7 May 2020

Mr John Pierce AO
Chair
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

Lodged online via: www.aemc.gov.au

Dear Mr Pierce,

Australian Energy Market Commission Discussion Paper: *Investigation into System Strength Frameworks in the NEM*

Energy Queensland Limited (Energy Queensland) welcomes the opportunity to provide comment to the Australian Energy Market Commission (the Commission) in response to the Commission's Discussion Paper - *Investigation into System Strength Frameworks in the NEM* (discussion paper).

System Strength is one of a number of foundation technical issues that needs to be navigated as part of the transition to a lower emission National Electricity Market (NEM) with a changing generation profile, that still provides the benefits, security and reliability that customers expect.

Energy Queensland's primary concern is that any framework must be appropriate for all large generators, regardless of whether they are connected to a distribution or transmission network. Energy Queensland has previously made a number of submissions[1] to the Commission on the lack of applicability of rules impacting major generators connecting to distribution network service provider (DNSP) networks, and notes that this discussion paper does not account for DNSP specific issues previously raised. Energy Queensland already has 1.4GW of either connected or committed >5MW large-scale generation with another 2.6GW in various stages of the connection process. System strength is already a significant DNSP challenge today.

An effective transition to a lower emission NEM will require transformation and optimisation across the entire electricity supply chain and any model and rule changes need to have regard to the impacts and opportunities across that supply chain, including distribution networks.

[1] Energy Queensland submission to Australian Energy Market Commission consultation on *Transparency of new projects*, May 2019;
Energy Queensland submission to Australian Energy Market Commission consultation on *Coordination of generation and transmission investment implementation – access and charging*, August 2019;
Energy Queensland submission to Australian Energy Market Commission consultation on *Renewable Energy Zones*, November 2019.

Energy Queensland's DNSP's, Energex and Ergon Energy, have been at the forefront of this change, supporting significant adoption of renewable generation and a country-leading rate of distributed energy resources (DER) adoption. Through the connection and commitment of 1.4 GW of large-scale renewable generation greater than 5MW (22 locations less than 30MW and 15 locations greater than 30MW), and a further 47 projects in various stages of the application process (with a total of 2.6 GW estimated capacity, including 34 locations greater than 30MW), Energy Queensland has developed a detailed understanding of how system strength and the system strength framework has impacted generators, distribution and transmission networks.

Given the potential investment and affordability implications associated with some proposed models, Energy Queensland believes that a robust analysis of the costs in comparison to consumer benefits is critical. As generators do not pay a Generator Use of Systems charge, any associated network costs are passed to the broad customer base through their network charges. It is not evident to Energy Queensland, that detailed cost benefit analysis has been conducted on any of the proposed models, although the discussion paper highlights that the current model is economically inefficient and certain models are more economically suitable than others. Energy Queensland suggests the Commission releases or develops supporting models to confirm these recommendations given the potential significance of the changes proposed.

While Energy Queensland is generally supportive of refining the existing system strength framework, we do not consider that a complete overhaul of the framework is required, particularly as the existing framework has had limited time to be effectively implemented in the context of other changes such as the Power System Model Guidelines and Generator Technical Performance Standards rules changes. It is Energy Queensland's view that targeted review and improvement of the key issues/challenges associated with the current framework would be the fastest and least disruptive way to progress the management of system strength. This would include a focus on model sharing provisions, a review of minimum short-circuit ratio requirements, reinforcement of the existing role that the Integrated System Plan (ISP) has in coordinated investment (particularly to support strategic system strength reinforcement), and further coordinated education and support to consultants, developers and investors about system strength implications from a centralised source to ensure consistency and continued whole of market investment into understanding weak grid options for renewable energy integration.

In terms of the proposed models, Energy Queensland does not support Model 1 or 2 in isolation in the way that they have been proposed, as they do not deal appropriately with DNSP connected generation. Model 1 could be modified to address this concern, by expanding the coordination and planning function to appropriately consider DNSP connected generation.

