AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Connecting Generation to the NSW Electricity System

Maintaining System Security

Dr Darren Spoor

Maintaining System Security

- AEMO's Obligations
  - The Power System should always be in a satisfactory operating state

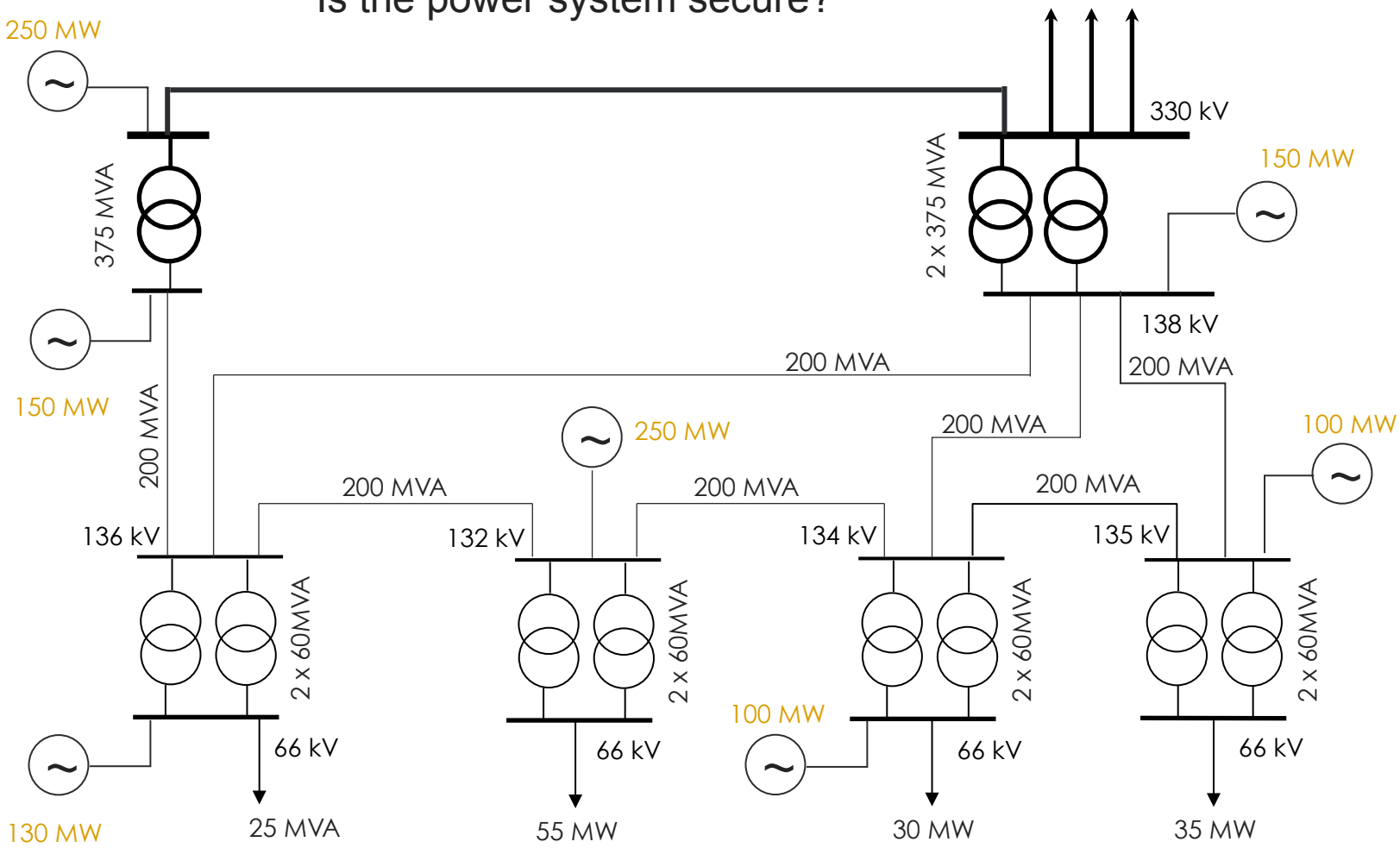
> NER 4.3.1(k)(1):
> Ensure the power system is, and is maintained, in a satisfactory operating state

