Centre for Energy and Environmental Markets

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Frequency Control Ancillary Services

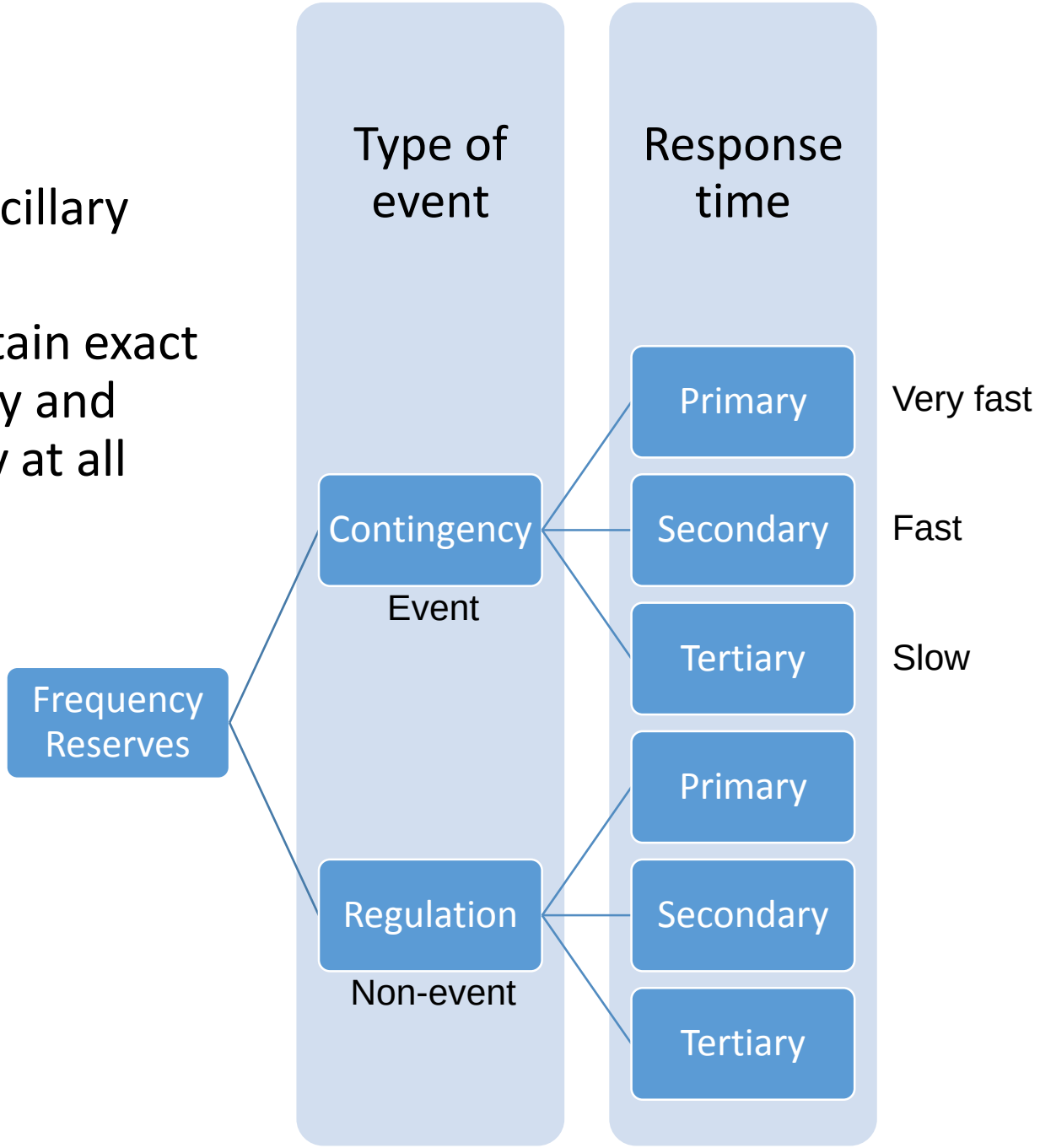
Is Australia a model market for renewable integration?

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.