Energy Queensland notes that the paper discusses the challenges associated with dynamic electro-magnetic transient (EMT) (i.e. PSCAD) modelling. EMT tools have proven in many cases to be the only way to appropriately represent the power system accurately and determine system stability. In fact Energy Queensland's experience has identified that traditional dynamic tools are limited in their effectiveness in a high power electronic asynchronous generator network.

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We strongly emphasise that this modelling is absolutely essential for analysing the performance of asynchronous generating systems. Energy Queensland does acknowledge that there is currently a general underestimating of the technical detail which does increase the complexity and time taken in the use of these models by all parties. However, as noted in this submission, Energy Queensland considers there are other ways that these issues can be addressed.

Should you require additional information or wish to discuss any aspect of this submission, please call Laura Males on (07) 4432 8222 or myself on (07) 3851 6787.

Yours sincerely

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Encl: *Energy Queensland's comments to the questions raised in the stakeholder submission template.*

Investigation into system strength frameworks in the NEM

STAKEHOLDER SUBMISSION TEMPLATE

The template below has been developed to enable stakeholders to provide their feedback on specific questions that the Commission is interested in due to the discussion paper. It is designed to assist stakeholders provide valuable input on those questions the Commission is interested in. However, it is not meant to restrict any other issues that stakeholders would like to provide feedback on.

SUBMITTER DETAILS

ORGANISATION:		Energy Queensland
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CHAPTER 2 – KEY ISSUES WITH THE CURRENT SYSTEM STRENGTH FRAMEWORKS

Section 2.3 – Key issues of the minimum system strength framework	
1. Do stakeholders agree with the AEMC's assessment of the issues of the minimum system strength framework?	Energy Queensland partially agrees with the Commission's assessment of the issues, noting that some cases referenced in the discussion paper do not suggest a failure of the framework, rather suggest cases where the framework was not followed due to timing. The discussion paper indicates that some nuance is required in assessing the 'issues' of the system strength framework. The framework came in to place in July 2018 and some generators are still connected who were committed prior to that date. This is less than two years and during that time there were also changes to the Power System Model Guidelines and Generator Technical Performance Standards. This has compounded the industry's challenge in being able to adopt this change without issue. The rate of change in terms of rules, as well as the rate of connections, is unprecedented, causing challenges for proponents, investors, manufacturers, AEMO and network

	service providers. It is suggested that further education and engagement between all parties will spur significant progress in meeting the technical challenges. The Commission notes, on page 11, of the discussion paper… "That is, TNSPs are responsible for providing the minimum system strength level, while operational issues (like contingency responses) is managed by AEMO through the definition of the minimum level and real-time interventions when necessary.". Energy Queensland notes that the management of planned outages is increasingly challenging for TNSPs, DNSPs and AEMO and it is our view that relying solely on real-time interventions may lead to a failure. It is important to consider this not just from a system strength perspective but also from a framework of planned outage management and considering the implications for the proliferation of small scale DER and large-scale distribution connected plant. It is suggested that the concept of a 'safety margin' should be incorporated in addition to the defined minimum. Additionally, Energy Queensland notes that in several places through the discussion paper PSCAD is referred to as "…complex, iterative nature of the modelling tools chosen to model system strength…" or alike. The inference is that the use of PSCAD or the undertaking of EMT modelling is optional and that modelling of this nature is onerous or is the cause of the delay. Energy Queensland began using PSCAD/EMT tools prior to the requirements of the Power System Model Guidelines and the System Strength Impact Assessment Guidelines, due to identified poor customer outcomes in terms of assessing generator performance on our network, and the subsequent impact to other customers, in terms of power quality and system stability. Therefore, Energy Queensland contends that difficulties attributed to PSCAD modelling are symptoms of power system complexities, and a skills shortage in this area. Energy Queensland does not view PSCAD modelling as an optional step, but rather an essential task to ensure continued quality service to existing customers whilst facilitating new entrants. Energy Queensland also suggests mandating of PSCAD model sharing amongst participants will improve modelling outcomes and further reduce delays in the assessment process.
2. Have stakeholders identified any other significant issues as a result of the minimum system strength framework?	Energy Queensland contends that the basis of the system strength framework is sound, and suggests that minor improvements could be pursued, rather than a complete overhaul.
Section 2.4 – Key issues of the "do no harm" framework	
3. Do stakeholders agree with this assessment of the issues of "do no harm" framework?	Energy Queensland suggests that more nuance is required in the assessment of the 'issues' of the 'do no harm' framework. As stated in the discussion paper, Energy Queensland agrees this is a physics and operational matter when connecting a new generator to the power system including

