Increase in Spinning Reserve Requirement Catering for Distributed PV Tripping

Presented to WA Electricity Consultative Forum

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Background

Distributed Energy Resources in SWIS

The South West Interconnected System (SWIS) is experiencing continued rapid growth of distributed energy resources (DER) with the installation of rooftop photovoltaic (RPV) systems known as distributed PV (DPV). There is now more than 1,500 MW of DPV installed behind the meter (on consumers' premises) in the distribution networks.

Emerging System Security Risk introduced by High DPV Penetration

As the levels of installed DPV grow, the amount of DPV that could be lost due to system voltage/frequency disturbances or abrupt weather changes is increasing, which could adversely impact frequency stability if it coincides with a generator loss. AEMO deems this phenomenon as an emerging system security risk in the SWIS. While not a new issue, the impact is growing and has materialised on a number of occasions.

Outcomes of AEMO's Investigations – Past Events

The outcomes of AEMO's preliminary investigations indicate that, to date this consequential impact has occasionally resulted in a net-loss of generation MW in the system in the order of 70-130 MW as observed from the analysis of events – refer to next page (line trip) and appendix (line & generation trip) for two real cases.

Presentation Purpose

The aim of the slide deck is to present AEMO's approach to address this issue in the short term and to share current work being done to better estimate the impacts.

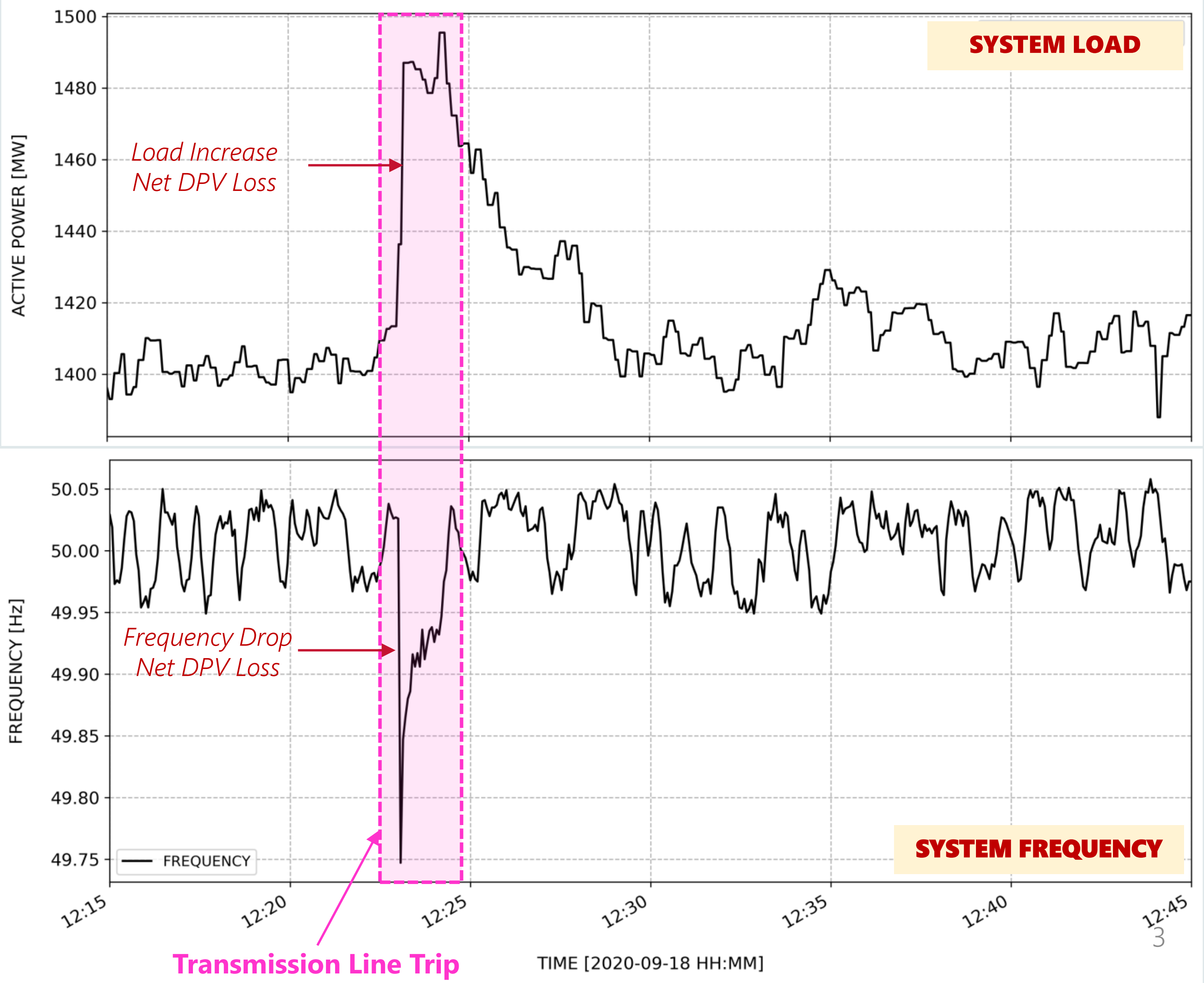
Background
Real Event Example (Line Contingency)

