

# FACT SHEET: FREQUENCY CONTROL



## FREQUENCY IN THE POWER SYSTEM

Australia's [National Electricity Market \(NEM\)](#) power system operates within a set frequency range around 50 Hertz (Hz). This underpins the safe, secure and reliable transmission of power through the electricity supply chain from generators to consumers.

Controlling power system frequency requires the constant balancing of electricity supply and demand. **If electricity supply exceeds demand at an instant in time, power system frequency will increase. If electricity demand exceeds supply at an instant in time, power system frequency will decrease.** If the change is too great, generation and load can be disconnected. In an interconnected power system, frequency is usually the same throughout.

Frequency operating standards in the NEM power system are set by the [Reliability Panel](#) appointed and convened by the Australian Energy Market Commission (AEMC). The Reliability Panel has obligations under the [National Electricity Rules \(NER\)](#) to make determinations and set standards in relation to power system security and supply reliability. In the case of frequency control, this includes prescribing maximum acceptable frequency deviations for different types of operating states or following events that can occur within the power system, such as:

- Normal operating conditions.
- Credible contingency events<sup>1</sup> (including tripping generation or load, or an unplanned network outage).
- Non-credible contingency events<sup>2</sup> (including loss of multiple generation or network elements, or an islanded operation where a region or sub-network is separated from the rest of the NEM).

## HOW DOES AEMO MANAGE FREQUENCY IN THE NEM POWER SYSTEM?

The NEM power system comprises a wholesale commodity exchange for electricity across Queensland, New South Wales (including the Australian Capital Territory), Victoria, Tasmania, and South Australia. As the NEM power system and market operator, AEMO is responsible for matching supply and demand through a centrally coordinated dispatch process.

The dispatch process operates on a five minute cycle and dispatches scheduled generation which, in combination with forecast non-scheduled generation (generally generation under 30 megawatts (MW)) and semi-scheduled generation (intermittent generation such as solar and wind), will match forecast demand from the transmission grid.

The central dispatch process aims to match electricity supply to electricity demand, as well as coordinate the generation capacity to be able to quickly respond to changes. This is done through a market mechanism which AEMO uses to ensure frequency control ancillary services (FCAS) are available to increase or decrease output at short notice. Although any technology can participate in the FCAS market if technically capable, these services have generally been provided by thermal (such as coal and gas) and hydro generation.

There are different ways to control frequency levels depending on the size of the deviation:

### Regulation FCAS

Frequency regulation is a centrally managed control process to maintain frequency on a continuous basis. AEMO's automatic generation control process detects minor deviations in power system frequency, and sends "raise" or "lower" signals to generating units providing regulation FCAS to correct the frequency deviation.

<sup>1</sup> Credible contingency events are events that are considered reasonably possible and which the power system is required to be secure against.

<sup>2</sup> Non-credible events are defined in Clause 4.2.3 of the [NER](#) and refer to very rare, large events against which the power system may not be secure.



These minor deviations in power system frequency can arise from a range of factors that create small mismatches between generation and demand. These can include any (or a combination) of:

- Aggregate variations in wind or solar generation output within the dispatch interval.
- Aggregate variations between actual and forecast demand within the five minute dispatch interval.
- Scheduled generation not meeting central dispatch targets.

