Responding to low UFLS availability

Presented to WA Electricity Consultative Forum

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20 October 2021

Agenda

Premise
Without mitigation, low availability of load for UFLS can create a risk of system collapse

1. Background
2. Events of 11-12 September
3. What is being done about it
4. Response to emerging power system limits

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Background – what is UFLS?

- Under Frequency Load Shedding is a last resort protection scheme, and relies on the fact that as frequency drops below a specified value, specific feeders will trip thus reducing the load on the system.
- This is typically required following the trip of multiple generator contingencies, which is known not to be credible, but may occur in unlikely yet severe events.

- There have been 4 UFLS events in the last 10 years, each of which has triggered only stage 1 UFLS, but this triggering has prevented a more severe system impact.
- While the purpose of Spinning Reserve is to prevent UFLS for a single credible contingency, the purpose of UFLS is to prevent a system black for a larger, non credible contingency or combination of contingencies.

Table 2.8 Under-frequency load shedding scheme settings for the South West Interconnected Network

Stage	Frequency (Hz)	Time Delay (sec)	*Load* Shed (%)	Cumulative *Load* Shed (%)	Capacitor shed (%)	Cumulative Capacitor Shed (%)
1	48.75	0.4	15	15	10	10
2	48.50	0.4	15	30	15	25
3	48.25	0.4	15	45	20	45
4	48.00	0.4	15	60	25	70
5	47.75	0.4	15	75	30	100

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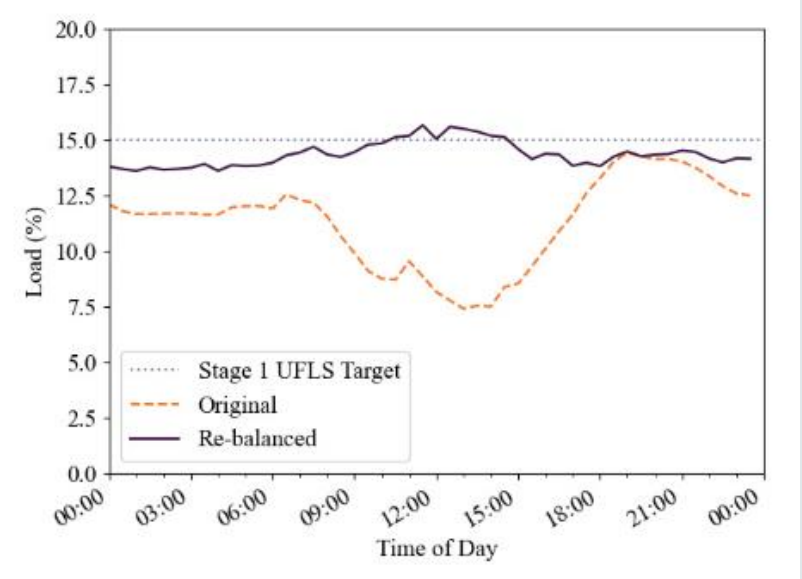
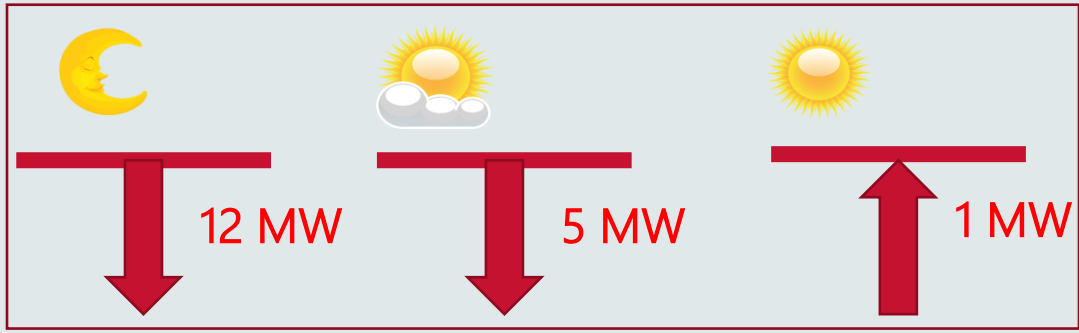
Background

- Increasing penetration of DER at a feeder level is reducing the amount of load that will trip during daylight hours, and in some cases even resulting in these feeders being “net generators”.
- In 2019, AEMO performed analysis on the effects of DER on UFLS volumes and found that backfeeding feeders were causing UFLS volumes to decrease during the middle of the day to well below the 15% requirement for each stage.
- Engagement with Western Power led to a re-balancing of UFLS Stage 1 and Stage 2, where backfeeding feeders were moved to the later stages.





