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Eneflux submission to ERC0222 Generator technical performance standards

Eneflux supports large scale generation developers and constructors in the National Electricity Market (NEM) in securing grid connection and establishing grid compliance. Companies that Eneflux is currently supporting include; Overland Sun Farming, RES Australia Ltd, IB Vogt GmbH, Infinergy Pacific, RCR Tomlinson Ltd, Green Light Contractors (Elecnor Group), and BayWa r.e..

Combined, these customers projects represent a large proportion of the generation capacity, either approaching construction or under construction in the NEM today. Prior to the establishment of Eneflux in early 2017, its director, Andrew Jones supported the majority of renewable energy projects that are currently operating in the NEM, in his previous roles at Roaring 40s and Lloyds Register. In addition he has also supported the first large scale wind projects in Mongolia, Thailand and Indonesia.

Eneflux welcomes the opportunity to provide input into the Generator Technical Performance Standards (GTPS) rule change process. GTPS are a key electricity market setting that plays a very important role in sourcing the services (in addition to energy), necessary to maintain power system security and reliability. More specifically, GTPS determine the level of each service provided by each generator.

These services come at a cost, so to ensure efficient outcomes (in line with the National Energy Objective (NEO)), the GTPS mechanism should result in new generation plant only incurring cost for services necessary to ensure the safe, secure and reliable operation of the power system. It is also critical to ensure that these services cannot be procured more efficiently through other means (such as broader network solutions).

Applying these principles, this submission seeks to identify some specific opportunities for the draft Rule to better progress the NEO.

Please feel free to contact me if you would like to discuss this submission.

Yours Sincerely,

Andrew Jones

Andrew Jones, Director

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1. Negotiation process

The draft Rule proposes to introduce a process by which Network Service Providers (NSPs) must provide justification in requesting an access standard higher than that proposed by a connecting generator.

In recent years, a material number of instances have been encountered where NSPs arbitrarily request automatic or close to automatic access standards resulting in either increased project costs or projects becoming unviable. Specific examples can be provided on a confidential basis upon request. As such, these provisions have an important role to play in ensuring that additional costs internalised into new generation projects are both necessary and efficient.

In developing this provision, it should be noted that negotiation power between a connecting party and a network company is highly asymmetric, with the connecting party generally having no choice as to which network the project connects to. Further, in the instance of solar, the dynamics of numerous projects competing for scarce grid capacity, very much limits the ability of connecting parties to engage in negotiations that risk delaying their project. This creates a situation where, irrespective of the wording of the National Electricity Rules (NER), a connecting party will generally have little ability to negotiate.

It is suggested the draft Rule should seek to mitigate this asymmetry in negotiating power by providing a high level of direction to the NSP with respect to the grounds for which they can reject an access standard.

The following principles are suggested:

a. The NSP must, on request, provide connecting parties any information reasonably required to determine whether a proposed negotiated access standard would adversely impact power system security, as required to ensure the proposed negotiated access standard meets the requirements of S5.3.4(b)(2).

b. Increased cost of equipment is a valid reason for a connecting party to limit the level of performance proposed.

c. In rejecting an access standard, the NSP must:
    i. Clearly identify the system standard or other standard or regulatory requirement that would not be able to be met as a result of the proposed access standard at the time of connection.
    ii. Clearly identify the minimum level of service (access standard) that would be required to allow the NSP to meet the relevant system standard or regulatory requirement.
    iii. Clearly identify how a service being requested from a connecting generator could not be more cost effectively provided by a network solution.

2. Transitional arrangements

It is considered that the draft transitional arrangements in conjunction with the draft Rule as proposed risk substantially increasing cost of generation and delaying or adversely impacting the feasibility of projects that are materially advanced. Often substantial development capital has been sunk into these projects. Specific project examples can be provided on a confidential basis upon request.

Three key aspects of the draft Rule have been identified as creating these risks.

Firstly, from a process perspective, the requirement for connecting generators to provide evidence to support negotiated access standards (5.3.4 (b2)) and NSPs to respond (5.3.4 (d1)) has potential to place substantial extra demand on NSP technical personnel and technical personnel within generation development companies, power systems consultancies, EPC contractors and equipment suppliers. These particular skill groups are already very much under pressure due to the rapid uptake in renewable energy in Australia over the preceding 24 months. It is anticipated that many organisations will struggle to resource these activities in a timely manner.

