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Margaret Cross,
Executive Director, Regulatory Development and Implementation
Essential Services Commission of SA
GPO Box 2605
Adelaide SA 5001

Dear Ms Cross

Re: License Conditions for Wind Generators – Draft Decision

Pacific Hydro is pleased to provide to the Commission the following comments concerning the licence conditions for wind generators connecting to the South Australian power system.

We would be pleased to discuss our submission further with the Commission as Pacific Hydro has some significant concerns.

Yours sincerely

Lane Crockett
General Manager, Australia Pacific

Introduction

Pacific Hydro would like to thank the Commission for the opportunity to comment on the draft decision for changes to the Wind Generation Licensing requirements in South Australia. As Australia moves forward into a carbon constrained future, it is important that policies and regulations move together to achieve the overall objectives of the future needs of the country.

We appreciate the opportunity to comment on the technical advice that was provided by the Electricity Supply Industry Planning Council (ESIPC) and have focussed our comments on the fault ride through and reactive power requirements.

The proposed changes to the license conditions concerning registration, wind forecasting and ancillary services are welcomed, and bring the conditions into alignment with processes that are required under the NER.

We are disappointed to see that the recommended changes to the licence conditions create a number of problems for the delivery of renewable wind energy projects in South Australia, in particular the fault ride through, voltage disturbance ride through and the delivery of reactive power. Our main concerns are noted below and we urge the Commission to consider seeking dynamic power system studies from AEMO to refine these obligations.

Technical Standards Automatic versus Negotiated

Pacific Hydro agrees that the licence conditions should be consistent with the NER and to this extent the licence conditions should still provide for the ability to negotiate appropriate levels of performance. We note that significant debate took place with NEMMCO during the development of the technical standards in 2007 over the matter of elevating the automatic standard requirements under the NER. NEMMCO's response to the debate was that there was a platform for negotiation and as that was in place, it was reasonable to raise the performance required under the automatic standard. The proposed licence conditions will mandate the automatic fault ride through criteria but with longer fault periods and include reactive obligations that are not derived from (or consistent with) the NER but appear to be sourced from the UK grid code.

It should be noted that NEMMCO designed many of the automatic standards around its performance expectations for very large modern synchronous generating units. For example parts of the automatic control standard S5.2.5.13 are not achievable for most small generators (under 650MW) regardless of technology. When automatic standards become mandated, this unnecessarily increases the costs and removes the ability of the market to deliver energy services in an economically efficient manner.

S5.2.5.4 Generating System Response to disturbances following contingencies

Pacific Hydro supports the detailed comments made by the wind turbine manufacturers on the issue of low voltage ride through.

S5.2.5.5 Generating System response to disturbances following contingency events

In the automatic standard, the 3 phase fault ride through criteria is achievable; however there remains doubt within the wind industry as to whether S5.2.5.5 (b) (iii) and (iv) are achievable. Many synchronous machines

are likely to have problems riding through the duration of faults contemplated in this clause. If other generators in the South Australian system can ride through faults held on for breaker fail times, then it would be reasonable to require a mandated standard. However it is our experience that in some cases this does not occur, based on system studies undertaken for the connection of the Clements Gap wind farm.

We are also aware that some protection systems in the South Australian network do not meet the system standards specified in Table S5.1a.2. The license condition should not be requiring a generating unit to ride through faults that are held on the system for longer than any time specified in the Table S5.1a.2 of the system standards. The licence conditions could include an to allowance for these anomalies and make the ride through limited to the times in the table S5.1a.2

Pacific Hydro was pleased to receive the Commission's clarification note published on the 7th July 2009, the release of the requirement to meet S5.2.5.5 (b) (2) is welcome as the level of response in this clause is not achievable.

Reactive Power Capability

Pacific Hydro is concerned that ESIPC, in its advice to the Commission, has been dismissive of the costs associated with meeting the equivalent of the automatic standard for reactive capability. Pacific Hydro agrees with Roaring 40's assertion that the costs would equate to 3-4% of the cost of building a wind farm. This is consistent with Pacific Hydro's own investigations which estimated the additional connection costs in South Australia at 20%, which roughly equates to 3 – 4% of total project costs.