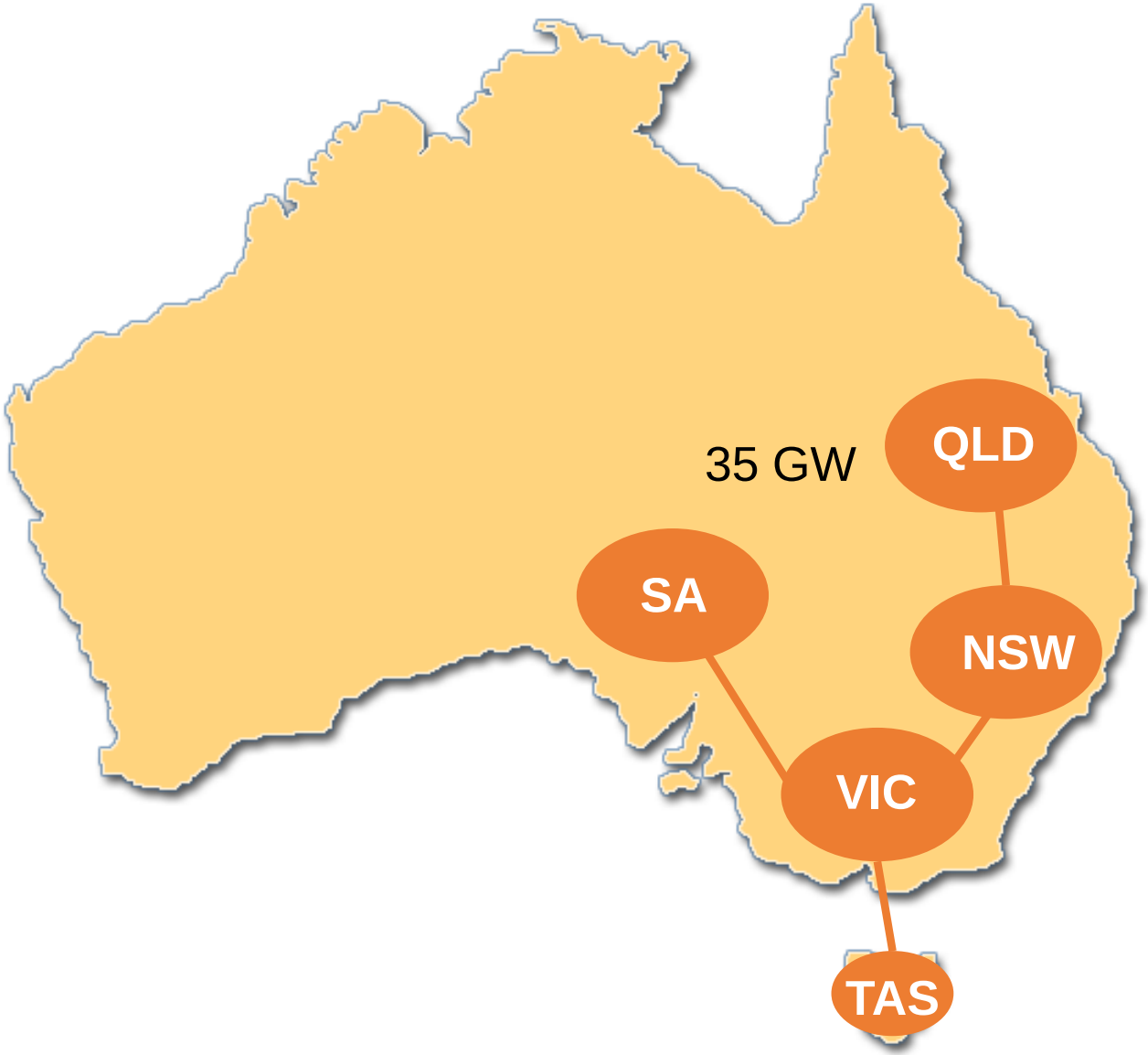
Impacts of wind on FCAS

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

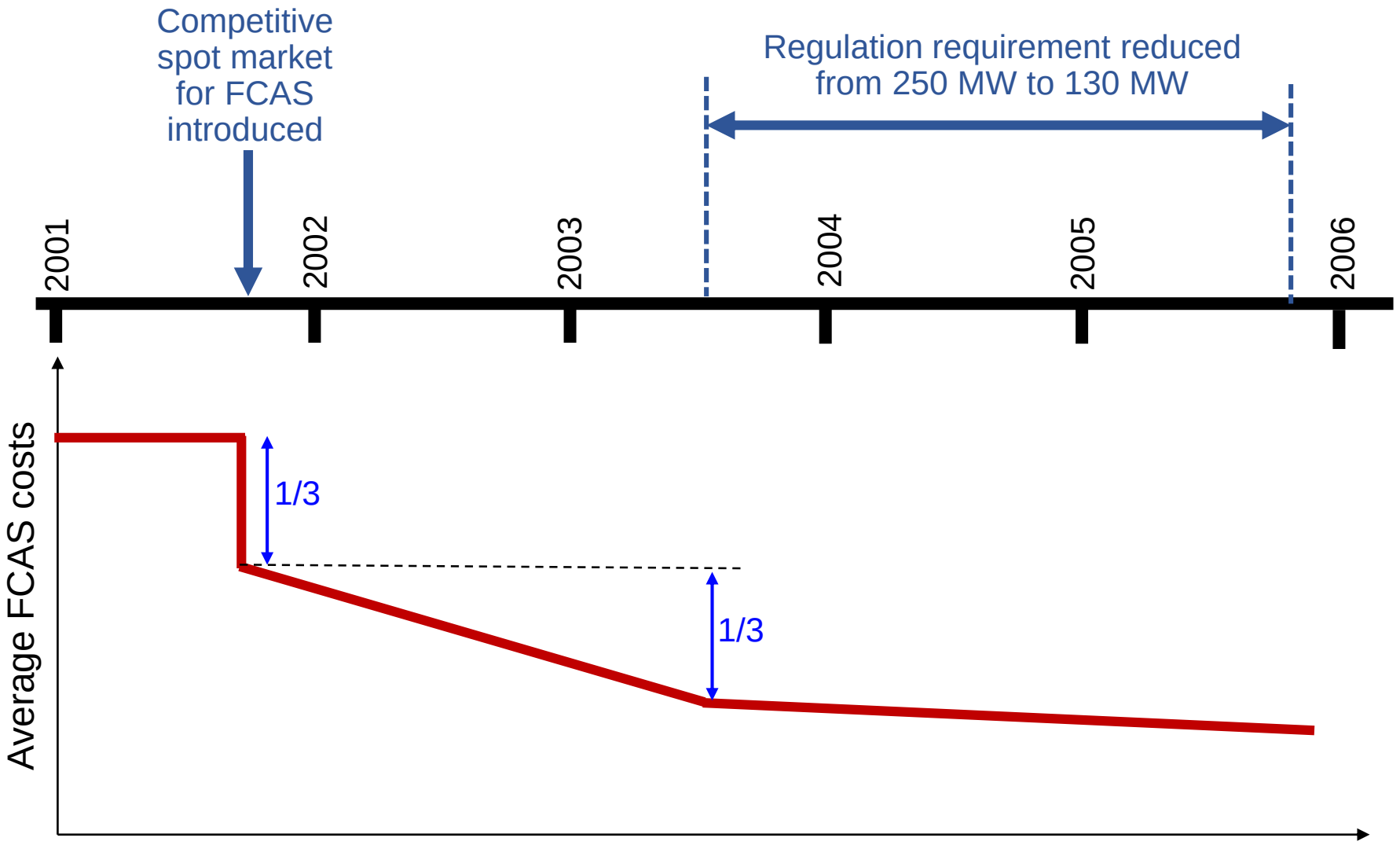
Effective market design can minimise the FCAS reserves required (eg. 5 min markets with short delays from gate closure to dispatch)

Australian National Electricity Market



National Electricity Market (NEM)