	the requirement to ensure that the connecting generator remains compliant in all cases and that the power system remains stable with the inclusion of the new entrant. Section 2.4 notes, “System strength impact assessments are time intensive and iterative processes due to the current modelling that is undertaken. In addition, these modelling processes can take significant time to run and model different scenarios given the scale of generation connecting to the network.” Energy Queensland believes that the Power System Model Guidelines have made good grounds in clarifying the considerations that proponents need to take into account when submitting a model suitable for efficient assessment. At the same time, application of the Power System Model Guidelines appropriately is not consistent across consultants which can have a significant effect on time and iterations. Energy Queensland cautions against attributing fault to the framework or a particular modelling package, when by its very nature, the complexity of the power system and the rate of the change therein is fundamentally the root cause. For example, there can often be a disconnect in understanding between investors, developers, and their consultants along with AEMO and Network Service Providers (NSPs). This is partly due to the lack of qualified persons to complete modelling work. This is not an issue with the ‘do no harm’ framework directly, but rather with rapid industry changes, requirements that are still being understood by industry and a tension between investor expectations and technical reality. Original Equipment Manufacturers for asynchronous technologies are still at a preliminary stage of development for weak grid application and model versions are constantly changing as performance issues are identified or controls are improved. In the discussion paper, the Commission has noted its understanding that many (if not all) generators seeking to connect in the particular regions are currently required to undergo the full "do no harm" process. This includes a full impact assessment, and requires remediation works to be completed in most cases. All generators connecting under rule 5.3A of the National Electricity Rules (NER) in Energy Queensland’s distribution networks (Ergon Energy Network and Energex) undergo a preliminary assessment. As per the System Strength Impact Assessment Guidelines, if the results indicate that

	a full assessment is required, then one will be undertaken. Indeed, all generators in Queensland, regardless of location, connecting under rule 5.3A will have some stability analysis performed in PSCAD, whether through a full assessment or a wide area stability study. The nature of the modern power system means that a genuine need for this analysis exists, without which the operation of existing generators (i.e. the continued ability for those generators to meet their performance standards with a new entrant), the stability of the new entrant, and the stability of the power system as a whole is at risk. For distribution connections, Energy Queensland disagrees that remediation works are required in 'most cases' that involve significant investment in plant. However, tuning and plant optimisation approaches are required in most cases. In Box 5 of the discussion paper, the statement is made "… Many generators that have connected to date that have had to comply with the "do no harm" obligation have opted for synchronous condensers...", in Energy Queensland's experience, this is not the case. In the Ergon Energy network there is one committed project that contains a synchronous condenser. This inclusion was prior to the implementation of the System Strength Impact Assessment Guidelines and was a natural conclusion for that generator based on the size of the system relative to the system strength when connecting. The Commission has also noted in the discussion paper that stakeholders have also advised that their modelling frequently has to be re-run, because numerous generators are connecting to the power system simultaneously. Energy Queensland acknowledges that commitment of a generator may lead to delays, in the form of a repeat of the full assessment, and in some cases, requirements to retune a generator or remediation. It is noted that the proposed models do not address this risk directly as control system interactions must always be studied, even in a strong network. To assist, Energy Queensland suggests the framework could mandate sharing of PSCAD/EMT models, and encourage proponents to work together more closely, to enable reduction of risk for all parties. It is also important to note that some iterations of model tuning and model development can be due to generating system models being inadequate or not performing according to minimum requirements of the Power System Model Guidelines. This points to a continued growth in maturity required for the market in model development and accuracy. Further, the discussion paper refers to complexity being compounded by the significant number of generators connecting to the system and the number of scenarios that need to be modelled. It