Pacific Hydro understands that the Commission is concerned that the wind farms connecting to the South Australian system need to be of a high standard, well controlled and integrated to the network. With this in mind we wish to raise several concerns about the technology specific wording that has been written into the reactive capability requirement and the broader matters of the system response.

Proposed License Conditions

1. *The generating plant operated by the licensee must at all times be capable of continuous operation at a power factor of between 0.93 leading and 0.93 lagging at the connection point at real power outputs exceeding 5MW.*
2. *At least 50% of the reactive power required to meet the above power factors must be dynamically variable, with the balance able to be provided by non dynamic plant. For the purposes of this requirement, dynamically variable means continuous modulation of the reactive power output over its range, with an initial response time of less than 200 msecs and a speed of response such that 95% of the steady state reactive power response is achieved within 1 second. The two second short term overload capability of dynamic plant may be used to fulfill the 50% dynamically variable requirement provided compliance to the other technical requirements can be achieved with the use of that short term capability.*
3. *The reactive power capability of the generation system operated by the licensee must be controlled by a fast-acting, continuously variable, voltage control system which is able to receive a local and remote voltage set point.*

4. *The licensee must be able to operate its generating system to a set power factor that is able to be set locally or remotely if that is the preferred mode of control at any time. The power factor control mode must be capable of automatically switching to voltage control mode during power system voltage disturbances, and automatically reverting to power factor mode when the disturbance has ceased.*

The first paragraph requires more reactive than most wind turbines in the market can provide, which is typically 0.95 lead to lag. This will have the effect of restricting the type of turbines that will be economically efficient in the South Australian marketplace.

The dynamic requirement in the second paragraph has been specified with a very tight response. This fast response appears to have been taken from the UK Grid Code which we understand is under further discussion and likely to be relaxed in the near future. We would ask that the Commission consider that it is not always beneficial for the wind farms (or generators) to have a rapid reactive response that is faster than the power system. There is a risk that the fast response could contribute to instability in the system, in particular under auto reclose events when the system itself has not settled. This would be particularly relevant in South Australia in which the auto reclose time following faults on the 275 kV system is 0.5 sec. We urge the Commission to have dynamic studies undertaken by AEMO to determine whether the speed of response is desirable for system stability.

It is difficult to interpret whether the second paragraph is referring to control action for reactive or voltage regulation, or if it is referring to the dynamic response following a transient event. There are several control actions that wind turbines can produce; one is a dynamic response to export additional reactive power under low terminal voltage conditions (such as caused by a fault), and another slower controlled response for reactive power associated with supporting voltage at the connection point. These two responses are very different yet both play an important role in providing support to the generating system and connection point control.

The requirement calls for a very fast connection point rise time on the generating system which results in a reduced amount of damping in the control system in order to achieve the response. The reduced damping will mean that the control system has a higher overshoot than what would normally be implemented in the reactive control of a wind farm. This is particularly true for wind farms using DFIG machines which can be continuously modulated to dynamically import or export reactive power. The controls, both at the turbine and at the connection point, tend to be fully damped with no overshoot and provide a slower well controlled change in reactive output. This is done to avoid multiple machines interacting in an oscillatory manner or hunting against each other. We are concerned that the tight response and technology specific requirement in the license condition disregards the use of the inherent dynamic reactive response from DFIG machines.

The Figure below is an example of a generating system response to a step change from 0 to 0.3pu, which illustrates that the connection point output is slower and very well damped (damping factor of 1). A set point change of 0.3pu at the connection point will control each of the turbines being adjusted to provide the increase in reactive power for management of the steady state voltages.

