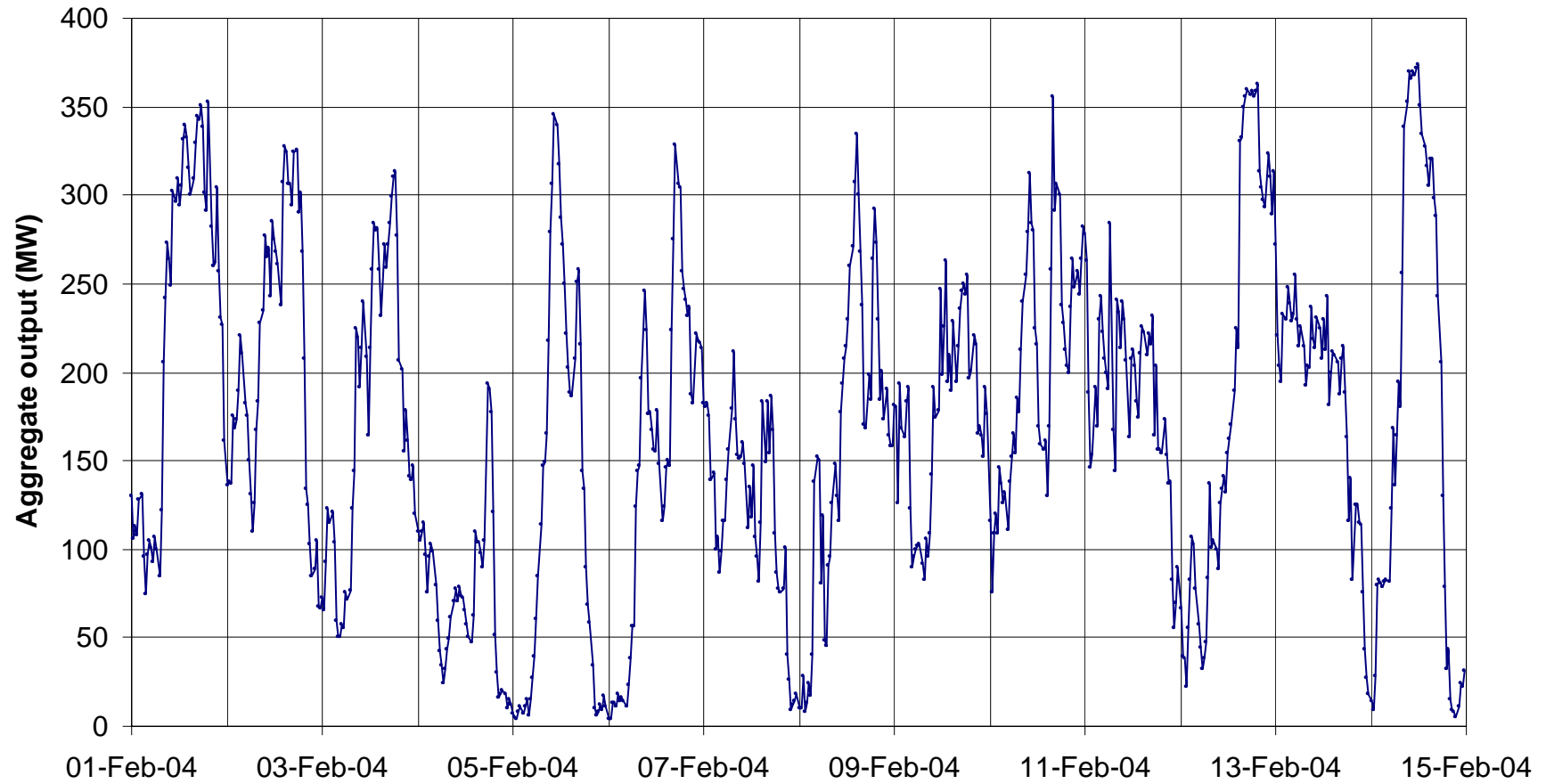
**David Swift**

CHIEF EXECUTIVE

Electricity Supply Industry Planning Council

17 December 2004

Aggregate SA Wind Output



### Attachment 3

Average annual output of wind generation in South Australia and estimated output which might be considered “firm”

	Existing and under construction			Existing, under construction and probable		
	Average Output (MW)	Capacity Factor	“Reliable” Minimum (MW)	Average Output (MW)	Capacity Factor	“Reliable” Minimum (MW)
1997 (part)	139	34.8%		364	35.6%	
1998	141	35.3%		342	33.5%	
1999	155	38.9%		348	34.1%	
2000	151	38.0%		358	35.0%	
2001	147	36.9%		355	34.8%	
2002	158	39.7%		420	41.2%	
2003	161	40.4%		422	41.3%	
2004 (part)	125	31.4%		335	32.8%	
Overall	148	37.3%	60	369	36.2%	153

The additional wind-farms being considered in the “probable” category demonstrate a slightly higher capacity factor in the best years but at the expense of slightly greater variability. The variability year to year in both cases is considerable, indicating the risk to wind-farm proponents of analysis based on a short period of wind data.

The level which could be considered “firm” from a reliability viewpoint is estimated by determining the level of wind energy which is met or exceeded 95% of the time during high load periods. This level has increased from previous Planning Council work because of better data and modelling.

#### Attachment 4

Half-hour to half-hour variation in wind generation.

Probability	Half-Hourly Change	
	Existing and under construction	Existing, under construction and probable
10% probability of exceedance	41.2 MW	127 MW
5% probability of exceedance	53.3 MW	168 MW
1% probability of exceedance	82.3 MW	260 MW
Once per annum	154.0 MW	480 MW
Worst case (7 years studied)	177.0 MW	595 MW

The half-hour to half-hour variation in the case of the existing wind-farms and those under construction is less than the largest generating unit in South Australia. As the loss of the largest generating unit is a credible contingency, the power system is already operated in a manner which maintains system security through a drop of generation of that scale. The Planning Council is concerned even in this case that Code changes and modifications to operating procedures are required to ensure all possible situations are properly managed.

The larger case including all probable wind-farms shows disproportionately larger rates of change due primarily to the greater concentration of several large wind-farms in two locations. The level of variability in this case is a cause for concern with the half-hourly variation in 1% of cases (or around 180 times per annum) exceeding current operating provisions for the largest contingency.

## Appendix C: WETAG Membership

The following table shows the membership of the WETAG. The working group was convened by NEMMCO at the request of WEPWG and formed by requesting nominees for representation of industry bodies such as the NGF, ERAA, AUSWEA, EUAA and REGA.

<b>Name</b>	<b>Company</b>	<b>Industry sector</b>
John Thompson	ElectraNet SA	TNSP / JPB
Stephen Clark	Transend	
Craig Oakeshott	ESIPC	
David Trethewey	TransGrid	
Colin Hackney	Country Energy	DNSP
Paul Driver	ETSA Utilities	
John Arneaud	Hydro Tasmania	Generators (nominated via NGF)
Mark Frewin	TXU	
David Parris	AGL	Retailers (nominated via ERAA)
Andrew Jones	Origin Energy	
Sami Aoude	Norske Skog	End Users (nominated via EUAA)
Nic Buckley	Tarong Energy	Wind Generation Developers (nominated via AUSWEA)
Kate Summers	Pacific Hydro	
Rob Jackson	Southern Hydro	Renewable energy generators (nominated via REGA)
Sarea Coates	Australian Greenhouse Office	Government
Murray Chapman Bruce Cameron Jennifer Crisp Ian Arnott Paul Ravalli Charlie Macaulay	NEMMCO	NEMMCO      Observer