WINDLAB
ACN 104 461 958

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Australian Energy Market Commission

Lodged via: https://www.aemc.gov.au/rule-changes/improving-nem-access-standards-package-1

RE: ERC0393 Improving NEM Access Standards – Package 1 draft determination

Windlab welcomes the opportunity to provide a submission on the AEMC's draft determination for the Improving NEM Access Standards – Package 1 (Reference ERC0393) rule change.

Windlab is a 100% Australian-owned renewable developer and asset owner, with over two decades of experience developing projects in the NEM. We have successfully developed 1GW+ of wind, solar and BESS projects to construction or operation stage, and have a near-term portfolio of 3GW+ expected to begin construction in the next two years. Our industry-leading in-house Grid Connections team has delivered some of the NEM's most innovative (and complex) projects in challenging parts of the grid without needing to use any external consultants, including technologies such as grid-forming and hybrids. This expertise puts us in a good position to comment on this rule change.

We are in ***strong*** **support** of the proposed package of changes and believe this resolves many critical issues present in the technical components of the grid connection process.

This package of changes will have an *extremely* positive, transformative and immediate impact by resolving many real issues with the current requirements, which generally include:

- **Resolving drifting interpretations to the original intention of existing rules:** Over time, the interpretation and application of rules has changed resulting in effectively new requirements that do not achieve their original intent or add value. For instance, the assessment of the continuous uninterrupted operation requirements for S5.2.5.4 were originally intended to being an assessment of maintaining active/reactive power capability and protection settings, which now sometimes drives needing complex custom control solutions to achieve a certain degree of dynamic performance – for a scenario that isn't even feasible to occur. The rule changes provide much needed clarity around some of these items, and will also provide consistency in understanding between different NSPs and individual engineers.
- **Acknowledging the complexity of power system dynamic performance and difficulties to characterise it:** When the rules were originally designed, generating systems typically consisted of large synchronous machines directly connected to the POC. The physics governing such systems could be sufficiently modelled using second-order dynamical systems, which, when subjected to step-like disturbances and reference changes, exhibited behaviours that could be succinctly understood through characteristics like their rise and settling-times. These types of characterisations were used to extend clauses like S5.2.5.5 in the 2018 rule change. Today, many projects connecting to the NEM do not conform well to these characterisations – multiple generating units, different layers of controllers, hybrid power plants and non-linear control characteristics. These heterogeneous systems make it less effective to classify dynamical response solely by second-order system metrics. When second-order system metrics are the only means of assessing performance, engineers may be incentivised to optimise for rise and settling times, rather than focusing on overall system stability. This is not conducive to creating generating systems that maximise network stability.
- **Better support for grid-forming inverters, hybrid projects, newer technologies and more complex projects:** Many of the asynchronous specific rules were written on the basis of past technology and project designs. With the case of renewables, this meant grid-following inverters in reactive power control, with a power plant controller at the point of connection and standard "fault ride through" modes. Technologies have changed since then – with some devices having grid-forming characteristics, local voltage control, hybrid projects with different technologies, multiple layers of controllers, multiple stage fault ride through modes, etc. These often provide substantial benefits for the power system, but are not compatible or well characterised under the current performance standards.
- **Focus the performance standards on credible, realistic requirements instead of purely hypothetical ones –** it is generally accepted that many of the capabilities required in the rules are simply not credible to ever be actually used in *any* scenario, but require real plant investment to meet compliance. An example might be the requirement in S5.2.5.1 Automatic Access Standard to maintain full inductive capability even when voltages are extremely low (a requirement to have the capability to make a bad situation even worse – which makes little sense), or the extreme multiple fault ride through requirements in S5.2.5.5 (requiring oversized chopper resistors in wind turbines for

scenarios to ride through scenarios that the entire grid would have long since fallen over for). The proposed changes mitigate most of this excessive gold plating and focus on what will actually benefit the grid.

