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Submissions in response to Amendments to AEMO instruments for Efficient Management of System Strength Rule Issues Paper April 2022

I welcomes this opportunity to make a submission to the Amendments to AEMO instruments for Efficient management of system strength rule as follows.

The amending rule implements the system strength mitigation requirement (SSMR), which evolves the existing 'do no harm' obligation and coordinates the supply and demand sides of the system strength framework[1].

On the supply side, AEMO must specify revised system strength requirements for system strength nodes, include **the minimum fault level** which ensures the necessary levels of system strength for effective operation of network and generator protection equipment and **the efficient level of system strength** which ensures efficient levels of system strength for IBR connection and operation (hosting capacity and constraint alleviation)[1].

On the demand side, new **minimum access standards** for relevant generators, loads and market network service providers (MNSPs) requires relevant plant to remain connected and operate stably at a **short circuit ratio (SCR) of 3.0** for voltage phase angle shift limits less than 20 degrees at the connection point[2]. The new access standards in the final rule impose additional requirements on newly connecting plant, and amend the requirements on network service providers when connecting or altering a generating system.

Revised system strength connection options with a new **system strength charging mechanism** which allows connecting parties to have the choice of paying a system strength charge or providing their own system strength ('remediating').

This reform aims for more effective use of system strength services and target to share the associated costs more efficiently between consumers and connecting parties. I fully support this reform.

I have below suggestion on the stability Assessment Process[3] as follows:

- ✓ Full impact assessment (FIA) should be performed if the SSSP fails to achieve satisfactory voltage waveform stability upon completion of stability assessment especially at the initial stage of evolving do no harm obligation to the system strength framework.
- ✓ FIA should be performed
    a. To identify IBRs with less SCR withstand capability and perform control improvement or retuning to reduce its needed system strength level for stable operation. If improvement or retuning is not possible, active power curtailment could be imposed to reduce its need for **higher the efficient level of system strength** for stable operation.
    b. To identify instability due to large amount reactive current injection and fast active power recovery following contingency
    c. To achieve better system level coordination of voltage & reactive power control strategy / proper tuning of SVCs for instability mitigation.

[1] System strength final determination, pg94

[2] National Electricity Amendment (Efficient management of system strength on the power system) Rule 2021 No. 11

[3] Amendments to AEMO instruments for Efficient management of system strength rule pg44

The aim is to reduce the need for efficient level of system strength for IBRs, especially grid following type based IBRs, connection and operation, and to achieve more effective use of system strength services and share the associated costs more efficiently between consumers and connecting parties at the end.

Below are details explanation.

Q39 Are there any other issues relevant to the Stability Assessment methodology that AEMO ought to take into account?

Under the Amending Rule, for Applicants who elect to pay the system strength charge, the Connecting NSP will need to carry out a Stability Assessment using a methodology to be set out in the SSIAG.

Like the Full Assessment, a Stability Assessment would be performed via EMT modelling for a range of disturbances, however, it is reduced in the observability of variables (observation of system voltages at key system nodes). This approach is considered to be aligned with the requirement to ensure stable voltage waveform in a steady state as well as following the contingency, but not during the event.

If the voltage waveform stability is not satisfactory and SSSP fails to adjust its plans to stabilise the voltage, the identified issues will therefore need to be addressed either by the Applicant (where associated with its own plant configuration), or by operational arrangements that will apply unless (and until) sufficient system strength services are available.

In my opinion, there might be worth to perform full impact assessment (FIA) for further investigation if the SSSP fails to achieve satisfactory voltage waveform stability upon completion of stability assessment. The reasons are listed as below:

Firstly, the new connecting generator has obligation to fulfil amending rule S5.2.5.15 and S5.2.5.16 with which it can remain connected and operate stably at a short circuit ratio (SCR) of 3.0 for voltage phase angle shift limits less than 20 degrees at the connection point. It is expected that new connecting has superior SCR/phase shift withstand capability compared to some of or most of the existing generators. Therefore, it has less tendency to initiate unstable control interaction (inverter instability) or cause oscillatory voltage following the contingency. As a result, the instability cannot be easily addressed by tuning of the new connecting generator or its re-configuration.