Secondly, the proposed minimum access standard for S5.2.5.5 places highly prescriptive standards on current control and injection during fault ride through events. It is expected that this clause, as drafted has a high potential to impact a substantial number of projects. Impacts could include a requirement for expensive additional plant (synchronous condensors or STATCOMs), changing of inverter supplier or revision of inverter firmware. It is understood that this may not be the intent of this clause, and this consideration is addressed later on in this submission.

Thirdly, due to the high number of connections for renewable generators currently being progressed in the NEM, shortages of suitably experienced power systems engineers are highly apparent, in both the power system consultancies and NSPs. As a result, connection applications are progressing at a very slow rate. While it would be reasonable to assume that a well developed connection application could be processed in under 3 months, in previous years, similar applications are taking considerably longer at the moment.

In order to mitigate these risks, it is suggested that the following options be considered:

1. That the final Rule come into effect 6 months after determination for existing connection applications (at time of determination), and that AEMO and NSPs be explicitly required to act in good faith to progress these applications in a timely manner. This would allow reasonable time for these advanced applications to be processed under the rules in place at time of application or;
2. That an alternative mechanism be developed which would grandfather the rules in place for “advanced applications” at time of determination, noting that careful thought would be required to define the criteria for “advanced applications”.

It is noted that in many regulatory environments it is accepted practice that the rules and regulations in place at the time when an application is made are the rules and regulations under which that application is to be assessed, that is that any further changes are not retrospective on existing applications that are part-way through the assessment process. This approach recognises the fact that a decision to invest in or proceed with an application is based on the information available at that time, including the regulatory requirements that may impact on cost, timing and project viability.

3. 5.2.5.5 Generating system response to disturbances following contingency events

The changes proposed in the draft Rule for both the automatic and minimum access standard include highly prescriptive requirements for injection of fault current. Experience of weak grid (SCR < 4) locations with three of the most commonly used utility solar inverters suggests the current injection provisions of the draft Rule have high potential to result in additional equipment (synchronous condensers or sometimes STATCOMs) being needed to meet these requirements. This would have a very similar effect to the proposed “minimum system strength” access standard, as in order to achieve the tight control of current mandated in this access standard, the plant would need controls and equipment equivalent to that necessary to operate under low fault level conditions.

Some specific issues and options for mitigation are outlined below.

Power System Phenomenon

PLL stability on voltage angle shift

Increasing the level of reactive current injection into faults on long transmission systems can result in a large increase in voltage angle shift on fault clearance. Large voltage angle shifts on fault clearance can cause Phase Locked Loops (PLLs) on solar inverters, full converter wind turbines and battery inverters to become unstable. In addition, Doubly Fed Induction Generator (DFIG) wind turbines can trip due to very high stator currents.

Low Voltage Ride Through cycling for shallow faults and voltage dips

Increasing the level of reactive current injection into shallow faults can cause the voltage to rise between the point of connection and inverter terminals, causing the inverters to exit Low Voltage Ride Through (LVRT) mode. The voltage then falls and LVRT mode is again entered. This LVRT mode cycling results in oscillatory behaviour.

This behaviour can be avoided by either reducing the level of current injection into the fault, or lowering the LVRT threshold to reduce the current injected for shallow faults while maintaining current injection for deeper faults.

Potential consequence of draft Rule

The proposed clauses S5.2.5.5(b)(1A)(3)(i)(A) and S5.2.5.5(c)(1A)(3)(i)(A) would require an injection of between 2-4% reactive current for each percentage decrease in voltage below the LVRT threshold. In addition, the proposed clause 5.2.5.5(i)(4) would remove flexibility in setting the LVRT threshold in order to increase current injection while avoiding LVRT cycling.

Based on experience over a large number of solar and wind projects and the most commonly utilised solar inverters in the NEM, it is anticipated that the draft Rule would often require a separate STATCOM or synchronous condensor (at substantial expense) that would otherwise not be necessary on projects with a SCR between 1.6 and 4.

Potential solution

A practical solution to this issue could be to:

- remove the requirement for capacitive current injection during faults from the 5.2.5.5 minimum access standard (delete clause S5.2.5.5 (c)(1A)(3)(i)(A)) and;
- remove limits on setting of LVRT thresholds from the 5.2.5.5 minimum access standard (delete reference to S5.2.5.5(c) in 5.2.5.5(i)(4)).

Power System Phenomenon

High Voltage Ride Through (HVRT) Entrapment

If inverter connected plant has a high level of reactive power capability, sustained shallow voltage dips can result in situations where inverters do not enter LVRT mode. As a result the park level closed loop voltage controller can seek to fully dispatch available reactive power in an attempt to recover the voltage at the point of connection. This results in voltages at the inverter terminals that are substantially higher than at the point of connection.