Event Story
On 18th September 2020, there was a transmission line trip in the SWIS at around noon, which resulted in load increase (~100 MW) and, in turn, a frequency drop in the system.

Behaviour of Traditional Power System
In the past, such an event (i.e. line trips) caused load drop and increased frequency conditions due to losing loads more than DPV (less DPV installed, hence generation excess).

DPV Impact
Nowadays, the outcome is exactly opposite during daytime or high PV times as the amount of DPV loss is higher than load loss as can be observed here.

Takeaway
This event indicates the importance of DPV loss for line trips, which exacerbate the frequency drop if it coincides with generation loss – refer to Appendix for details of a past event.



AEMO’s Action

AEMO's Action
Outcome of Analysis

Leveraging NEM DER Knowledge

- Significant work has been done in the NEM in an attempt to better understand and be able to model the behaviour of DPV, particularly in relation to its ability to ride through disturbances and the subsequent impact on the system.
- Estimates have been developed of the amount of load and DPV that would trip for various fault severities, and considering the location of the fault relative to DPV installations.
- The complexity of this analysis is further challenged by the limited ability to interrogate actual response of devices behind the meter, although a limited data set is currently being assessed.

Analysis in WEM

<u>Are the figures/numbers found in NEM applicable to WEM?</u>

- This knowledge has been used, together with the outcome of local incidents, to determine the validity of using similar assumptions in the SWIS. Various case studies of actual transmission faults have shown the responses to be similar to that estimated through the modelling.
- Future Work: Ongoing analysis is being done to improve the modelling capability, as well as better understand any differences behind the assumptions required for the SWIS specifically.

AEMO's Action

While this analysis continues, AEMO is taking action to reduce the risk associated with specific contingencies. These actions will evolve as better understanding of the technical responses is established.

AEMO's Action
Increase in Spinning Reserve Requirement

AEMO's Immediate Action

- To manage Power System Security, AEMO has incorporated the estimated net MW loss of DPV, which is consequentially lost for certain contingencies, in the calculation of Spinning Reserve Ancillary Service (SRAS) requirement where applicable. This is in the order of around 10% of the real-time DPV output and is based on empirical evidence from the last events.

Why is there a need to increase the SRAS requirement?

- Ensuring adequate SRAS is necessary to prevent an UFLS event for a single credible contingency.

What determines the need to increase the SRAS requirement in Real Time?

- AEMO has increased the SRAS requirement, in specific Trading Intervals. The Trading Interval subjected to this change are when the combination of a credible network contingency and estimated consequential net DPV loss forms the largest generation contingency, which mostly happens during high DPV times (i.e. daytime).
- The credible network contingency of more likely faults on the North Country 330 kV transmission line, which causes both generation loss and voltage depression will be initially considered. The amount of generation loss due to the this network contingency includes the tripping of Yandin and Warradarge wind farms as they are connected to a 330V single line.