Overall, this will deliver substantial benefits to consumers:

- **Make the grid connection process faster and more efficient –** by removing many of the arbitrary requirements that appear to be "requirements for requirements sake", the grid connection process can focus on resolving and optimising what matters. This will allow more projects to achieve grid approvals quicker – often a blocker for projects to reach financial close and start construction. Accelerating these projects will bring cost effective renewables to market faster, bringing down power prices.
- **Reduce unnecessary capital cost for generation projects –** several of the existing requirements often drive the requirement for extra capital cost that may not be needed by the system. This can include extra inverters to achieve the requirements of S5.2.5.4, or STATCOMs being installed to achieve certain rise/settling time requirements during faults for S5.2.5.5. If these are not required or providing benefits to system security and stability, then they're effectively gold plating the system, which ends up being charged backed to customers through long term power prices.
- **System security is maintained** – these changes have been developed with careful thought by AEMO on what the power system actually needs to be stable, secure and robust. By focusing on the practical outcomes for the power system instead of arbitrary and sometimes even harmful requirements, these changes at the very least do not degrade power system security, and may even improve it.

A more detailed breakdown of our response to each proposed change and its benefits is included in the **Appendix** of this letter below. While we have proposed a few minor amendments for the overall package of changes, we would also like to emphasise that even in the current form we are in strong support of all of them and that these amendments are more about fine tuning.

AEMO undertook an extensive, robust and in-depth consultation process with industry as part of their own process to provide the recommendations for this rule change with some of the best minds in the industry from various types of stakeholders who understand the challenges of the current grid connection process intimately (including AEMO, NSPs, developers, OEMs and consultants) providing input. We recommend that AEMC rely on that extensive work undertaken by AEMO and progress the proposed changes in the final determination.

If the AEMC would like further clarifications or feedback, Windlab is happy to support. Please do not hesitate to contact me via email or mobile.

Regards,

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Appendix

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Clause	Proposed Change	Windlab Position	Windlab Comments
S5.2.5.1	Reduce the voltage range for full reactive power requirements.	**Strongly Support**	Windlab finds this change extremely beneficial. Making the reactive-capability curve voltage-dependent has several positive implications. The proposed AAS curve accurately reflects that almost all generating systems in the NEM will operate in a voltage-droop mode for most of their lifecycle, except during the commissioning phase. This means that when voltages are low, there isn't a scenario where the plant would be required to absorb reactive power, and conversely when voltages are high, there isn't a scenario where the plant would be required to export reactive power. This allows for more effective tuning of voltage-droop performance, as the range of possible operating scenarios is now less conservative. The same tuning benefit will also extend to the optimization of OLTC dynamics. Additionally, the cost of constructing generating systems could be significantly reduced, as it is more likely that systems can be connected with less redundant/oversized inverters being installed purely for reactive power support.
S5.2.5.1	Clarify and amend reactive power capability requirements considering temperature derating.	**Amend**	It is currently common practice for Negotiated Access Standards to include generating system de-rating characteristics in Clause S5.2.5.1 (which include not just reactive power – caused by current capabilities of inverters reducing, but in the cases of wind turbines, sometimes also active power de-rating from the turbine generator itself) – and Windlab support this being more formally included in this NER. It is also possible for a generating system to be configured such that it doesn't de-rate at all, and can maintain its full P/Q capability up to a certain temperature, after which it disconnects from the power system. For certain types of generators, this may be less than 50°C. For wind turbines for instance, it's more common for them to disconnect in the range of 40°C to 45°C. This is because in those hot conditions, wind speeds are low and turbines are not designed to operate. For devices that *are* capable of operating to that temperature – such as BESS or solar inverters – they are naturally incentivised to maintain as high a temperature rating as possible to be able to capture the high energy prices during this period. Windlab proposes that the Automatic Access Standard should be that the generating *system* can **maintain its full active and reactive power capability *without derating* up to the temperature where it disconnects – where that temperature could be any number between 40°C and 50°C**. Noting that this only impacts the Automatic Access Standard, Windlab view this clause as a minor impact and propose the change as a fine tuning improvement.
S5.2.5.1	Clarify requirements for the compensation of reactive power when units are out of service.	**Amend**	Windlab is concerned about the AAS draft rule requiring that a generating system has "no impact on voltage compared with the plant being fully disconnected" **is not achievable by any plant on the NEM, forcing all generators to negotiate an NAS.** All generating systems have some level of passive components – HV transmission lines, main power transformers and 33kV reticulation –