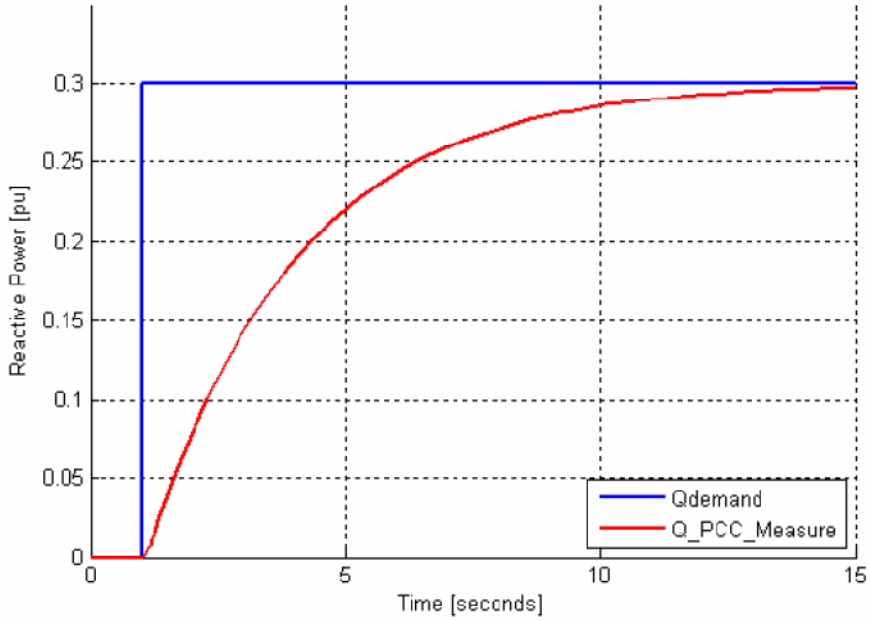


Figure 2: Example simulation for wind farm reactive power response

This example is a highly damped response and while a wind farm can be tuned to provide a slightly faster response it is unlikely that it could be produced within one second. This response however, is not the fast acting voltage support mechanism that occurs with low voltages. The reactive response that occurs for voltage support under fault conditions is much faster but this is a turbine by turbine response, not a "generating system" response.

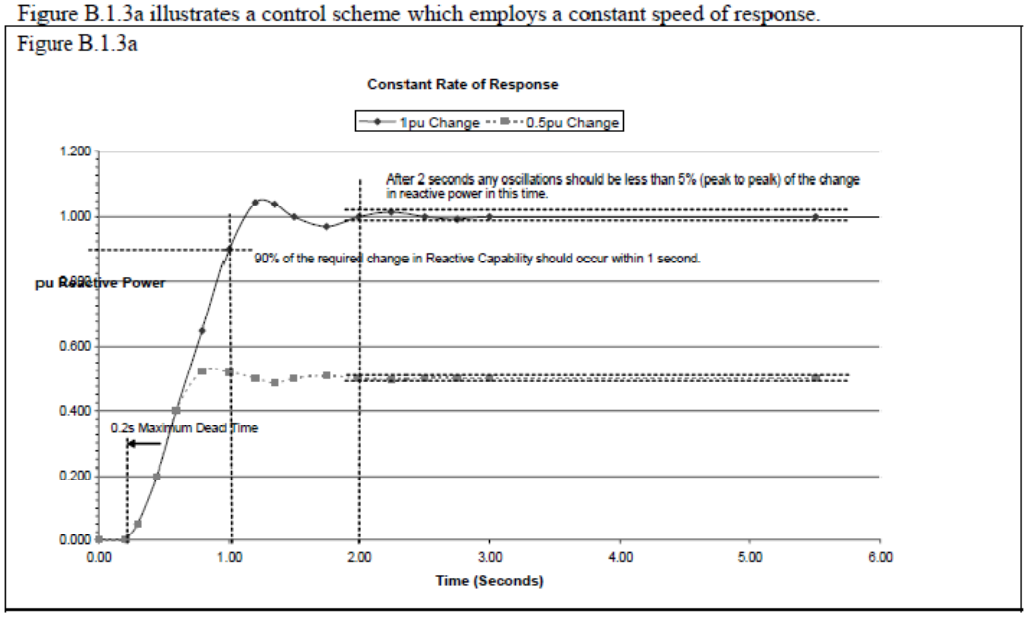
The license conditions therefore appear to be drafted assuming a wind farm is sourcing reactive power from a large dedicated Flexible AC Transmission System (FACTS) device rather than from a collective response from the turbines themselves, such as is possible with DFIG turbines. There are voltage stability benefits to the power system in having the reactive capability delivered in this manner, in particular for co-ordination with system transformer tap changers.