  - The Power System may operate in an insecure state for no longer than 30 minutes

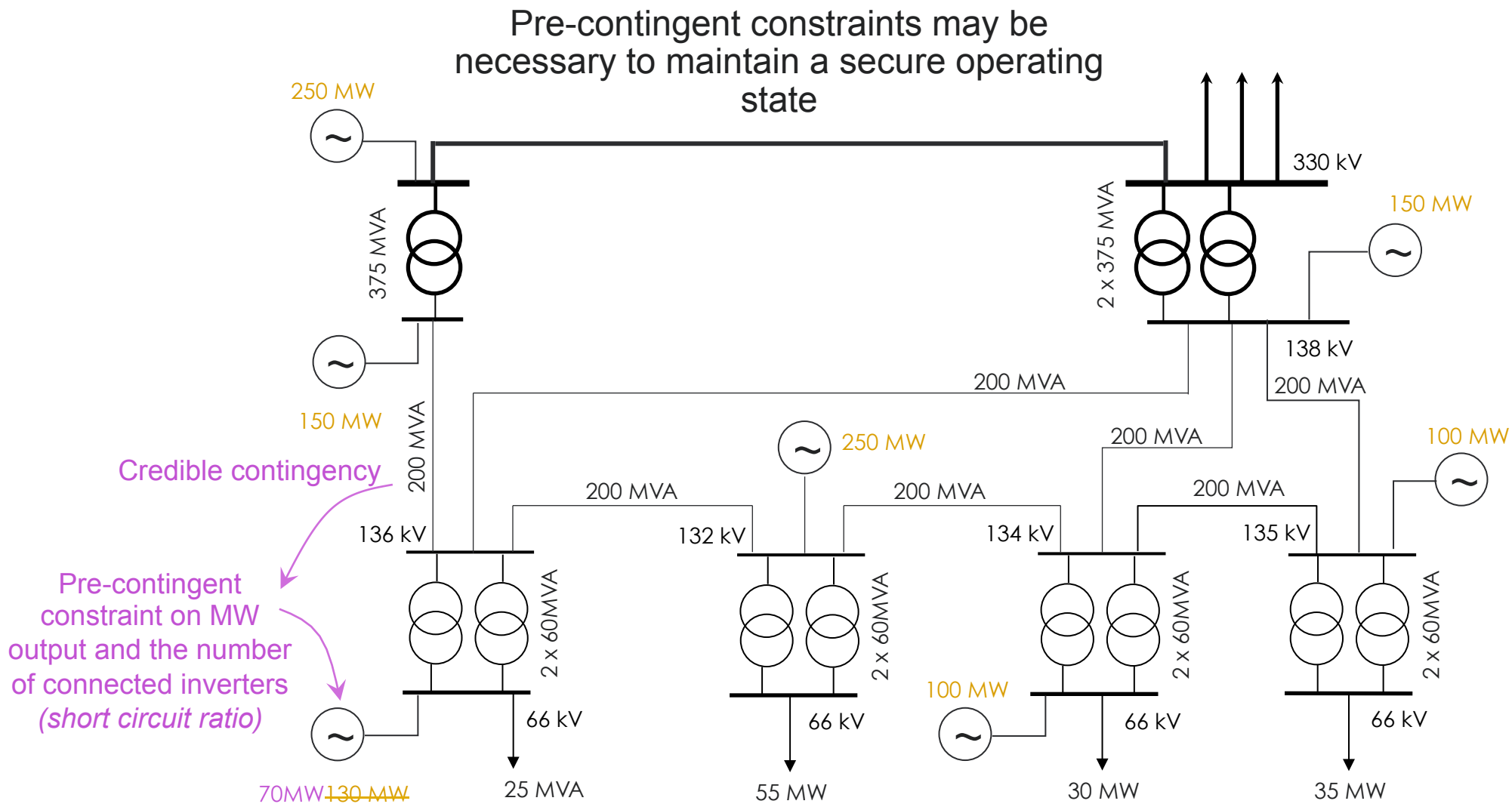
> NER 4.2.6(b):
> Following a contingency event (whether or not a credible contingency event) or a significant change in power system conditions, AEMO should take all reasonable actions:
>
> (1) to adjust, wherever possible, the operating conditions with a view to returning the power system to a secure operating state as soon as it is practical to do so, and, in any event, within thirty minutes; or
>
> (2) if any principles and guidelines have been published under clause 8.8.1(a)(2a), to adjust, wherever possible, the operating conditions, in accordance with such principles and guidelines, with a view to returning the power system to a secure operating state within at most thirty minutes