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			which all provide some level of line charging currents and no load losses (noting that we are *excluding* harmonic filters or capacitor banks from this list, as they can – and should - be easily switched out when not required). For larger wind farms, this can be as much 20-30 MVAr. While most generating systems have the capability to continue to control reactive power while not generating active power (eg, "Q at night" on solar inverters, or "STATCOM mode" on wind turbines), this clause refers specifically to the scenario where *they are all disconnected*. An example for this scenario might be being removed from service for maintenance, the devices tripped due to a system event outside of the performance standard ride through requirements, a system strength management scheme, or a fault that has disconnected the whole wind farm. The only way to meet a "no impact to voltage" requirement while generating units are disconnected – in other words, 0MVAr – would be to disconnect these elements from the generating system. However, it is not feasible to then disconnect the whole wind farm's reticulation network. Critical auxiliary loads (including SCADA, protection, communications, cooling systems, yaw systems on wind turbines, signals to a 24/7 control centre, AEMO dispatch systems, etc) are usually supplied through auxiliary transformers that draw power through the connection point. These must remain connected, otherwise it would be impossible to safely control, monitor and operate the generating system (while they usually have backup UPSs and gensets – these will only last 3-10 hours). Furthermore, the very act of energisation – a staged process to bring online the transmission lines, then transformers, then 33kV cables, then auxiliary transformers – would put every single generating system in breach of this AAS requirement on every occasion up until the inverters could be energised to compensate for the passive elements. This would be the same scenario if separate elements – such as STATCOMs or shunt reactors – were used to compensate for these losses. Windlab note that it is aware of some project agreeing to these sorts of requirements of 0MVAr at POC with no inverters connected during development stage without being fully aware of the ramifications during actual site operations. Given these scenarios are rare, it may be that these requirements are simply not enforced (or noted) for projects that agree to these requirements. Windlab proposes that **the Automatic Access Standard should be worded similarly to the MAS, with an acceptable voltage range clearly defined (eg, <1%).** This would allow some projects to meet the AAS, especially when connecting to a stronger part of the grid while other projects would need to negotiate a larger voltage range. Noting that this only impacts the Automatic Access Standard, Windlab don't see this as a major deal breaker (as they can always propose a Negotiated Access Standard), however our concern is more that it promotes an impossible standard as the starting point for negotiations.
S5.2.5.1	Simplify standards for small connections (less than 30 MW in the mainland and less than 7	**Support/ Neutral**	While this change is not of particular interest to Windlab (all our projects are >30MW), it provides added flexibility, which could simplify negotiations. Therefore, Windlab supports this change.

