Frequency Control Ancillary Services
Is Australia a model market for renewable integration?

Dr Jenny Riesz
Wind Integration Workshop – 24th October 2013
FCAS reserves

• Frequency Control Ancillary Services (FCAS)
• “Reserves” that maintain exact match between supply and demand for electricity at all times.
Impacts of wind on FCAS

FCAS incorporates much of the ‘system integration’ costs & challenges of wind

- Increases variability of net demand
  - Increases requirement for regulation reserves
- Displaces synchronous plant
  - Reduces system inertia and automatic governor response
  - May need to adjust contingency services to more precisely procure required services

Effective market design can minimise the FCAS reserves required (eg. 5 min markets with short delays from gate closure to dispatch)
Australian National Electricity Market

National Electricity Market (NEM)

35 GW

QLD

SA

NSW

VIC

TAS
FCAS market experience in the NEM

Competitive spot market for FCAS introduced

Regulation requirement reduced from 250 MW to 130 MW

Average FCAS costs

New Zealand Electricity Commission, Frequency Regulation Market Development, Appendix E: Preliminary Cost-Benefit Assessments
Unique aspects of FCAS in the NEM

**Primary frequency response market**

- Fast primary frequency response market requiring full response within six seconds

**Dynamic reserve setting**

- Fully dynamic determination of regulation reserves based upon real-time measurement of time error

**Causer pays payment recovery**

- Sophisticated ‘causer pays’ mechanism for recovery of regulation payments
Primary Frequency Response Market

Fast 6 second response time
Primary frequency response

- Autonomous response triggered by frequency drop
  - Very rapid response following contingency (deployed in first 5-10 seconds)
  - Very few markets have an explicit market for a service this fast

<table>
<thead>
<tr>
<th>Market</th>
<th>Fully activated within...</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>-</td>
<td>Not explicitly included in any USA market</td>
</tr>
<tr>
<td>Europe</td>
<td>30 seconds</td>
<td>Start within a few seconds, at least 50% deployed within 15 seconds (ENTSO-E requirement)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1 second</td>
<td>Sustained for 60 seconds</td>
</tr>
<tr>
<td>Australian NEM</td>
<td>6 seconds</td>
<td>Sustained for 60 seconds</td>
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</table>
Contingency Reserves Response Times

- 6 seconds
- 60 seconds
- 5 minutes
FCAS in the NEM

**FCAS (8 markets)**

**Regulation**
- Raise
- Lower
- AGC
- AGC

**Contingency**
- 6 second (R/L)
- 60 second (R/L)
- 5 minute (R/L)
- Governor
- Governor
- Rapid Gen

AGC: Automatic Generation Control signal from AEMO

Generator responds to locally sensed frequency

Dynamic reserve setting

Regulation Reserve
## Static regulation reserve requirements

<table>
<thead>
<tr>
<th>Region</th>
<th>Separate/Combined</th>
<th>Rule</th>
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<tbody>
<tr>
<td>PJM</td>
<td>Combined</td>
<td>Based on 1% of the peak load during peak hours and 1% of the valley peak during off-peak hours.</td>
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<tr>
<td>NYISO</td>
<td>Combined</td>
<td>Set requirement based on weekday or weekend, hour of day, and season.</td>
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<tr>
<td>ERCOT</td>
<td>Separate</td>
<td>Based on 98.8th percentile of regulation utilized in previous 30 days of same month of previous year and adjusted by installed wind capacity.</td>
</tr>
<tr>
<td>CAISO</td>
<td>Separate</td>
<td>Use a requirement floor of 350-MW up and down regulating reserves which can be adjusted based on load forecast, must-run instructions, previous CPS performance, and interchange and generation schedule changes.</td>
</tr>
<tr>
<td>MISO</td>
<td>Combined</td>
<td>Requirement made once a day based on conditions and before the day-ahead market closes.</td>
</tr>
<tr>
<td>ISO NE</td>
<td>Combined</td>
<td>Based on month, hour of day, weekday/sat/sun.</td>
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Dynamic regulation reserve

Wind turbine power curve – highest variability in the central region

Wind likely to be most variable when operating in the central range

Set reserves dynamically to reduce costs
Regulation reserve setting in the NEM

• Set dynamically by the “time error”
  • Accumulated deviation of frequency over time from 50Hz
  • Will schedule more reserves if frequency deviates a lot, or for a long time

Default:
130 MW raise
120 MW lower

Time error exceeds ±1.5 seconds?
Add 60 MW regulation per 1 second deviation

Upper limit 250 MW

Only carry required reserves, automatically adjusts to wind variability, demand variability, inertia, etc
Causer Pays Payment Recovery

Regulation Reserve
Cost recovery

- In most systems all FCAS costs are allocated to loads
- Removes price signals for market participants to manage variability and uncertainty they add to the system
NEM – Payment for FCAS:

**Contingency Raise**
- Need is caused by generators
- Pro-rata by energy generated in that trading interval

**Contingency Lower**
- Need is caused by loads
- Pro-rata by energy consumption in that trading interval

**Regulation**
- Paid for by loads/generators whose variability contributes to system frequency deviations

**Paid for by:**
- Generators
- Loads
- Causer Pays
Causer Pays

Attribution of regulation costs:

Calculate “contribution factors” for each load/generator every 4 seconds

Generators/Loads with negative contribution factors pay relative proportion of FCAS cost (aggregated over 1 month)

Aggregated by portfolio (beneficial operation of one unit can correct for deviations in another)

Contribution factors:

- Deviation from expected dispatch
  - Positive – Assisting in correcting system frequency
  - Negative – Causing deviations in system frequency
Benefits of causer pays methodology

More cost reflective signals
- To wind farms (and other generators)

Incentives to manage variability & uncertainty
- Select less variable sites or technologies?
- Self-imposed occasional curtailment to limit unanticipated ramps?

More economically efficient outcomes
- Stronger incentives to reduce variability when regulation is expensive

Technology neutral
- Eg. Biomass and landfill gas observed to be significant contributors to variability, pay their share of regulation costs
- Variable loads pay more
Other beneficial aspects of the NEM

<table>
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<th>Technology neutral approach to provision of FCAS</th>
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<td>• No barriers to provision by renewables, as long as they meet the technical requirements</td>
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<th>Single platform market</th>
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<tr>
<td>• No day-ahead market (real-time only)</td>
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<td>• FCAS reserves set dynamically in real time, based upon latest information</td>
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### Adjustments that may be required in the NEM

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<th>Optimise contingency response times</th>
<th>Inertia</th>
<th>Following service</th>
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| • Revise 6s, 60s, 5min response times to new technology capabilities? | • Market for inertia?  
• Very fast FCAS service? | • Slower regulation service?  
• Ramping constraints causing out-of-merit dispatch |
Can the NEM provide an effective model for other FCAS markets?

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Thank you

www.ceem.unsw.edu.au