The proposed license condition is framed as if all the dynamic reactive power is coming from an auxiliary FACTS device such as a DVAR or STATCOM. The wording appears to be similar to the UK grid code with some modifications rather than consistent with the relevant sections of the control system standards in the current NER. The UK's Guidance Notes for Power Park Developers provides the response required as illustrated in their Figure B1.3a[1]. We understand that these response requirements are under discussion in the UK and are likely to be relaxed.

[1] Guidance Notes for Power Park Developers (September 2008 – Issue 2)

Figure B.1.3a illustrates a control scheme which employs a constant speed of response.

Figure B.1.3a



This clearly allows a dead band prior to the response commencing of 0.2 sec, and the requirement to reach 90% of the steady state response in 1 second. The proposed license drafting requires 'an initial response time of less than 200 msecs' making the dead band less than 0.2 sec and the 'speed of response such that 95% of the steady state reactive power response is achieved within 1 second' is faster than the UK requirement of 90%.

This appears to be an unnecessary adoption of the UK standard and is above the NER automatic standard. In control theory almost all definitions of rise time would ask for the measurement of time taken to rise from 10% to 90% of the steady state step change as per in S5.2.5.13.

In S5.2.5.13 the Reactive and Voltage Control System standard defines rise time as being:

(a) For the purpose of this clause S5.2.5.13:

> **rise time** means in relation to a step response test or simulation of a *control system*, the time taken for an output quantity to rise from 10% to 90% of the maximum change induced in that quantity by a step change of an input quantity.

There is little reason for the Council to have recommended a change to the rise time requirement of 95% rather than 90%.

Also reducing the time allowed to 1 second is above the automatic standard as the NER clause S5.2.5.13 (b) 4 (vi) states: "has *reactive power* rise time, for a 5% step change in the *voltage* set-point, of less than 2 seconds;"

We recommend that the Commission consider redrafting the conditions to allow the wind farm to deliver the inherent reactive power from wind turbines where possible (as this is both efficient and economic), and not specify control times higher than the automatic standard in S5.2.5.13.

We further seek that the Commission clarifies the intent of the dynamic reactive response. For example, is it to provide support to voltages during a transient event, or to provide steady state network support services?

Pacific Hydro suggests that paragraph two of the criteria might be better worded as:

2. "At least 50% of the reactive power required to meet the above power factors must be dynamically variable, with the balance able to be provided by non dynamic plant. For the purposes of this requirement, dynamically variable means continuous modulation of the reactive power output over its range.

In response to a low voltage single contingency event the reactive response must be sufficient to ensure that the connection point voltage is regulated in a manner that does not prevent the Network Service Provider from achieving the requirements of clauses S5.1a.3 and S5.1a.4.

The two second short term overload capability of dynamic auxiliary reactive plant may be used to fulfill the 50% dynamically variable requirement provided compliance to the other technical requirements can be achieved with the use of that short term capability."

The third paragraph expects that the reactive capability is provided solely from auxiliary dynamic reactive plant and not from the turbines themselves. There are currently 3 MW wind turbines that can produce slightly more than the 0.93 lead to lag reactive capability required of the automatic standard in the NER. This capability is entirely dynamic and is controlled through both the wind turbine control systems and the wind farm control systems. This capability would meet the automatic standard of the NER S5.2.5.1 and some of the automatic standard of S5.2.5.13, but it would not necessarily meet the rise time criteria specified in this license proposal. It would have a slower rise time with a higher damping factor.