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	MW in Tasmania) unlikely to have material adverse impacts on the power system.		
S5.2.5.2	Delete a reference to a superseded Australian Standard.	Support/ Neutral	The deletion of the reference to the superseded Australian Standard has minimal impact on the connection application process. Windlab supports this change.
S52.5.4	Allow the point of application for overvoltage requirements to be negotiated for medium and low voltage connections.	Support/ Neutral	This change pertains only to connection points with voltages below 66kV, which is unlikely to affect Windlab. However, the change does offer increased flexibility, potentially simplifying negotiations, thus Windlab supports this change.
S5.2.5.4	Bound requirements for over-voltages above 130% and introduce obligations to minimise recurring switching surges.	**Strongly Support**	While it is easy in a model environment to conduct 5.2.5.4 tests in accordance with the proposed interpretation, in a practical sense it is difficult to achieve OEM support (eg, in data sheets or letters) that their equipment can survive above 130% voltage. In reality, insulation coordination strategies (such as surge diverters) would mitigate these sorts of events, but as OEMs are not typically in control of these studies it is difficult to get support. It is reassuring to see the NER rule change reflect the practical limitations of a generating system, rather than an idealized requirement that could lead to over-engineering or extended negotiations of a generating system's GPS.
S5.2.5.4	Clarify the meaning of 'continuous uninterrupted operation' for moderate voltage disturbance requirements.	**Strongly Support**	Windlab strongly supports this change. Reducing the maximum disturbance to 10%, while allowing reliance on tap-changers and other explainable transient responses, in conjunction with the changes to S5.2.5.1, should reduce the need to oversize our inverters to meet the performance requirements of S5.2.5.1 and S5.2.5.4. This approach is likely to reduce the capital cost of projects, with minimal impact on grid performance, as it focuses on optimising for realistic, normal operating conditions rather than an unlikely worst-case scenario. Furthermore, it avoids some NSPs for requiring demonstration of dynamic performance for voltage disturbances that can exceed 10% on an "infinite grid" scenario – a hypothetical scenario that cannot occur on the real system. This often is an extremely challenging test, that sometimes requires extensive site-specific control strategies being implemented for a scenario that is unfeasible.
S5.2.5.5	Define the end of a disturbance for multiple fault ride through.	**Strongly Support**	Windlab very strongly supports these changes. These changes ensure that each fault is seen as a distinct event, precluding the extreme back-to-back fault sequences that were permissible according to the current rules. With back-to-back faults, it's always possible to hand-select a sequence of faults that will result in the generating system tripping. Hence, it was always been an unofficially accepted with NSPs and AEMO that such fault sequences should not be applied when studying a generating system's MFRT capability.

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			It is much better to have these extreme cases explicitly precluded from the test set.
S5.2.5.5	Refine compliance requirements for multiple fault ride through.	**Strongly Support**	Windlab very strongly supports these changes. Like the back-to-back faults, with sufficient knowledge of a plant's voltage control strategy, it is often possible to identify a worst-case sequence of faults that could result in the generating system tripping. In the past, Windlab has followed the DMAT recommendations for MFRT, performing a randomized set of tests on the generating system. However, this approach only demonstrates that those specific randomized tests do not trip the system and provides no insight into other fault sequences, which lacks transparency. It also does not incentivize conducting an extensive range of MFRT tests. Allowing for the negotiation of allowing specific classes of MFRT sequences that may have a particularly adverse interaction with a generating system's VCS to trip the generating system has benefits the network. It encourages developers to proactively identify and share potential tripping scenarios with the TNSP/AEMO during the connection application process, with the ultimate goal of mitigating risk through a negotiated access standard.
S5.2.5.5	Relax the continuous uninterrupted operation requirement for fault level below minimum for which the plant is tuned.	**Strongly Support**	Windlab strongly supports these changes. This clarification facilitates faster connections as it, much like the other MFRT changes, reduces the likelihood that engineering time and GPS negotiation time is spent on edge-cases with vanishing likelihood of occurrence in the real-system.
S5.2.5.5	Delete reference to a metallic conducting path.	**Support/ Neutral**	This change has very little impact on the overall connection process from a developer's point of view, and as such Windlab has no objections to supporting it.
S5.2.5.5	Move parts clause S5.2.5.5 into a new clause S5.2.5.5A.	**Support/ Neutral**	Windlab has no issues with the document restructure.
S5.2.5.5	Amend the requirements for active power recovery after a fault	**Strongly Support**	Windlab very strongly supports these changes. Modifying the definition of when a disturbance ends to be 20ms after the voltage has recovered to within the [85%, 115%] range is critical, as it aligns the definition of active power recovery with the actual causal active power control response of the system—an aspect that can be effectively engineered. Furthermore, allowing the "95% active-power recovery level" to be a function of the frequency-droop/inertial response of the system is essential for the connection of grid-forming generating units. The current rules are written with the assumption that all inverter-based generators are grid-following devices, and hence, the mismatch between grid-following and grid-forming type responses dominates the connection process.
S5.2.5.5	Amend rise time, settling time and commencement time requirements for reactive current injection.	**Strongly Support**	Windlab strongly supports the removal of the settling-time requirement for Iq injection. When connecting distributed generating systems to low SCRs, such as wind farms, the overall plant can exhibit a good Iq injection response but poor settling times due to the movement of voltages at the generating unit terminals.

