AEMC

INFORMATION

Final rule for efficient reactive current access standards for inverter-based resources

Final determination will lower the reactive current capability that inverter based resources need to provide and facilitate more efficient connection of renewable generation and batteries

The Australian Energy Market Commission (AEMC) has made a more preferable final rule that lowers the reactive current fault-response capability that connecting inverter-based resources need to provide, and also clarifies several related terms. This will facilitate greater efficiency in the connection requirements of inverter-based resources (IBR), such as batteries, wind and solar, while also ensuring the security of the power system.

This final rule and determination will facilitate more efficient connection of inverter-based technologies, such as batteries, wind and solar, while maintaining a secure power system. The final rule will also support more flexible negotiation on the reactive current capability that inverter-based generators have to provide to ensure voltage stability is maintained at least cost.

Components of AC power

Alternating current power comprises two components - active and reactive power:

- active power is the form of electrical current that does actual work - i.e. provides light, heat and motion, whereas
- reactive power helps facilitate the transport of electrical current by maintaining stable voltages in electrical circuits.

Importance of providing reactive current after faults

This final determination responds to two rule change requests that recommended the Commission lower the minimum amount of reactive current injection or absorption capability that inverter-based (or asynchronous) generators need to provide after a voltage disturbance.

Voltages can be disturbed or be faulted for a variety of reasons but such changes often follow a lightning, animal or vegetation strike on power lines, which leads to a sudden voltage disturbance. Typically, these disturbances lead to generators either injecting reactive current to lift voltages back to an acceptable proportion of normal voltages or absorbing reactive current to lower voltages back into the normal range. If voltage disturbances are not arrested by the rapid injection or absorption of reactive current, voltages may deviate further from their normal levels, which in turn affects the capacity of nearby generators and loads to remain connected to the power system.

The Commission's Final rule

The Commission's final rule recognises the importance of requiring inverter-based resources to provide reactive current to arrest these voltage deviations, because inverters are typically able to provide some capability at a fairly low marginal cost. However, the current standard is resulting in some systems, especially wind farms, to invest in auxiliary dynamic reactive plant to satisfy the existing minimum access standard capability requirement. This investment in auxiliary equipment is not always likely to support the achievement of system security outcomes at least cost and the Commission considers that there should be more flexibility to agree to a more efficient level of reactive current provision by connecting resources.

The Commission's final rule will require generators to provide a value greater than zero per cent of their maximum continuous current per unit change in voltage. This will require inverter-connected resources to provide some response at the connection point and also

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ensure that they do not absorb reactive current at the connection point during under-voltage faults and do not inject reactive current at the connection point during over-voltage faults. Unlike the draft determination, the final rule does not provide the flexibility to agree to a lower level of reactive current provision. Stakeholder submissions to the draft rule and determination noted that allowing flexibility to agree to a level of reactive current response below zero would lead to there being no effective minimum access standard.

The Commission's final determination and rule has thus balanced the trade-off between:

- ensuring that the minimum reactive current capability access standard is appropriately calibrated to specific system security needs, and does not lead to generators having to make unnecessary investments in auxiliary equipment that may lead to poorer voltage control outcomes, especially in low system strength parts of the power system
- maintaining a sharper incentive, than the draft rule would have, to ensure generators tune reactive current control equipment to optimally use the plant's inherent capability to provide a reactive current response that is tailored to local electrical conditions.

Over time, the Commission expects that the more preferable final rule will lead to NSPs having to be more proactive in planning for and investing in dynamic reactive plant to ensure stable voltage levels during steady-state conditions and maintain adequate reactive power reserve margins to respond to faults. Meeting these obligations will require NSPs to establish the need for such investments as part of regulatory investment tests for transmission and distribution.

Final rule will facilitate more pragmatic negotiations on the design of reactive current responses to support both a fast and stable response

A further issue identified through the rule change requests was that responses from inverter-based resources often trade off the stability of a reactive current response to ensure that the response is provided quickly. Stakeholders noted that current definitions for the adequacy of a reactive current response in the rules are appropriate for controlled test conditions but are less relevant when assessing the adequacy of reactive current response to more complex, unbalanced faults that are the most onerous type of fault condition seen in practice.

To ensure that reactive current responses are both fast and stable, the Commission's final rule will:

- introduce a new standard that will require reactive current responses to start within 40 milliseconds (ms) of a fault-initiating condition agreed upon by all connecting parties
- increase the requirement for the response to rise from 10% to 90% of its maximum level from 40 ms to 80 ms
- delete the settling time requirement from the rules as it is a success criterion that is only applicable to certain, simple faults with step characteristics that are rarely seen in practice. For more complex voltage faults, the settling time requirement is not relevant to an assessment of the adequacy of a reactive current response.

The final rule determination will reformulate the success criteria that defines the characteristics of an adequate reactive current response to a fault that is typically seen in practice. This reformulation will also provide connecting parties, NSPs and AEMO with some rules-based guidance on how devices should be tuned and the numeric response characteristics that control systems should aim to achieve, while balancing flexibility to agree to a slightly different standard if local conditions demand it. Submissions to the draft determination did not raise any concerns with the way we had formulated these success criteria for adequate reactive current responses.

Submissions to the draft determination did recommend that it would be valuable for the rules to provide clearer definitions for what constituted an 'adequately controlled' reactive current response and what constituted 'excessive voltage rise' on unfaulted phases. However, the Commission has determined not to provide definitions for these terms in the rules as doing so may inadvertently reduce the flexibility these terms are intended to provide to NSPs on the matter of what constitutes a good or effective reactive current response. Instead, these matters are better considered in the context of negotiations with NSPs regarding what constitutes an acceptable response in a given location.

Final rules provide clarity on several other elements of the rules to assist connection negotiations

The Commission's final rule also provides clarity on three other elements of the rules to:

- Reflect the practical experience that voltages often remain depressed outside the normal operating range after fault clearance, which means that active power cannot recover to its pre-fault level. The final rule will address this by requiring that negotiation on the timing of active power recovery to its pre-fault level also consider whether voltages remain between 90% and 110% of the connection point normal voltage. This provides further clarity relative to the draft rule which required the timing of active power recovery to be contingent on the 'stable' recovery of voltage, but stakeholders considered that the word 'stable' would introduce unnecessary definitional ambiguity.
- Provide a definition of 'maximum continuous current' such that it is calculated as based on the rated apparent power of the generating system agreed under NER Schedule 5.2.5.1if assessed at the connection point, and an alternative metric if it is assessed at a different location - e.g. the rated apparent power of each generating unit if assessed at the unit terminals or a site-specific derating factor if assessed at a location between the unit and the connection point.
- Maintain the existing definition of 'continuous uninterrupted operation'. This recognises that issues with the current definition of CUO arise from a strict interpretation of part (d) of the existing definition and that any change may complicate negotiations on what constitutes remaining in CUO under a given set of disturbance conditions and thus lead to unintended consequences.

Implementation

The amended provisions in the final rule will come into effect one week from the publication of the final rule and determination, for those who have submitted a connection enquiry or an application to connect, but have not received an offer to connect. AEMO and NSPs will receive a 30 business-day extension to relevant connection process timeframes, for three months from today.

These timeframes have been brought forward from those set out in the draft rule in response to stakeholder feedback.

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