## Contingency FCAS

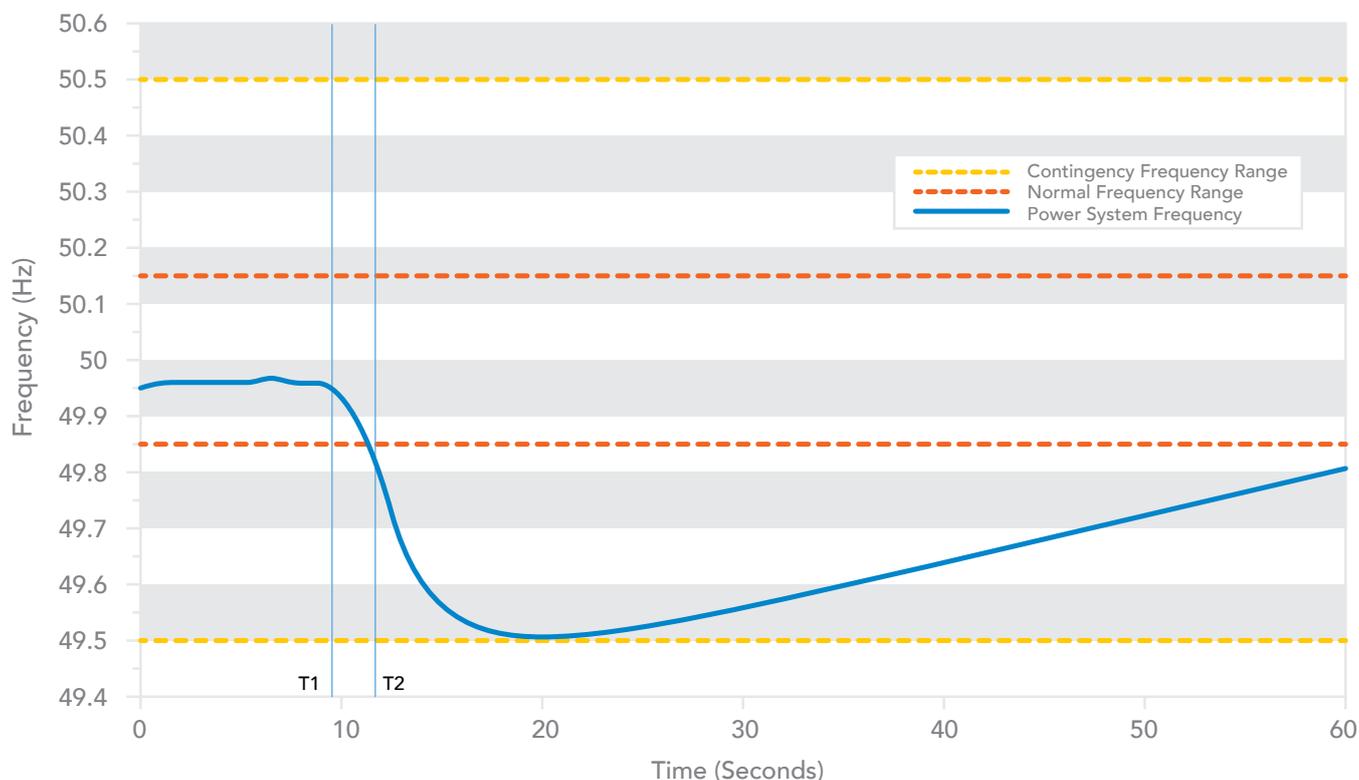
Contingency FCAS responds to larger deviations in power system frequency. Providers of contingency FCAS respond to correct frequency deviations arising from larger supply-demand imbalances which may occur following a sudden, unplanned network outage or disconnection of generation or load from the power system. Contingency FCAS is divided into raise and lower services at three different speeds of response - 6 seconds; 60 seconds; and, 5 minutes.

Some examples of FCAS providers include:

- Generator governor response: where the generator governor reacts to the frequency deviation by, for example, opening or closing the turbine steam valve and altering the MW output of the set accordingly.
- Load shedding: where a load can be quickly disconnected from the electrical system (can act to correct a low frequency only).
- Rapid generation response: where a frequency relay will detect a low frequency and correspondingly start a fast generator (can act to correct a low frequency only).
- Rapid generating unit unloading: where a frequency relay will detect a high frequency and correspondingly reduce a generator output (can act to correct a high frequency only).

Figure 1 shows the control of frequency in the NEM during normal operation (at the left of the figure), and following a contingency event. In this figure, a contingency event at the time shown as T1 results in a sharp drop in power system frequency which passes outside the normal frequency operating range at T2. In this scenario, contingency FCAS would be used after T2 to arrest the fall and begin restoring frequency to the normal range.

Figure 1. An example of the frequency deviation following a credible contingency event



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If frequency moves outside the contingency band, emergency protection equipment may disconnect generation (for a high-frequency event) or electricity load (for a low-frequency event).

## Emergency frequency control schemes

In rare circumstances following unlikely, or non-credible contingency events, the frequency deviation can be large. If this happens, emergency frequency control schemes may be activated. Under-frequency load shedding (UFLS) is one such scheme implemented to manage a large drop in frequency following an unexpected event that results in too little electricity supply to meet demand.

UFLS is a distributed system which can disconnect predetermined blocks of load if power system frequency falls below a range of specific thresholds. It is designed to progressively disconnect load to prevent frequency falling to a level that may ultimately result in the collapse of the power system. UFLS works to reduce electricity demand very quickly to balance the power system by turning off electricity supply to groups of customers. Under the UFLS scheme, AEMO, in consultation with network service providers and jurisdictional system security coordinators, determines the frequency settings and size of the load blocks and time delays to minimise load shedding while arresting major frequency deviations as effectively as possible.

If there is an event that results in electricity supply greatly exceeding demand, the power system frequency will increase and may exceed the upper frequency threshold in the frequency operating standards.

Through their protection systems which detect frequency deviations, generation will disconnect if the frequency is too high. If generation disconnects in a haphazard manner, too many might disconnect meaning the electricity supply is then insufficient to match the electricity demand. To avoid this situation, over-frequency generation shedding (OFGS) control schemes can be designed to coordinate the response of generation for these very high frequency deviations.

For more information about FCAS see the [Guide to Ancillary Services in the National Electricity Market](#).

## ABOUT AEMO

AEMO is responsible for operating Australia's largest gas and electricity markets and power systems, including the National Electricity Market and interconnected power system in Australia's eastern and south-eastern seaboard, and the Wholesale Electricity Market and the South West interconnected power system in Western Australia. AEMO also operates the Victorian Declared Wholesale Gas Market and the Victorian gas transmission system; the wholesale gas Short Term Trading Market hubs in Adelaide, Sydney and Brisbane; the Wallumbilla Gas Supply Hub in Queensland; and the Moomba Gas Supply Hub in South Australia. As Australia's independent energy markets and power systems operator, AEMO provides critical planning, forecasting and power systems security advice and services to deliver energy security for all Australians.

## FURTHER INFORMATION

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