	is important to note that even if the system strength framework is altered, the number of scenarios required to be modelled will likely be materially the same and the inherent modelling challenges will still be present. Energy Queensland is unclear what the Commission means by its reference to full impact assessments determining key connection requirements but are undertaken late in a project's timeline. For distribution connected projects, they are undertaken prior to development of the connection contract, i.e. much earlier than suggested by the Commission Energy Queensland notes that proponents are often not comfortable with proceeding to a higher cost investigation, before being confident that they can achieve their desired power export due to thermal or non-stability limitations. Additionally, Energy Queensland highlights the explicit articulation of TNSP's undertaking the detailed modelling and the connection to the TNSP network. Given that the framework equally applies to DNSPs and generators connecting at the distribution level, Energy Queensland requests that the Commission refer to 'the connecting NSP', rather than simply the TNSP. In section 2.4.3 of the discussion paper, the Commission notes that given the locational aspects of renewable resources, many new entrants are connecting electrically close to each other, thereby creating the opportunity for individuals to share some or all of their remediation works where there are economies of scale to be realised. The Commission also notes in section 2.4.3, the value to new entrants of coordinating remediation work is particularly evident when installing synchronous condensers as network side, shared assets. However, Energy Queensland notes that in Queensland, the solar resource is not concentrated in the same manner that wind resources can be. This means there is ample availability of resource (of varying quality) across the state, though only a very small area of Queensland contains solar generation. Therefore this is not tied to the resource, but rather economics where generators are attempting to utilise existing built infrastructure and thus concentrating at electrically common locations. The framework at present does not prevent proponents working in good faith with each other to accomplish a common goal, including the facilitation of centralised plant for the purpose of supporting system strength. However, Energy Queensland's experience is that the framework does not encourage this practice either.
4. Have stakeholders identified any other significant issues as a result of the "do no harm" framework?	The Commission has made the *Transparency of the Connections* rule change. However, Energy Queensland notes this does not apply to DNSP-connected projects, regardless of size. As a result, transparency of all >5MW generation seeking to connect to the NEM is not available and projects

	connecting to DNSPs (there are currently more than thirty projects in enquiry or application stages across Energy Queensland's distributors networks) are not visible to the market, Energy Queensland suggests that the Commission could mandate model sharing between proponents. This would resolve some uncertainty for proponents if they were enabled to perform their own assessments to a reasonable level of detail prior to application. The intellectual property issues cited by manufacturers could be managed by 'black boxing' models, similar to what occurs for PSS/E models.
Section 2.7 – Conclusion	
5. What are stakeholders' views on the Commission's proposal to consider evolving the framework to a more integrated approach for system strength in the NEM?	Energy Queensland agrees that in some cases a more centralised approach is warranted. However, this discussion paper does not provide any modelling or economic analysis on what the appreciable difference to consumers will be. This is a critical step for the progression of any option. It has been stated that the current framework adds costs to generators. However, each of the options presented in the discussion paper may shift cost, be less efficient for generators, TNSPs or connecting NSPs and each option may present a different cost outcome for consumers. It is noted that at present, generators do not pay Generation Use of System Charges. As such Energy Queensland identifies that cost recovery for a TNSP/DNSP for network assets is very different compared to the cost recovery for a commercial entity developing a project that has a power purchase agreement (or participates in the market in general). Although it is recognised that a TNSP providing centralised system strength for all generators may be 'simpler' in some cases, consumers should not suffer financial penalty. Energy Queensland strongly advises not to reduce the level or type of analysis that occurs prior to connection of any generation system. Energy Queensland suggests this will lead to additional future costs and complications. Delaying risk to a later stage also compounds costs exponentially, with little benefit to a generation project.