Appendix

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Real Event Example (Line + Generation Trip) Network Contingency on 2021-01-02

Event Story:

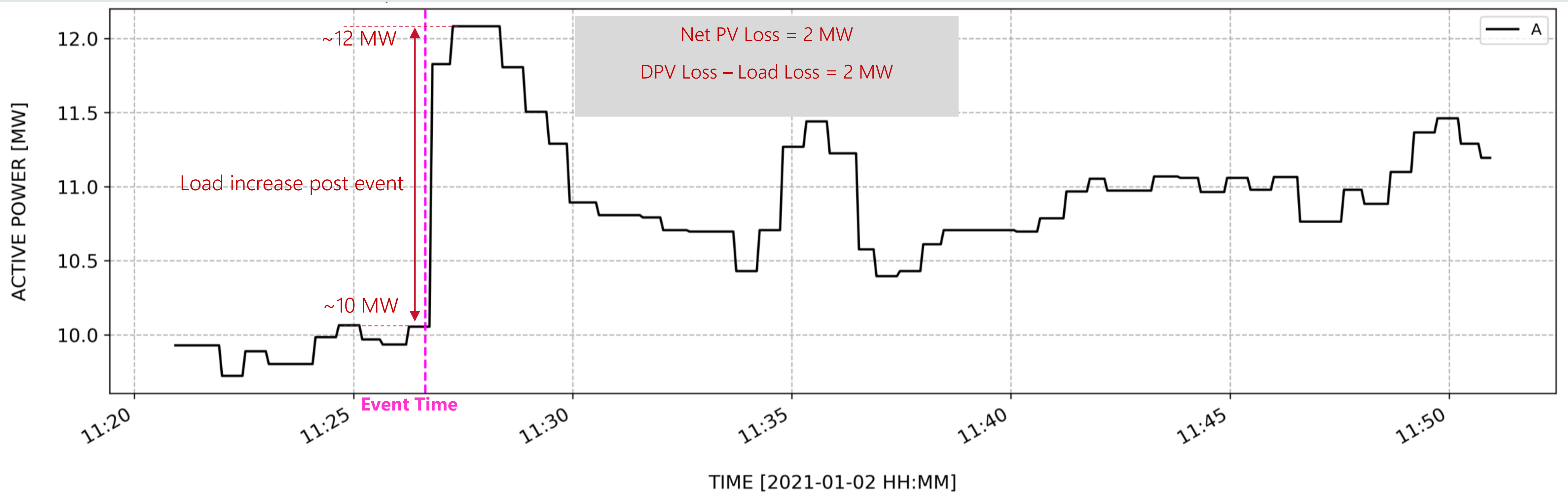
- Date: At 11:26:38 (AWST) on Saturday 2 January 2021,
- Fault Type: Single-phase short-circuit fault
- Equipment: 330 kV transmission line in the North Country area
- Consequence: Clearing the fault by opening the faulted line and losing Yandin and Warradarge wind farms.
- System Impact: Total generation contingency size considered for the calculation of the SRAS requirement prior to the event was formed by Yandin and Warradarge, and it was ~257 MW. However, the trip resulted in a net generation loss of ~320 MW considering all load, generation and DPV losses.

Event Analysis:

From the initial analysis of the event, it was estimated that more than 130 MW of DPV (net MW with the consideration of underlying load disconnection) consequentially tripped.

Note: the actual MW loss could be different as the analysis has been done at the transmission level using the SCADA data.