Connecting Intermittent Generation

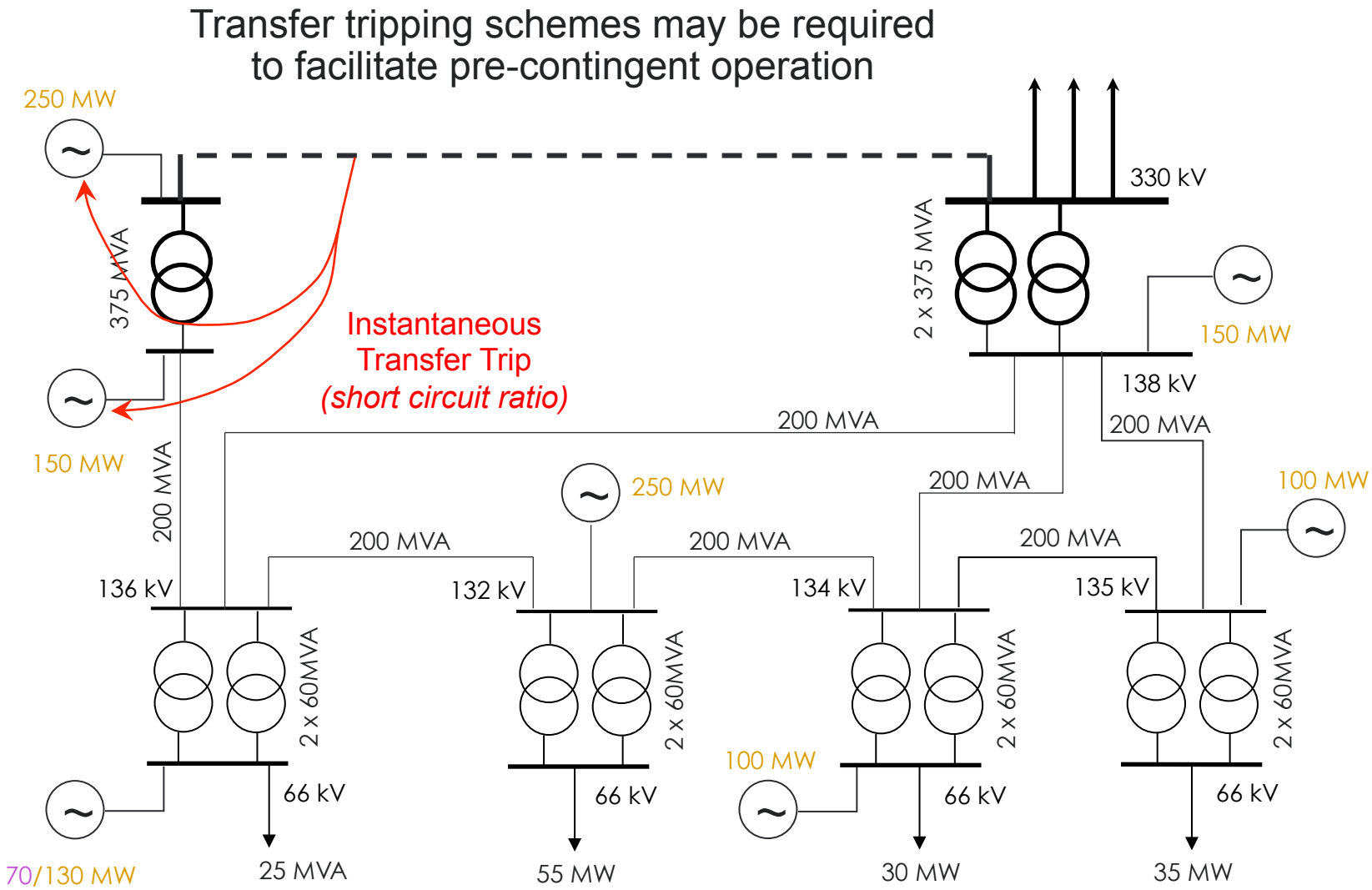
Is this power system satisfactory?
Is the power system secure?