CHAPTER 3 – CONSIDERATIONS FOR PROVISION OF SYSTEM STRENGTH

Section 3.1 - What is system strength?	
6. Do stakeholders agree with the Commission's characterisation of system strength?	Energy Queensland generally agrees.

7. Has the Commission set out all the necessary considerations for defining a system strength service? If not, what additional considerations could be included?	Energy Queensland suggests it is imperative that any framework links back to the ISP.
8. Do stakeholders consider the regulatory definition of system strength should be updated/changed? If not, why not? If so, how could this be done?	Energy Queensland has no comment.
9. Do stakeholders consider that the system strength definition should recognise active and passive system strength procurement? If not, why not? If so, how could this be done?	Although Energy Queensland understands the intent of the discussion paper in this regard, tuning is a response to system strength and occurs for many reasons. It is not a 'passive contributor', more a threshold for stable operation of a network.
10. Do stakeholders agree that clarifying the NER system strength service definition is likely to contribute to more/broader options for the system strength provision?	Energy Queensland believes clarity is important, but as the discussion paper states, traditional services (through retirement or the locational nature of system strength) may not be available.
11. Are there any additional sources of fault current in the NEM that can contribute to meeting system strength needs?	Energy Queensland has no comment.
12. Are there any other technologies in the NEM that can contribute to meeting system strength needs that should be considered?	While Energy Queensland is aware and supportive of innovative technology solutions, rule changes should remain technology agnostic. It is noted that cost-effective use of grid-forming inverters may provide an economic outcome compared to other system strength improvement measures and could form part of the economic analysis conducted by the Commission.
Section 3.2 - Why is system strength needed?	
13. Do stakeholders agree with why system strength is needed?	Energy Queensland broadly agrees system strength is needed. It is noted that inadequate system strength management may have flow-on risk and additional cost to generators and customers in terms of power system stability and safety.
14. Are there any additional reasons for why system strength is needed in a power system?	System strength and synchronous fault currents are inherent in the way the power system has been designed.
15. Do stakeholders agree with the characterisation of the impact of inverter-based generation on system strength?	Energy Queensland suggests that there needs to be a move to a philosophy where generating systems are tuned for contingent system strength conditions (potentially even as an alternative

	setting group) where existing fault levels are higher but may change due to operational changes (i.e. planned or unplanned events) or power system evolution.
16. Are there any additional impacts on system strength that should be taken into account?	Energy Queensland has no comment.
Section 3.3 - The provision of system strength in the NEM	
17. Do stakeholders agree that with the characterisation of system strength thresholds?	The Commission notes in the discussion paper that, in the extreme, fault levels must be kept below the rating of equipment which is required to interrupt the fault current to isolate the impacted network element. Energy Queensland notes high fault levels can also be a problem throughout the power network. All electrical equipment, both that owned by NSPs and network users, should be able to withstand maximum fault levels. It is a concern to Energy Queensland that some network users choose to install lower-fault rated equipment without considering future network evolutions. Future change in reinforcement of minimum system strength could lead to those ratings being exceeded, leading to equipment damage and safety risk to people, and cost to customers in terms of network upgrades. Energy Queensland considers that both a minimum and maximum fault should be defined. Energy Queensland has been working with this challenge for many years as the evolution of embedded generation in weaker radial networks (and even strong urban networks) has put upward pressure on fault levels. As a network, it is relatively straightforward to assess the impacts, prepare for (plan) and resolve (although expensive) the impact of rising fault levels. It is significantly less so for our customers where design is often outsourced for a price point and the conditions of the day. This approach results in lack of consideration for future system changes or even the customer's change in use (such as a future connection of a generator).
18. Are there any additional thresholds or alternative characterisations that might be included in the investigation?	Energy Queensland has no comment.
Section 3.4 - The provision of system strength in the NEM	
19. Do stakeholders agree with the system strength attributes?	Energy Queensland generally agrees.

20. Are there any additional attributes of system strength that the Commission should be aware of?	Energy Queensland has no comment.