3. "The reactive power capability of the generation system operated by the licensee must be controlled by a fast-acting, continuously variable, voltage control system which is able to receive a local and remote voltage set point. "

Paragraph 3 expects that the reactive power capability can be under voltage control whereas paragraph 4 calls for a different control system on the generating system. This further supports the intention of the conditions is to require auxiliary reactive power from FACTS devices. The rules for synchronous machines allow the synchronous machine to provide reactive power in the manner that its control systems allow. Further, the requirements of the NER limit the range in which a voltage control system is expected to operate, and it does not specify a requirement for a remote voltage set point. The NER refers to co-ordination of settings and having a controllable range and providing voltage

regulation in a manner that does not prevent the Network Service Provider from achieving the requirements of S5.1a.3 and S5.1a.4. [2]

4. *The licensee must be able to operate its generating system to a set power factor that is able to be set locally or remotely if that is the preferred mode of control at any time. The power factor control mode must be capable of automatically switching to voltage control mode during power system voltage disturbances, and automatically reverting to power factor mode when the disturbance has ceased.*

The last requirement mandates the manner in which the power factor control and the voltage control interact. The wording is not consistent with current control practice as the power factor control mode at the generating units does not "switch" to voltage control mode. In the dynamic response of both STATCOM devices and DFIG machines there is a fast acting control loop that is triggered by low terminal voltages, and sets off a voltage support mode that quickly exports a high reactive power response. This is not necessarily a 'voltage control' action but rather a voltage support action.

The latest turbine technologies provide for a variety of control methods and not all machines are controlled in the same manner. Some wind turbines are providing reactive power control as an option rather than power factor control. The customer selects which control options are required in order to meet the grid code standards, hence they select and pay for only what they need.

As fixed power factor control can cause voltages to generally rise with increasing power outputs, it is not always desirable to operate machines in a fixed power factor control mode. The last two paragraphs of the criteria limit the control methods, expecting all generating systems to use the same (older) control method of power factor control. This causes a requirement to purchase "power factor control" even if reactive power control would provide better connection point control.

The NER did not mandate which control method should be used but required the provision of voltage regulation in a way that it could be met by a variety of control methods. It allows for power factor, reactive control or voltage control. If connected to higher voltages (greater than 100kV) then using either reactive or voltage control methods are likely to meet the regulation requirement.

A requirement to provide power factor control even if better performance can be achieved using reactive or voltage control methods is inefficient. So the last paragraph creates an expense and removes the ability to use other control methods that are available now that wind turbines have moved beyond power factor control.

Accordingly Pacific Hydro recommends that the last paragraph (Item 4) is removed as it does not improve the control systems or the regulation of the voltage and could be interpreted as being contrary to the NER clauses S5.2.5.13 (b) (4)(ii) and S5.2.5.13 (d)(3)(i).

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[2] NER S5.2.5.13 (d) (3)(i) – clause S5.2.5.13 (b)(4)(ii) is similar but expects more voltage support.

Conclusion

Pacific Hydro believes that the license conditions as proposed will have a detrimental effect on new wind developments in South Australia. In summary, the proposed standards will:

- not result in the most economically efficient outcome in relation to new wind farm connections;
- unnecessarily increase the cost of new projects in South Australia therefore making investment in other states more attractive; and
- restrict the opportunity for DFIG turbines to be used in the South Australian market as the proposed standards do not allow for their inherent reactive power capabilities.

Pacific Hydro acknowledges that the intention of the revision to the licence requirements is to align the conditions with the NER. In our analysis, we believe that the wording has not adopted the principles of control required in the technical standards of the NER and instead has moved away from the NER and further introduced requirements from a different grid code.

It is very concerning that the Commission has proposed a revised set of license conditions that create a barrier for new investment for wind farms in South Australia. ESIPC has acknowledged that the current conditions have resulted in a less than optimum outcome and our analysis suggests that the revised drafting does not rectify these problems. Pacific Hydro strongly urges the Commission to reconsider the proposed licensing conditions.