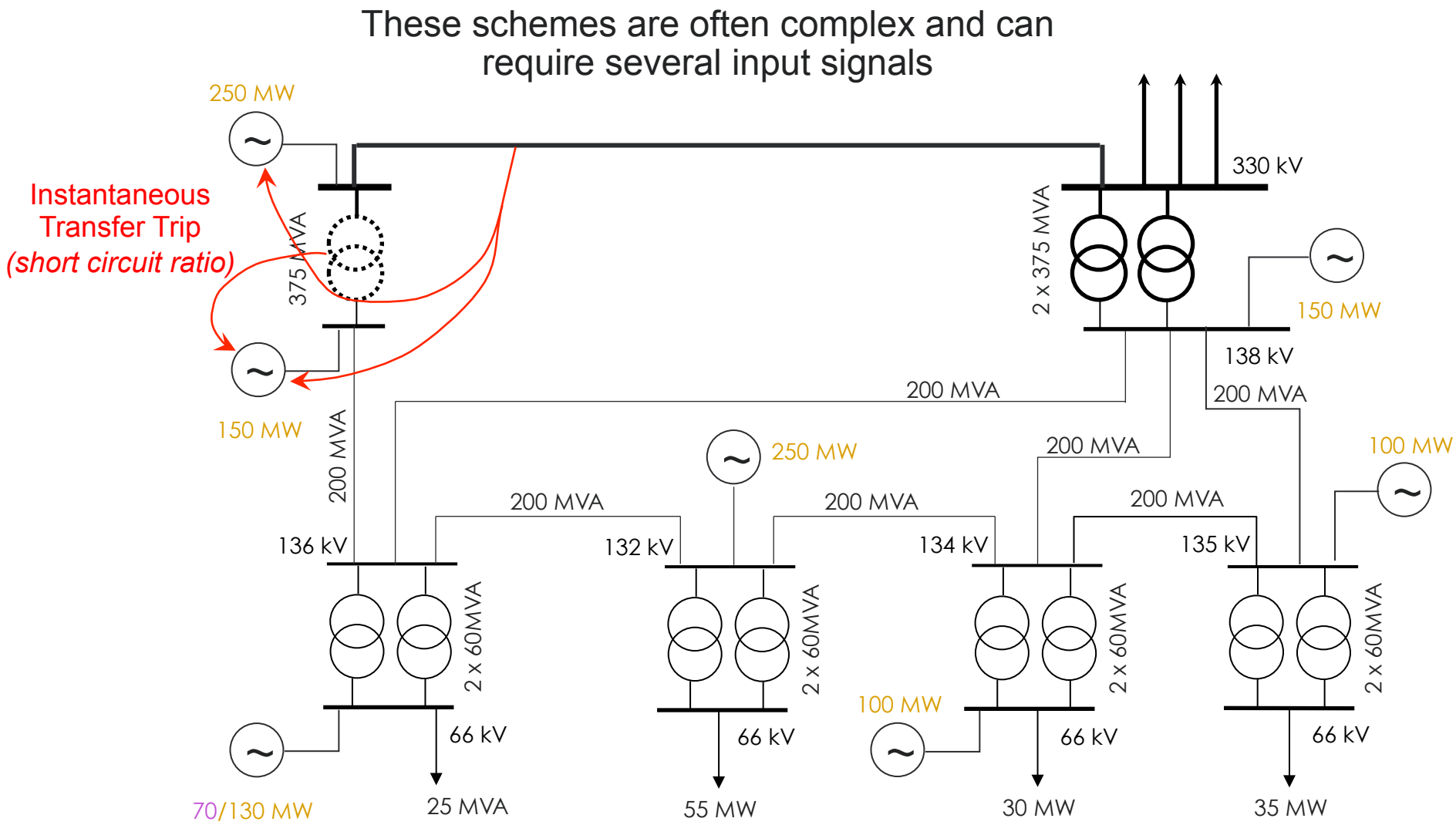
Connecting Intermittent Generation



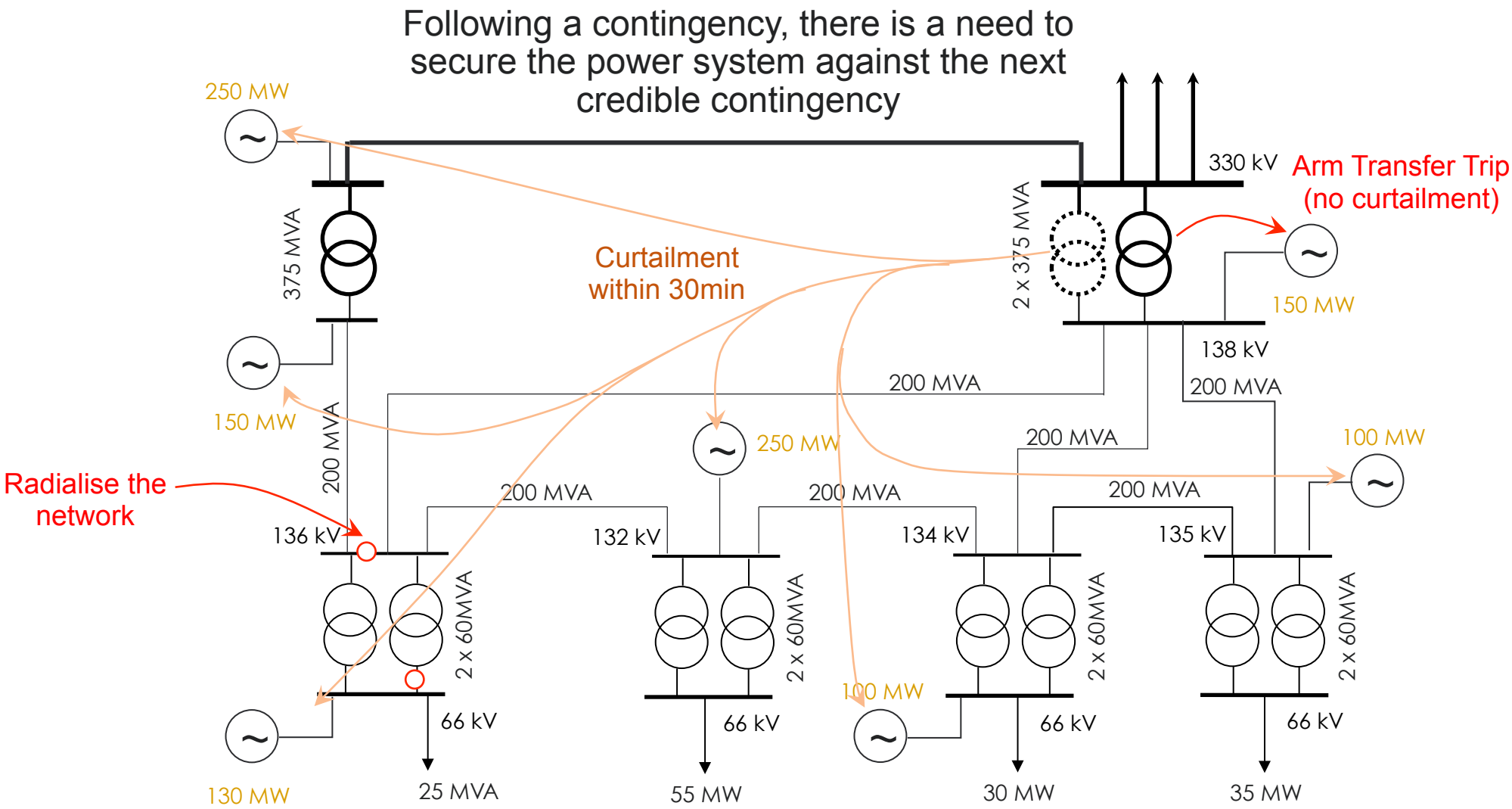
Connecting Intermittent Generation



Connecting Intermittent Generation