CHAPTER 4 – EVOLVING SYSTEM STRENGTH FRAMEWORKS

Section 4.1 - Approach to developing a new framework	
21. Do stakeholders agree with approach (Plan, Procure, Price, Pay) to developing a new framework for system strength? Are there additional steps/concepts that should be explored?	Energy Queensland maintains that any change to the framework is examined from an economic perspective to ensure end-users of energy at not worse off in terms of cost.
Section 4.2 - Models for delivering system strength	
22. Do stakeholders agree with the summary of the potential capabilities of each system strength model in Table 4.1?	Energy Queensland is of the view that some components of each of the proposed models has utility and forms part of an overall strategy of managing system strength in the network.
Section 4.3 - Model 1: Centrally Coordinated	
23. Do stakeholders agree with the characterisation and assessment of a centrally coordinated model? Are there any other advantages and/or challenges?	Energy Queensland is generally in favour of this methodology as a means of addressing a 'minimum' system fault level. It is noted that coordination with DNSPs to identify likely DER growth scenarios, and to identify locations of low and high fault levels, should be required. Energy Queensland also highlights that TNSP-owned remediation, generally won't assist with DNSP connections distant from the transmission network (or transmission node), thereby potentially causing increased connection costs for those proponents. Additionally this may not be the best use of the power system in a high distributed energy future.
Section 4.4 - Model 2: Market based decentralised	
24. Do stakeholders agree with the characterisation and assessment of a market based decentralised model? Are there any other advantages and/or challenges?	This model is an outworking of the 'solution' to system strength shortfalls. At present, there is no barrier to TNSPs or generators using this market based approached to secure system strength services.
Section 4.5 - Model 3: Mandatory service provision	
25. Do stakeholders agree with the characterisation and assessment of a mandatory service provision	Energy Queensland is supportive of generators providing their own system strength if required. Energy Queensland does not agree that additional synchronous condensers (or other system

model? Are there any other advantages and/or challenges?	strength devices) will make the power system inherently complex; the power system is already increasing in complexity (comparing a 1GW generator to 10 x 100MW generators which is made up lots of small elements).
Section 4.6 - Model 4: Access standard	
26. Do stakeholders agree with the characterisation and assessment of an access standard model? Are there any other advantages and/or challenges?	Energy Queensland is in favour of a requirement that new generating systems connecting to the NEM are able to operate at predetermined low system strength levels. It is recognised that there is a challenge for existing systems if system strength is reduced in many locations.
Chapter 4 - General	
27. Are there other model(s) stakeholders think should be explored?	Energy Queensland has no comment.
28. What combinations of models (i.e. hybrids) should be explored further?	It is Energy Queensland's view that all proposed models can be used in the appropriate context: - TNSPs to centrally plan and procure system strength services, which may be market based solutions, to maintain a minimum requirement whilst also considering the maximum fault level for an area. - Generators to 'bring their own' system strength requirement, which may be market based, or plant at their location to facilitate their own efficient connection. - All new generating systems connecting are able to operate stably at low system strength levels, thereby reducing the overall network need for system strength.
29. Do stakeholders have any suggestions as to how any/all the models set out could be implemented or modified? Please comment on any and all models possible.	Energy Queensland has no comment.

CHAPTER 5 – SYSTEM STRENGTH IN DISTRIBUTION NETWORKS

30. What factors make system strength provision in distribution networks unique from transmission networks?	The distribution network in regional Queensland has an extensive 'sub-transmission' network, in some cases with low system strength levels at the MV level (66kV, 33kV, 22kV, 11kV). This is because these networks are often remote from large synchronous generation and have higher-impedance lines. Some parts of the distribution network have very high fault levels, where adding additional system strength will have a detrimental impact on electrical equipment and minimum service standards.

	In addition, there are many locations where smaller synchronous generators are installed. These are not considered in the network-wide system strength studies as their nature (i.e. non-scheduled) prevents them being relied on. However they also contribute to system strength in some cases. This may have localised benefits. However, Energy Queensland notes DNSPs are prevented from engaging to resolve DNSP system strength constraints when it is a TNSP matter only.

