Connections & Power Systems Advisory Pty Limited
hello@cpsadvisory.com.au
www.cpsadvisory.com.au
PO Box Q972
Queen Victoria Building
NSW 1230

19 August 2022

Australian Energy Market Operator (AEMO)
via email planning@aemo.com.au

System Strength Requirements Methodology and Power System Stability Guidelines – Second Stage Consultation Submission

Dear AEMO,

Connections & Power Systems Advisory Pty Limited ("CPSA") welcomes the opportunity to provide a submission to the second stage of consultation on the System Strength Requirements Methodology (SSRM) and Power System Stability Guidelines (PSSG).

CPSA is an engineering consultancy firm with a focus on grid connection with a team that has over 5 GW of experience connecting generators and loads to the National Electricity Market. We have experience working with network businesses, the market operator, generators, load customers and hence a range of experience. We do not represent any particular industry roup and our submission is based on ensuring there is a pragmatic approach to managing the power system and enabling an orderly transition of the energy sector.

Our high-level observations on the SSRM and PSSG are:

- The term 'System Strength" is a catch all phrase used to identify a range of issues and should be used with care.
- The importance of identifying the key issue to be addressed, that being converter stability of Inverter Based Resources (IBRs) in both the SSRM and PSSG.
- The importance of differentiating power quality issues from issues related to converter stability, the latter of which is what the SSRM is aiming to address.
- Ensuring an accurate classification of power system stability in relation to IBRs and converter stability.

1. SYSTEM STRENGTH REQUIREMENTS METHODOLOGY

We note that there are many considerations in the SSRM that are more relevant to power quality phenomenon than converter driven stability associated with IBRs.

Care is required to ensure we differentiate between the limitations of IBRs (that being converter stability) versus power quality issues that would be present regardless of the connection of IBRs.

Our specific comments on the draft SSRM are provided below in ***Table 1***.

Table 1 Comments relating to the SSRM

Section	Item	Details
4.3	Reference to stable operation of capacitor banks and reactors (shunt or series)	Shunt devices are not impacted by converter driven instability in that they are passive devices where the output is a function of voltage. Hence, they should not be covered by this guideline.
4.3	Reference to AS/NZ 61000-3.7	This standard covers limits for short term flicker, long term flicker and rapid voltage changes which are all power quality phenomenon. Power quality is the responsibility of the Network Service Provider (NSP), hence it is not clear how AEMO's assessment of this will be undertaken , how this will be coordinated with the NSP's obligations and what the outcome of this assessment would entail. The SSRM should provide more detail on how this will be assessed as power quality issues are often already present in parts of the network in the absence of IBR connections. For example, rapid voltage changes or flicker issues can be caused by large motors starting or operation of electric arc furnace (both of which are not related to converter stability associated with IBRs). We urge AEMO to provide clarity on how power quality will be considered in the SSRM. Ultimately, converter driven instability or interactions can present as a power quality issue, however the root cause is often poor tuning or coordination of controllers and a lack of damping. Increasing 'system strength' by increasing the synchronous fault level would only mask pure tuning of converters.
4.4.2(d)	*'any other requirements in the NER and AEMO's Power System Stability Guidelines relating to power system stability'*.	The PSSG as they stand refer to "System Strength" as a form of stability which is not correct. System Strength is a catch all phrase which refers to systems where issues other than converter instability can arise. We do not envisage any material issues with this clause provided that

		"System Strength" as a form of stability is replaced with a more appropriate term in the PSSG (see below for our recommendation).
5.1	Reference to 'voltage waveform instability'	Care should be taken as this term is undefined and is likely to be misinterpreted to be either a power quality issue or a stability issue (or both). Voltage distortion (a power quality issue usually related to harmonic distortion) and voltage stability (a form power system stability) on the other hand are well understood and defined terms.
5.1.1	Criteria 1 – Voltage magnitude	Reference to voltage excursions and voltage step changes are power quality issues, not those related to converter stability. We are concerned that power quality issues are being resolved by solutions intended to resolve converter stability related problems.
5.1.2	Criteria 2 – Change in voltage phase angle	Setting a limit of 45 degrees based on sync check relay settings (between 30 and 60 degrees) is not appropriate in the context of converter stability. Sync check relays angle thresholds are set to limit the impact on the network and/or to generators when circuit breakers are closed (closing breakers with large angle differences results in mechanical stress to rotating machines). Angle change limits should be set based on the ability of IBR Phase Locked Loops (PLLs) to accurately track the voltage vector. More research and assessment is required before an angle limit can be settled upon, else it may result in an overbuild of 'system strength' services.
5.1.3	Criteria 3 – voltage waveform distortion	Reference to voltage waveform distortion is a power quality issue. It isn't clear what the acceptable limit is. Voltage waveform distortion is typically managed by the network service provider allocating appropriate emission limits to manage overall harmonic distortion within planning limits. Resolving harmonic issues can only be undertaken efficiently by utilizing harmonic filters to reduce harmonic currents (not by increasing 'system strength' via synchronous generators or additional interconnection).

2. POWER SYSTEM STABILITY GUIDELINES

We note that AEMO is proposing to amend the PSSG definitions for the forms of stability by the inclusion of the term "System Strength" under A.1.6. We urge AEMO to reconsider this and propose an alternative definition for the following reasons.

Table 2 Comments relating to the draft PSSG

Comment	Details
System Strength is not a form of stability	The term system strength is a catch all term in the context of synchronous and asynchronous generators that is not intended to capture the issues related to Inverter Based Resources (IBR)s. Prabha Kundur, one of the most authoritative people in the field of stability and control talks about a weak networks as: *"The ac system is considered as 'weak' from two aspects: (a) ac system impedance may be high, (b) ac system mechanical inertia may be low". (Power System Stability and Control, Prabha Kundur).* The concept of weak networks has existed for decades and is used to identify both voltage and frequency issues (regardless of the generation technology) which then requires further analysis.
Converter driven stability is a more appropriate form of stability for the PSMG	The Efficient Management of System Strength rule change was intended to ensure IBRs can operate stably. To this extent, we need to focus on the specific problem such that we can find suitable solutions. The key problem being that we need to ensure IBRs can operate such we operate the power system within the limits of their converters to avoid converter instability. On July 4 2021, there was a revised version of the "Definition and Classification of Power System Stability" which was specifically modified by adding a new category (form of

	stability) called Converter driven stability[1]. We recommend AEMO consider this new category in the context of the PSSG to be specific to the form of stability that is to be managed. We believe converter stability is a more appropriate classification.
Reference to Voltage Waveform	Care is needed in referring to the voltage waveform and stability as changes to the voltage waveform are typically power quality issues. For example, a network with a high level of Total Harmonic Voltage Distortion due to non-linear loads would result in a distorted voltage waveform. Voltage distortion is typically caused by non-linear loads drawing current across the network impedance. Voltage distortion can be reduced by either reducing the distorting current or reducing the network impedance. It is more efficient to reduce the distorting current (usually by sinking it via filters) than it is to reduce the network impedance (by adding synchronous plant or increasing interconnection).
References to resilience will add uncertainty	References to resilience under A.1.6 of the PSSG should be reconsidered as the term is undefined, not relevant in the context of classifying power system stability and has differing interpretations across the industry.

[1] https://ieeexplore.ieee.org/document/1318675/authors#authors

We appreciate that this a complex topic and hence welcome the opportunity to discuss any of the afore mentioned in further detail with the AEMO.

For any further information, please contact Winodh Jayewardene at winodh.jayewardene@cpsadvisory.com.au.

Yours sincerely

Winodh Jayewardene
Managing Director