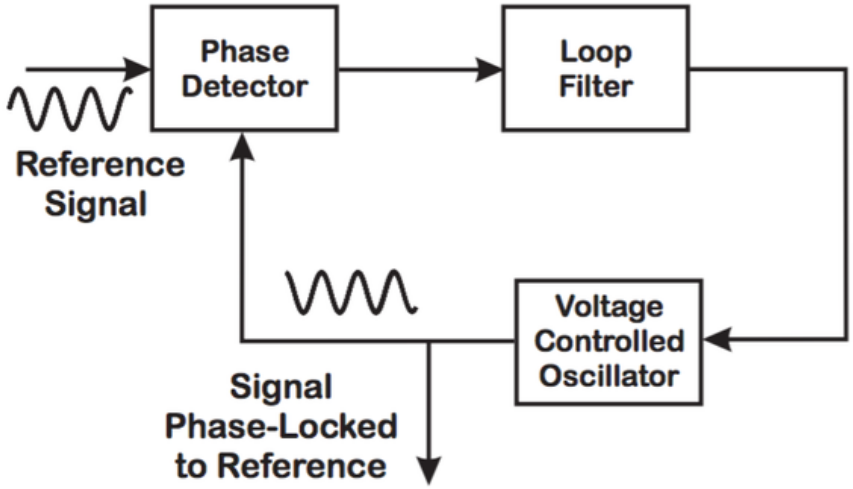


Connecting Intermittent Generation

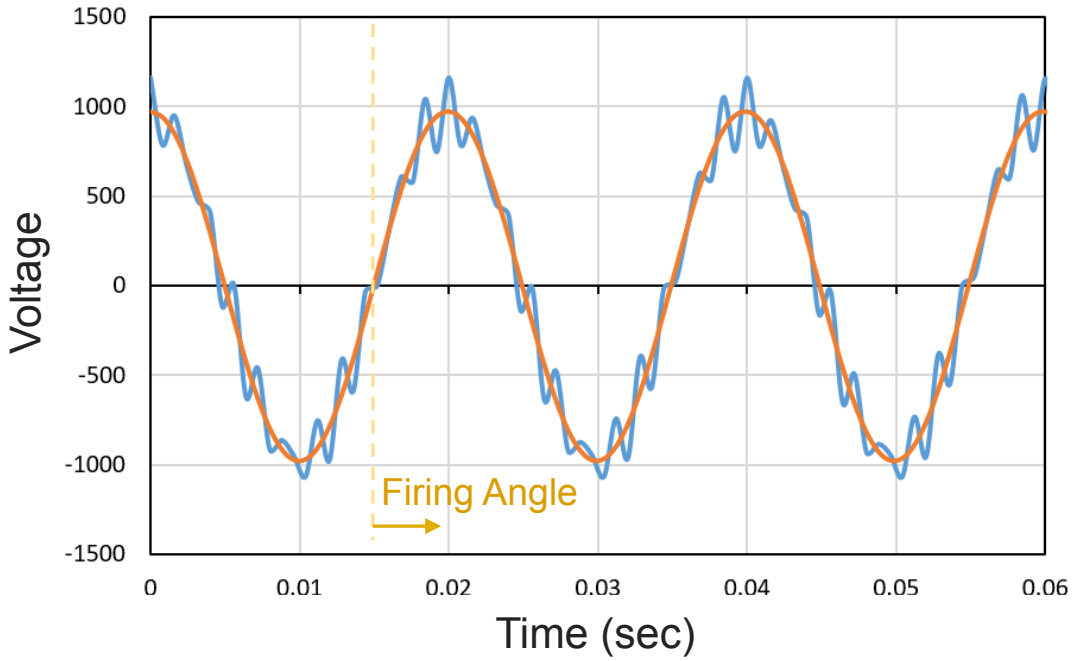


Impact of System Strength

- Phase locked loops
  - PLL's are used to
    - derive the frequency and phase
    - replicate an input waveform that is then used to time inverter firing angles
  - Adjusting the voltage angles
    - controls the MW output
  - Adjusting the voltage magnitude
    - controls MVAr output