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			Furthermore, when assessing this in the real system or during PSCAD Wide Area Studies, the dynamic performance of other generating systems will also move voltages during the fault, which can unfairly impact the settling time of the generating system being assessed. This rule change better aligns the practical and intuitive understanding of what benefits the network with what is recorded in the Generator Performance Standards (GPS). Additionally, the 10ms commencement time is a welcome change, as it better aligns the rise-time to reflect the portion of the response controlled by the generating unit.
S5.2.5.5	Amend arrangements for the commencement of reactive current injection and provides clarity on reactive current injection location.	**Strongly Support**	Windlab strongly supports this change. Although Windlab understands that there is flexibility in where reactive current can be measured etc. in the current rules, having the locations and conditions described in the NER itself reduces connection application uncertainty, especially between different NSPs or engineers.
S5.2.5.5	Clarify the response requirements for balanced and unbalanced faults, and recognise negative sequence current responses.	**Support/ Neutral**	Windlab supports these changes. The rules provide greater clarity on what is expected. While the change is technically more onerous than the current rules, having AEMO's expectations clearly outlined in the NER is preferable to receiving the same request through an issues register during the connection process.
S5.2.5.7	Limit its application to synchronous generation only.	**Support**	Windlab supports these changes.
S5.2.5.7	Clarify the meaning of continuous uninterrupted operation	**Support**	Windlab supports these changes.
S5.2.5.8	Strengthen and streamline emergency over-frequency response requirements.	**Support**	Windlab prefers the adjusted rule, as it makes explicit that the active-power reduction rate can be negotiated when the chosen generating unit technology is not physically capable of achieving the AAS rate. The issue of not being able to achieve the current requirements is common amongst wind turbines, which are limited by the mechanical speed that their pitch motors and the mechanical force the wind turbine towers can handle. It preferable for a generating system to ride through these types of frequency disturbance events, rather than exacerbate the disturbance by tripping a potentially large wind farm (which the current rules push a wind turbine towards as its too slow to ramp down within 3 seconds).
S5.2.5.8	Require plant protection settings to be set to maximise capability to ride through disturbances.	**Support/ Neutral**	Windlab supports this change. This suggested change is already aligned with the ethos of how Windlab configures its generating systems, and as such, does not appear to make the connection application procedure more onerous.