Real Event Example (Line + Generation Trip) Network Contingency on 2021-01-02



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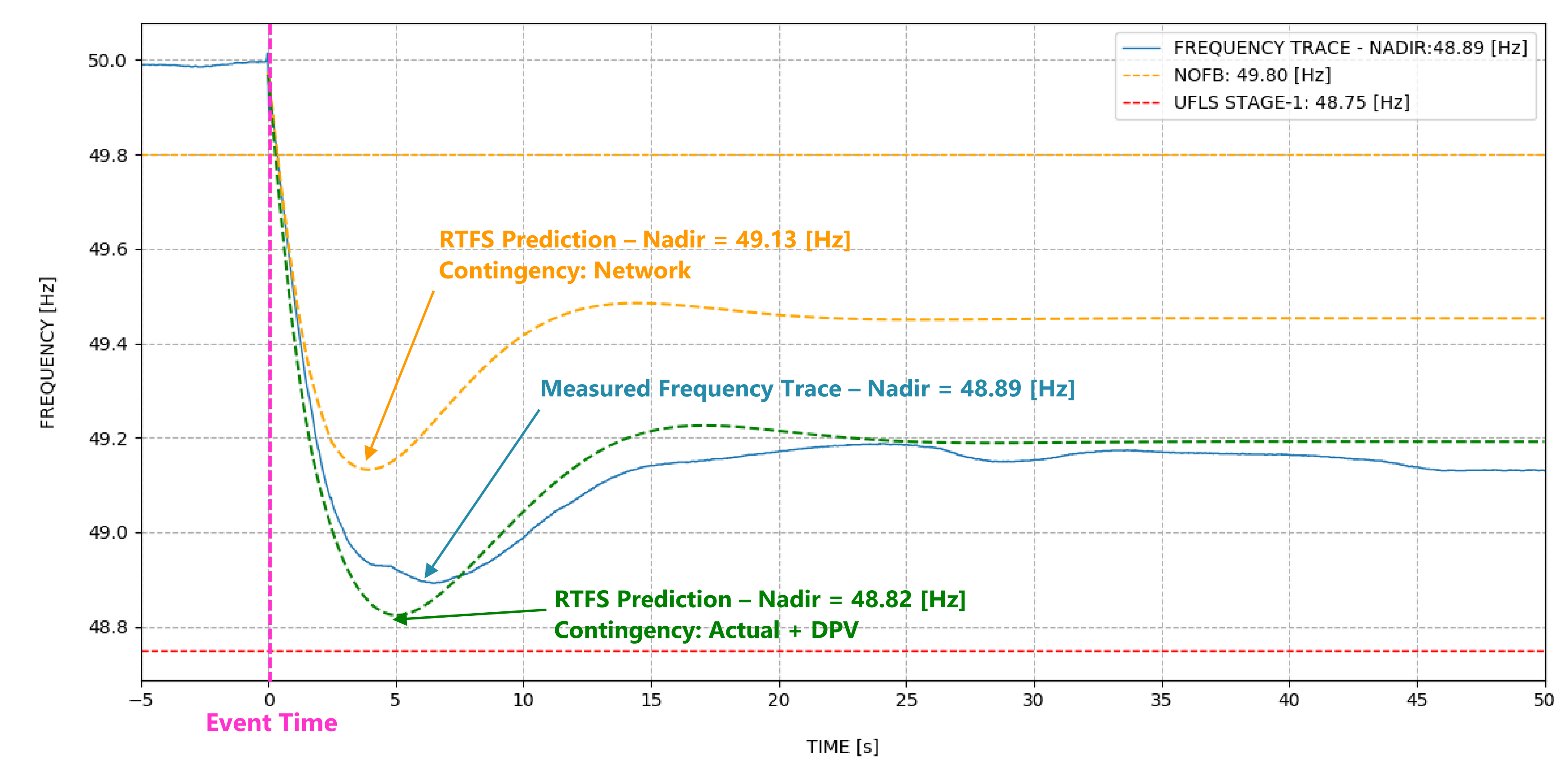
Real Event Example (Line + Generation Trip) Network Contingency on 2021-01-02

- **Why is the consideration of the DPV loss post system line faults important?**

Dismissing the DPV loss might lead to failing to arrest the frequency post generation loss in the system as lower SRAS will be provisioned due to lower SRAS requirement.



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