Secondly, integrating new connecting generator (let limiting the discussion with grid following type based IBRs) in general reduces the SCR (by any SCR definition) seen from the committed generators under the same system strength node. If one or some of the existing generators could not withstand reduced SCR, it might exhibit oscillatory behaviour in the system strength nodes as shown in Figure.3[4]. The above-mentioned existing generator(s) are the root cause of the instability.

Measures could be taken to identify these generators having less low SCR withstand capability and control improvement and control parameters re-tuning can be carried out to reduce the demanded system strength level for maintaining the voltage waveform stability for the area. This will be beneficial for the future new connecting generators in the area as well.

Thirdly, the NER S5.2.5.5 has very demanding requirement for reactive current injection during fault and active power recovering post fault in the AAS. The high reactive current injection has the potential to cause instability due to hunting or retriggering of the LVRT control logic

[4] Amendments to AEMO instruments for Efficient management of system strength rule pg43.

especially during shallow fault and furthermore could cause issues with the generating unit's ability to detect fault clearance locally by sensing the restoration of voltages.[5]

Further, projects which have fulfilled AAS with grid following type IBRs has difficult in operating stably under reduced or low SCR conditions. This is because when voltage has been cleared by protection e.g., removing one of faulted transmission line, the active power increases rapidly and flow on larger impedance of the circuit which will drive voltage down again and cause a further voltage dip. The large amount of reactive current injection will drive IBRs voltage high and thus out of fault again. The retriggering FRT has the potential to cause instability as well.

The exiting generators fulfilling S5.2.5.5 have potential to cause instability following contingency. Therefore, it is good to investigate the voltage waveforms for these generators to determine whether they are the troublemakers.

Fourthly, based on previously experience with FIA, there were many occasions that the tunings have been required for SVCs or system level coordination of voltage and reactive power control in a large area.

It is recommended that the above-mentioned three possible instability contributors (or more) should be considered with FIA to determine root cause of voltage waveform stability and reduce the demanded system strength level for the given system strength node. I understand tremendously endeavour is needed to remove these bottlenecks of voltage waveform instability. However, if it is not being addressed carefully at the initial stage of evolving do no harm obligation to system strength framework, they could always be root cause of voltage waveform instability in many new connecting generator stability assessments. The resulting voltage waveform instability cannot be remediated by new connecting generator self-tuning. As a result, there is tendency that the new connecting generator will need to pay system strength remediation (SSR) in addition to system strength service (SSS).

This is contradicted with the aims of evolving do no harm obligation to system strength framework which is aimed for more effective use of system strength services and sharing the associated costs more efficiently between consumers and connecting parties

On the other hand, if FIA has been performed where stability assessment fails, it has potential to reduce the need of **the efficient level of system strength** for the future connecting IBRs stable operation by improving the existing generators withstand capability of low SCR grid and better system level coordination of voltage & reactive power control strategy / proper tuning of SVCs etc. Together with the enforcement of new **minimum access standards,** less voltage waveform stability is expected to see in the future and less efficient level of system strength is expected to be needed for stably operating of IBRs during steady state and following contingency.

In summary, in the submission in response to Amendments to AEMO instruments for Efficient Management of System Strength Rule issue paper, it has been suggested that

- ✓ Full impact assessment (FIA) should be performed if the SSSP fails to achieve satisfactory voltage waveform stability upon completion of stability assessment especially at the initial stage of evolving do no harm obligation to the system strength framework.
- ✓ FIA should be performed
    a. To identify IBRs with less SCR withstand capability and perform control improvement or retuning to reduce its needed system strength level for stable operation. If improvement or retuning is not possible, active power curtailment

[5] NATIONAL ELECTRICITY RULE CHANGE PROPOSAL, Reactive current response to disturbances (clause S5.2.5.5), GE International Inc, Gold wind Australia, Siemens Gamesa Renewable Energy and Vestas Australia

could be imposed to reduce its need for **higher the efficient level of system strength** for stable operation.

b. To identify instability due to large amount reactive current injection and fast active power recovery following contingency
c. To achieve better system level coordination of voltage & reactive power control strategy / proper tuning of SVCs for instability mitigation.

Please feel free to contact me should you require further information or other supporting documents.

Yours Sincerely,

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