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S5.2.5.8	Move the vector shift requirement from clause S5.2.5.16 to clause S5.2.5.8	**Support/ Neutral**	Windlab has no issues with the document restructure.
S5.2.5.10	Add new requirements for instability detection and response	**Amend**	Windlab opposes the Automatic Access Standard requirement for oscillation detection facilities which *"automatically disconnect the plant for unstable behaviour"*. While this trivial to meet (with off the shelf devices sub-synchronous detection devices available), Windlab is concerned that their mass adoption could lead to substantial risk to the power system if implemented by all generating systems. This is because it is the nature of control systems that attributing sole fault for instability is not possible by looking at a single generating system. If a generator could determine whether it is solely responsible for initiating, exacerbating, or contributing to a network-wide oscillation, this risk could be assessed definitively in a SMIB environment. However, this is not the case. Network-wide resonance is not solely dependent on an individual generating system but rather on the network itself and its operating conditions. As such, if oscillations are detected at the POC of a particular generating system, but the resonance is caused by an interaction between multiple generators, then all of the generators involved may detect the interaction simultaneously and trip at the same time. This would be a catastrophic event. This risks escalating instabilities that could be resolved by a single generator being disconnected into major system events. Any oscillation protection scheme needs to be coordinated by a central party – the NSP or AEMO, who may implement staged tripping schemes triggered from instability detection signals (such as tripping one generator at a time, waiting for a period of time, then another, etc), manual intervention by operators, or more complicated schemes that use synchrophasor measurements to determine the best actions. Instead of the requirement for systems which automatically disconnect the facility, Windlab proposes that the generating system must be capable of receiving a trip signal from the NSP or AEMO, who can implement more coordinated instability protection schemes on a system-wide basis.
S5.2.5.13	Remove impediments to unit-level voltage control	**Strongly Support**	Windlab supports this change. As a renewable energy developer, connecting large generating systems to locations in the NEM with low synchronous fault levels, Windlab is always seeking generating unit technologies that enhance system stability and performance. It is excellent to see the NER being adjusted proactively to account for grid-forming technology, particularly for distributed generation over large spatial areas, where local voltage control at the generating unit terminals is preferable. This added flexibility provides another tool for engineering solutions that benefit both the developer and the network.
S5.2.5.13	Prioritise stability over the speed of a plant's	**Strongly Support**	Windlab supports this change. It is always beneficial to have a clear understanding of the preferred performance trade-offs when AAS cannot be feasibly met.

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	response across a range of system impedances.		By explicitly including AEMO's preferred trade-off of good, stable performance at maximum impedances over rise/settling times at low impedances, this change not only provides valuable engineering direction but is also likely to reduce the number of model tuning iteration cycles between the developer, TNSP, and AEMO during the connection process.
S5.2.5.13	Add materiality thresholds on settling time error bands.	**Strongly Support**	Windlab supports this change. This adjustment relaxes the active-power/reactive-power error bands used for determining settling-time performance, which will be particularly beneficial for hybrid generating systems where interactions between different types of generating units can occur. While these interactions are mild and expected, the existing settling-time thresholds can lead to poor settling-time metrics for certain tests, even though the qualitative assessment of the disturbance is acceptable. These changes would have expedited the connection approval process for previous Windlab projects, as the error bands are now relative to the overall plant size rather than the size of the disturbance.
S5.2.5.13	Amend and clarify requirements for multiple modes of operation and treatment of voltage settling time for reactive power and power factor modes.	**Strongly Support**	Windlab strongly supports this change. It is a thoughtful recognition of the engineering effort required to implement alternative control modes. Allowing for testing of 'secondary' control modes under more favourable grid conditions, with less stringent performance requirements, will improve the NEM. This approach enables developers, AEMO, and TNSP engineers to focus their efforts on scrutinizing generating systems under the types of scenarios that are practically expected in the NEM. Furthermore, if a plant is proposing to be in voltage control as that is what required due to poor system strength, it is unreasonable to assess it on its performance in Q-control or PF-control, where it will inevitably be unstable – that's why it is proposed to be in voltage-droop control in the first place.
S5.2.5.13	Recognise system strength services provided by system strength service providers.	**Support/ Neutral**	Windlab supports this change. This should help streamline the connection process for developers who need to procure system strength.
Chapter 10	Amend the definitions of continuous uninterrupted operation, rise time and settling time.	**Strongly Support**	Windlab strongly supports this change. Windlab has encountered obstacles in the connection process due to the previous definition. In hybrid plants with grid-forming type dynamics, multiple dynamic responses are often superimposed. In such scenarios, a disturbance may trigger a response that doesn't meet the rise-time metrics according to the current definition, even though the qualitative response is beneficial for the network. The new definition ensures that these qualitatively good responses are more likely to also meet the rise-time performance, making the process more aligned with practical network performance.

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