Digitisation, computer modelling: what are we doing and where are we going?

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On 24 January 21 AEMO's SCADA system failed for around 55 minutes[1]. AEMO's report into this event provides a summary of conclusions one of which states "the power system remained in a secure operating state throughout this incident."

The reason the power system remained secure is due to the reintroduction of primary frequency control that occurred after the rule changes proposed by Dr Peter Sokolowski and later AEMO. The process to re-establish the primary frequency control took several years, but by Janurary 2021 there were enough retuned generating units to control the power system.

When the centralized SCADA system is not working it means the data values snapped around a minute prior to the dispatch period are not valid for the NEM dispatch engine. The dispatch targets are no longer sent through the AGC to generators, the system operator is blind to system events, the VAR dispatch system would have incorrect inputs and no automated instructions can be issued. The market dispatch targets would be based on a fixed forecast that is not able to be updated when actual demand is trending away from the forecast. The actual demand is not available to the system operator. Therefore, dispatch targets contain greater error the longer the SCADA system is down.

The lights did not go out. The re-introduction of local primary control in accordance with fundamental power system control principles is the primary reason for this. It is an example and an important reminder that control principles as established over the last hundred years of power engineering are not to be ignored.

Prior to the reintroduction, it can be proven that the NEM had been converted to a grid following system with open loop control through the market systems. Market dispatch targets or centralised SCADA signals (whether AGC or not) are delayed signals, communication latency between the sending end to receiving end cannot be ignored.

Given we know electrical charge travels a fraction under the speed of light, the science of transmitting power and how we control power has to be understood from first principles. It cannot be managed from remote computers processing excessive volumes of data to figure out a new operating conditions, such a system is too slow. Operational control must be undertaken through local generation control systems. Imagine, electrical engineers figured all of this out without computers. Electricity has been provided to societies in a reliable manner before the desktop computer became a thing. If we had not figured out how to control electricity, the computer and the integrated chip would never have been developed.

While too many engineers are currently engaged in running thousands of case studies, producing volumes of charts from running 'dynamic studies' in PSCAD or PSS/E , I have to ask how many are actually interpreting the model results? Who is understanding whether the tools are realistic or not, whether the results are what is expected for the given transfer functions? Who has thought about whether the assumptions that enable the use of the SMIB are appropriate for the location and the tuning that is being undertaken?

[1] https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2021/final-report-total-loss-of-nem-scada-data.pdf?la=en

Enforcing the NER imperative for 'automatic standards' has created a recipe for connection that assumes all technologies must be similar or identical in their control responses. Applying the one rule fits all approach to generation technologies is impractical as different technologies have different characteristics.

System control engineering practice always applied principles of tuning generation for a wide range of operating conditions, this enables controls to work collectively together, providing damping for local and system modes. While I recognize power production is transitioning to power electronic generation sources, the remains ~75 per cent synchronous machine production and doubt this will ever be completely removed given the push to install synchronous condensers and hydro generation with pumped storage. Hence rotating synchronous machines will remain part of the system, so their natural frequencies, control responses and the system modes must be considered when tuning new generators to the system.

I have to ask is the current connection process using the complex wide area PSCAD model in the time domain suited for assessing the control response for a wide range of operating conditions? The answer has to be no if it is only assessing a single operating condition. Are we inadvertently tuning all the new technologies for a corner case condition? If this is true, do we understand the consequences?