FCAS market experience in the NEM



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

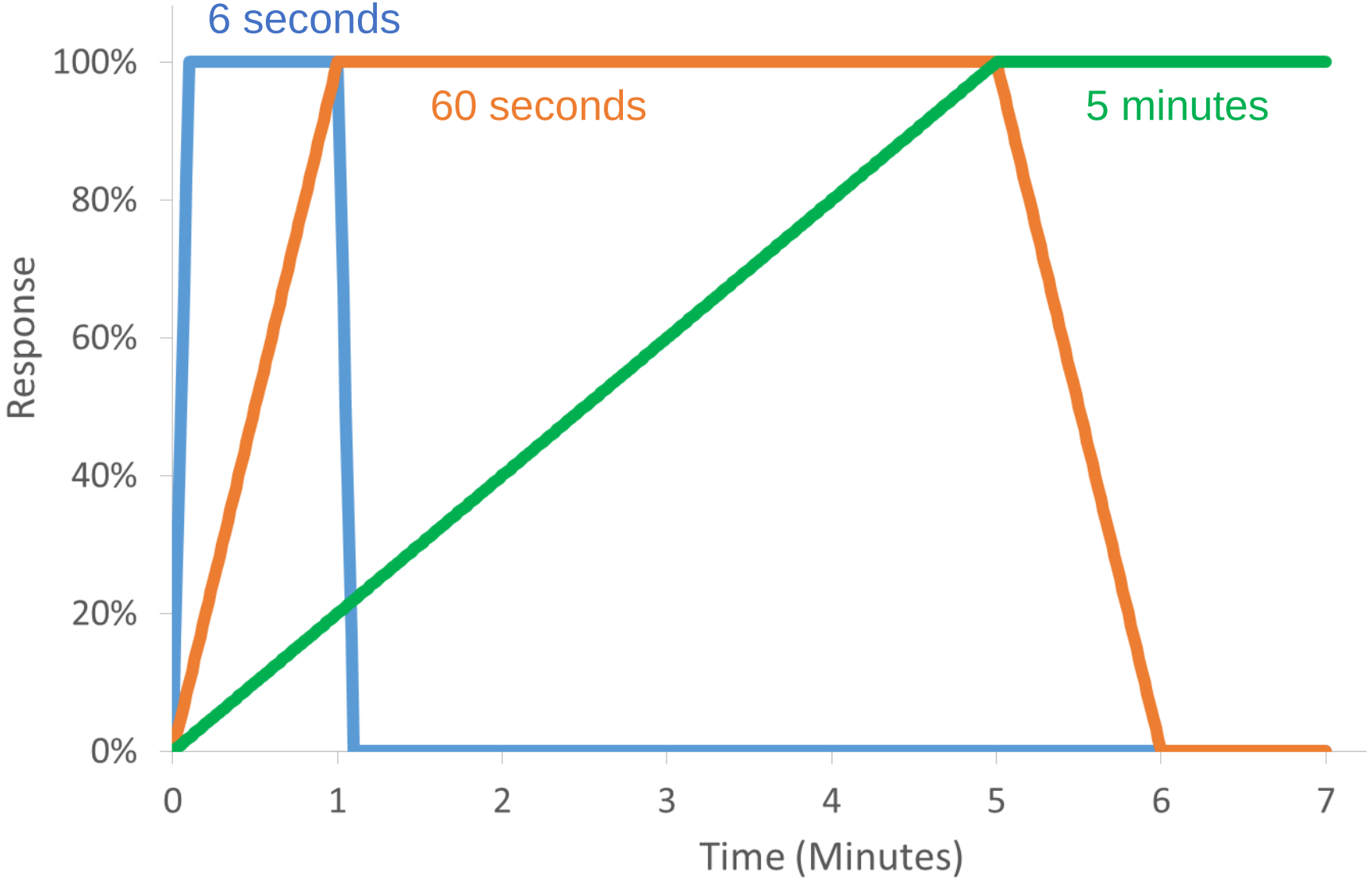
Fast 6 second response time

Primary frequency response

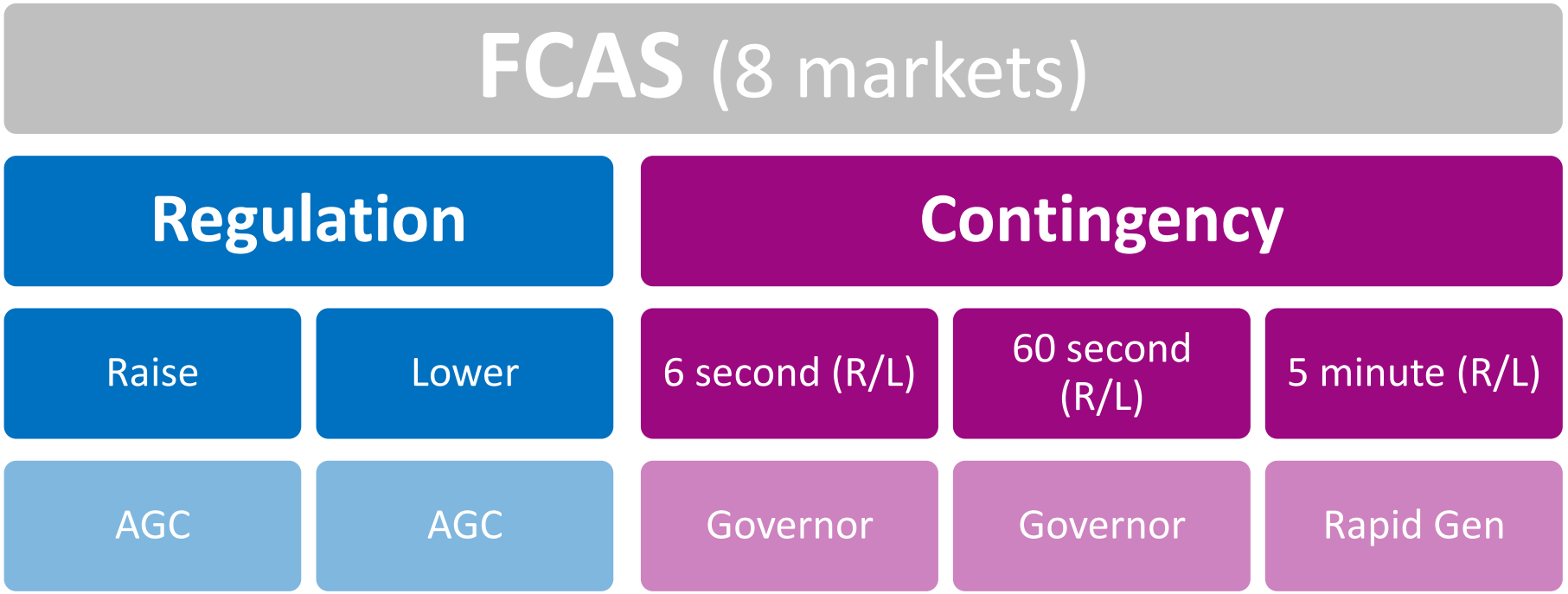
- Autonomous response triggered by frequency drop
  - Very rapid response following contingency (deployed in first 5-10 seconds)
  - Very few markets have an explicit market for a service this fast

Market	Fully activated within…	Notes
USA	-	Not explicitly included in any USA market
Europe	30 seconds	Start within a few seconds, at least 50% deployed within 15 seconds (ENTSO-E requirement)
New Zealand	1 second	Sustained for 60 seconds
Australian NEM	6 seconds	Sustained for 60 seconds

Contingency Reserves Response Times



FCAS in the NEM



AGC: Automatic Generation Control signal from AEMO

Generator responds to locally sensed frequency

CIGRE Technical Brochure 435 – Ancillary Services : an overview of international practices. Oct 2010.