Background

- As part of the DER Roadmap Action 10, the UFLS scheme was reviewed in a series of studies led by Western Power (with AEMO support) and beginning in early 2021.
- The model considered the performance of the system following an increasing (non credible) contingency size and taking into account the inverter performance leading to tripping of DER at lower frequencies.
- The first set of studies completed in July 2021 examined the performance of the UFLS scheme with intact load availability.
- A second set of studies completed in August 2021 with actual and forecast UFLS load availability indicated that there were risks of system collapse at lower contingency sizes. The results were presented in early September 2021.
- Following the minimum system demand load on the 5th September, Western Power informed AEMO that there was insufficient load on the UFLS scheme.
- Joint studies suggested that such low UFLS load availabilities puts the system at risk after the simultaneous loss of the three largest generators.

Events of 11th and 12th September

- Based on the information received and studies done in the days prior to this weekend, the maximum contingency size that could be accommodated at various system load levels without risking system collapse was determined.
- Based on a prudent risk assessment, it was assumed that this contingency should come from no fewer than four generators (acknowledging that there are multiple possible considerations here).
- The available options to mitigate the impact of low UFLS load was to:
  - Increase the availability of spinning reserve
  - Dispatch all Market Generators to limit the maximum contingency size and the sum of the four largest facilities.
- It is important to note that the contingency size was not dependant on generator type.
- A number of operational challenges were experienced during the course of the weekend as it was the first time these particular actions had been required, and operational tools had not yet been developed to manage this new constraint.

Events of 11th and 12th September

Saturday 11th September

Minimum system load forecast: 1175 MW

Actual minimum system load: 1178 MW

- Additional Balancing Portfolio generators were started to provide extra Spinning Reserve
- A number of facilities were constrained down to reduce the combined output of the four largest generators

Sunday 12th September

Minimum system load forecast: 975 MW

Actual minimum system load: 1012 MW

- Additional Balancing Portfolio generators were started to provide extra Spinning Reserve
- A number of facilities were constrained down to reduce the combined output of the four largest generators
- NewGen Kwinana was constrained below the level at which it was able to provide LFAS Down. Therefore, Backup LFAS was required

What is being done about it?

- **Lots of studies:** refining the original conclusions by reviewing some of our initial assumptions, e.g. use of cascading as opposed to instantaneous generator trips, and testing sensitivities, e.g. re-allocation of tripped DPV to UFLS.
  - New information (e.g. new transmission customers on UFLS) and testing of assumptions has led to the limits being reviewed and updated.
- **Adding transmission load to the UFLS scheme:** Western Power has included 9 Transmission customers on the UFLS scheme and is doing further work to include an additional 16 customer to the scheme.
  - To manage the risk of over-tripping at higher loads, this component of the UFLS scheme is only enabled when the system load reduces below a predefined level
  - The remaining customers require infrastructure / asset works in order to enable and will be implemented in the near future
  - Expect that under normal operation the contingency limits will only be material at very low loads

What is being done about it

- AEMO's *Renewable Energy Integration – SWIS Update* paper recommends actions to implement UFLS medium- and long- term solutions as a priority action.
- Studies being done by AEMO and WP under DER Roadmap Action 10 are supporting the investigations needing to be done to implement these actions.
- The recently published WEM Rules, to come into effect in June 2022, place an obligation on AEMO to develop (with WP) UFLS requirements and an obligation on WP to develop UFLS specifications to meet those requirements.

Emerging operational limits and responses

- To manage the changing power system a number of actions have already been taken in response to emerging power system limits, and it is likely that others may be requried as loads further reduce and more detailed studies are concluded.

- Actions already in place to mitigate some of challenges:
  - GIA contingency limit – constrains the largest generator contingency at low loads
  - Switching out 330 kV lines for voltage control
  - Additional Spinning Reserve to cover DPV tripping at certain times
  - UFLS contingency limits

- Other actions that may potentially need to be taken:
  - Further increase in Spinning Reserve for covering DPV tripping
  - Putting on more gas turbines out-of-merit to provide voltage and frequency support
  - Management of DPV
  - Fast Frequency Response by Energy Storage Resources
  - Mechanism for managing system strength issues

These challenges are not unique to WA and the NEM (particularly SA) are experiencing similar issues.

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