31. What are the key issues for system strength in distribution networks, including the magnitude and urgency of system strength issues in distribution networks?	Energy Queensland has developed a detailed understanding of how system strength and the system strength framework has impacted generators, distribution and transmission networks. Current (DER) adoption in Energy Queensland's DNSPs includes:
	• Connection and commitment of 1.4 GW of large-scale renewable generation greater than 5MW (connected under rule 5.3A of the NER), and connected across 11kV, 22kV, 33kV, 66kV, 110kV, 132kV networks. The 1.4 GW is made up of:
	  ○ 22 locations 5MW-30MW
	  ○ 5 locations 30MW-50MW
	  ○ 10 locations >50MW.
	• A further 47 projects in various stages of the application process (with a total of 2.6 GW estimated capacity) made up of:
	  ○ 13 locations 5MW-30MW
	  ○ 13 locations 30MW-50MW
	  ○ 21 locations >50MW.
	• Connection and commitment of 46 MW of medium scale generation between 1.5MW and 5MW.
	• Connection of more than 603,900 small-scale residential and commercial-sized DER (up to 1.5MW) with a total capacity of around 3.5 GW.
	
	Through the connection of these renewable generators, learnings enable Energy Queensland to cite a number of key issues for system strength in distribution networks.
	
	Differentiation must be made between the MV voltage level and low voltage networks in the distribution network. It is true that there is lower system strength in the MV network in some

	places. The LV network (i.e. 400V/230V) generally has high fault levels, with the exception of some rural, SWER and isolated network, where premises may be supplied off a small distribution transformer (i.e.15-25kVA). For other systems, fault levels will be high enough that stability in that context is not a concern, and small-scale generators will trip-off due to frequency excursions or voltage excursions rather than hitting a stability limit. System strength in the distribution network has an impact in the following ways: - Fault levels too low for motors and other mechanical devices to function correctly - Fault levels too high to allow additional rotating machines to connect - Fault levels on rural and regional sub-transmission lines being too low to facilitate large generation connections. In terms of magnitude, the available fault level at a number of nodes across Queensland distribution networks is already negative. To date, this has been largely managed through tuning and appropriate runback schemes, with only one synchronous condenser required thus far. In many cases generators have been able to achieve connections with short-circuit ratios less than three with this approach. There are limited locations at a sub-transmission level in Queensland where a full assessment would not be required for any generator larger than 5MW. In terms of urgency, outside of refinements to the framework already discussed in this response, Energy Queensland does not consider that additional distribution-specific reforms are required in the immediate future.
32. How should any system strength issues in distribution networks be addressed? Are any model(s) from Chapter 4 appropriate to address system strength provision in distribution networks?	Unlike the transmission network, the distribution network (particularly in Queensland), is not uniform, nor would increase in system strength in one area have an impact on with wider system strength. The distribution network is best serviced by generators performing to robust standards to manage differing levels of system strength. Energy Queensland seeks further engagement with the Commission, AEMO and other DNSPs about further options that may facilitate ways to support continued connection of large distributed generation in the distribution network.
33. Additional Comment	Energy Queensland is unclear what the Commission means, in reference to the paper, regarding low visibility over the behaviour of distribution networks: As explored in the Commission's Economic regulatory framework review (2019), that DNSPs may have low visibility of DER connections in each area, and the voltage and current beyond that measured at zone substations, and that as a consequence, determining the system strength needs of different localities using modelling or another means may prove difficult.

	. All generators, whether connecting under Chapter 5 or Chapter 5A of the NER, must apply to the DNSP, and upon commissioning, supply a commissioning report. Likewise fault levels are determined for all negotiated (Chapter 5A) connections, generation and load, to identify any system strength risks. In addition, DNSPs such as Ergon Energy and Energex, have deployed a range of metering devices throughout the network, including power quality meters, power quality analysers, as well as voltage regulators connected via SCADA, that are used to gather information on the behaviour of the network, and identify where issues may exist. Given this, Energy Queensland would appreciate further clarification from the Commission on this point.