Should the voltage recover suddenly, the voltage at the inverter terminals rises substantially and the inverters enter HVRT mode. Upon entering HVRT mode, the inverters will either become trapped in this HVRT mode or drop out of HVRT mode, depending upon the level of inductive current response setting of HVRT mode.

Ideally, the inductive current response setting for HVRT mode should be set so that the inverters would exit HVRT mode should this occur. Unfortunately, an aggressive inductive current response would generally be required which often results in HVRT limit cycling as described below.

HVRT Limit Cycling

When a voltage rise that results in inverters entering HVRT mode, aggressive reactive current absorption as part of the HVRT response can cause the voltage at the inverter terminals to drop substantially relative to the point of connection, causing the inverters to exit HVRT mode. The voltage then rises and HVRT mode is again entered. This results in oscillatory behaviour.

This behaviour can be avoided by either reducing the level of current injection into the fault, or raising the HVRT threshold to slow the current injection for mild voltage rises while maintaining fast current injection for more severe voltage rises. Often inverter HVRT thresholds are set in the range of 1.15 to 1.2, so allowing closed loop park level voltage control to manage all but the most severe voltage rises.

Potential consequence of draft Rule

The proposed clauses S5.2.5.5(b)(A1)(3)(i)(B) and S5.2.5.5 (c)(1A)(3)(i)(A) would require the injection of between 2-6% inductive current for each percentage increase in voltage above the HVRT threshold. In addition, the proposed clause 5.2.5.5(i)(4) would remove flexibility in setting the HVRT threshold in order to increase current injection while avoiding HVRT cycling.

Based on experience over a large number of solar and wind projects, and the most commonly utilised solar inverters in the NEM, it is anticipated that the draft Rule would often require a separate STATCOM or synchronous condenser (at substantial expense) that would otherwise not be necessary on a wide range of connection point conditions.

Potential solution

A practical solution to this issue could be to:

- remove the requirement for inductive current injection during faults from the 5.2.5.5 minimum access standard (delete clause S5.2.5.5 (c)(1A)(3)(i)(A)) and;
- remove limits on setting of HVRT thresholds from the 5.2.5.5 minimum access standard (delete reference to S5.2.5.5(c) in clause 5.2.5.5(i)(4))

Power System Phenomenon

Stabilisation of PLLs on weak grid projects

On weak grid projects with very low SCR (often on "fringe of grid"), it is necessary to slow down the inverter level current control and PLL gains in order to ensure stability of the PLL, particularly upon fault clearance. This is due to rapid changes in voltage angle that arise from rapid changes in current injection on weak grids.

Particularly in relation to radial "fringe of grid" applications, it is possible to get stable generation operation and acceptable voltage outcomes at very low Short Circuit Ratios (SCR) by de-tuning the current response of inverters during fault ride through and relaxing control of the dq reference angle upon fault clearance.

Potential consequence of draft Rule

The proposed clauses S5.2.5.5(b)(A1)(3)(ii), S5.2.5.5(b)(A1)(4) , S5.2.5.5 (c)(1A)(3)(ii) and S5.2.5.5 (c)(1A)(4) create a requirement for rapid current variation during faults, and tight control of the dq reference angle on fault clearance (by limiting active power import).

These provisions are expected to create situations where expensive synchronous condensors or STATCOMs will be required to achieve compliance, despite perfectly acceptable power system outcomes being achievable without this equipment.

Potential solution

A practical solution to this issue could be to:

- remove clauses S5.2.5.5 (c)(1A)(3)(ii) and S5.2.5.5 (c)(1A)(4)
- consider whether clauses S5.2.5.5(b)(A1)(3)(ii) and S5.2.5.5(b)(A1)(4) are desirable in that they would have an almost

identical effect to the proposed system strength access standard that has already been rejected.

4. Additional suggestion to improve the draft Rule

Notification of agreement of access standards for connecting generators

Generators perform interconnection studies for the purpose of supporting proposed GTPS under the NER Chapter 5 connection process. These studies are required to consider other generation projects that have achieved committed status. Due to the large number of projects currently seeking to connect to the NEM, it is becoming very difficult to determine the status of other projects (that need to be considered) in the connection process in a timely manner.

To improve the timeliness and efficiency of this process, it is proposed that a provision be added under Clause 4.14 for AEMO to maintain and publish a register of projects that have completed the 5.3.4A process and as such have agreed GTPS. It is proposed that it would be reasonable for AEMO to publish the details of a project for which generator performance standards have been agreed within 7 days of agreement being reached (in line with the 5.3.4A process).