- Types of phase locked loops
  - Three single phase PLL's
    - Then extract the positive sequence
  - A single three-phase PLL
    - *abc* to quadrature *dq* transformation
    - Requires the measurement of system frequency.

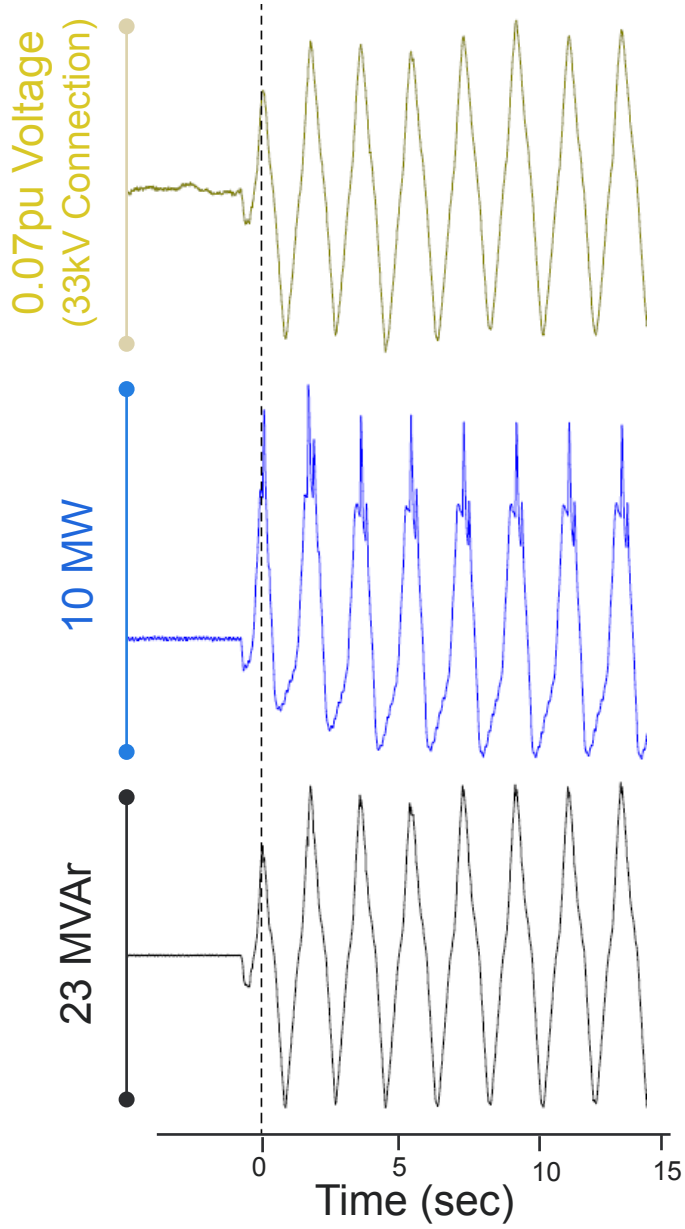


AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Impact of System Strength

- Maintaining Commutation
  - PLL's work well where there is a good signal to noise ratio.
  - They are susceptible to
    - phase angle changes
    - frequency changes
    - amplitude changes
    - unbalanced inputs
    - load type, if suddenly islanded
    - *low fault level (signal to noise) conditions*

- Remediation Options
  - Transfer tripping schemes that cater for:
    - Islanding requirements
    - System strength limitations, etc
  - External synchronising reference signals
  - Increasing system strength



Maintaining System Security

Questions?