Dynamic reserve setting

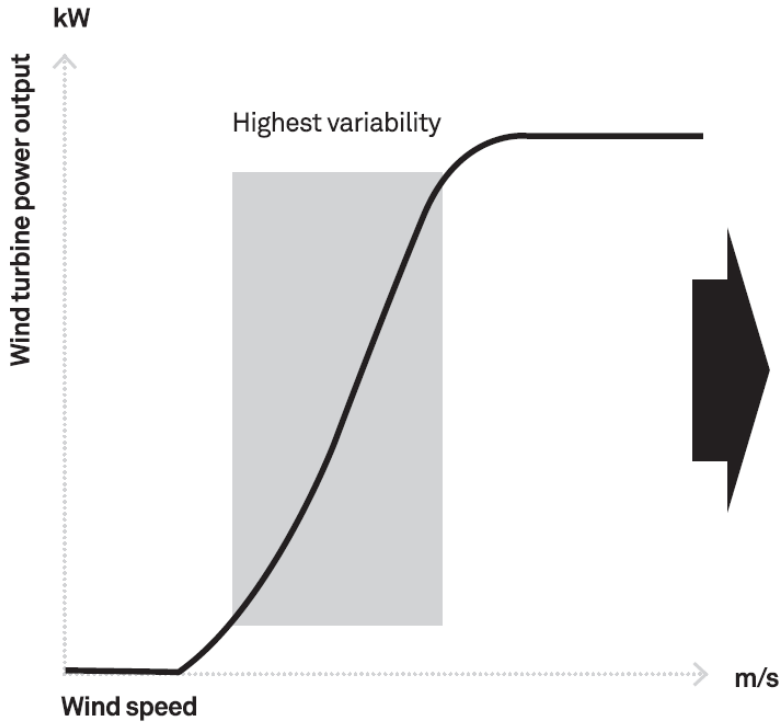
Regulation Reserve

Static regulation reserve requirements

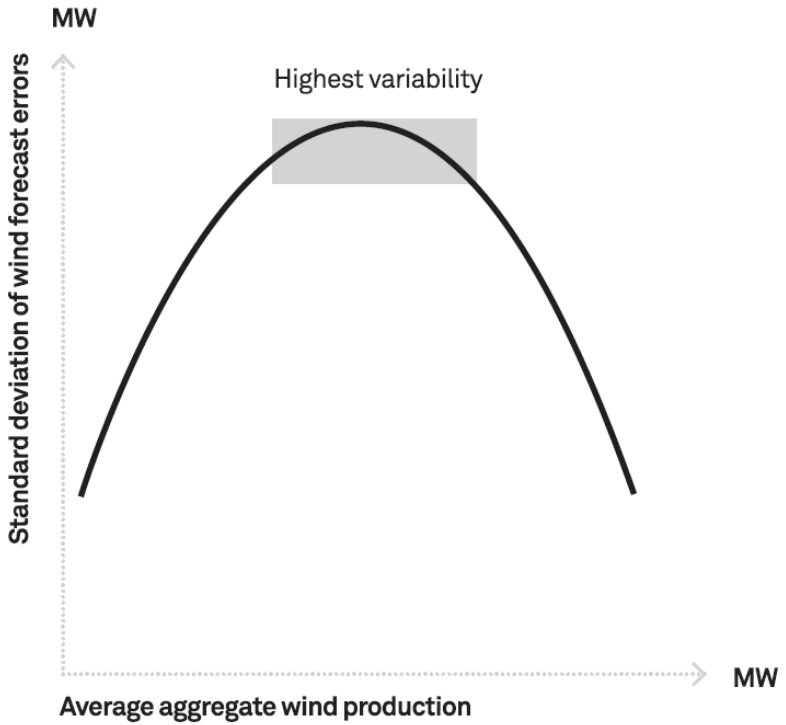
Region	Separate/ Combined	Rule
PJM	Combined	Based on 1% of the peak load during peak hours and 1% of the valley peak during off-peak hours.
NYISO	Combined	Set requirement based on weekday or weekend, hour of day, and season.
ERCOT	Separate	Based on 98.8th percentile of regulation utilized in previous 30 days of same month of previous year and adjusted by installed wind capacity.
CAISO	Separate	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.
MISO	Combined	Requirement made once a day based on conditions and before the day-ahead market closes.
ISO NE	Combined	Based on month, hour of day, weekday/sat/sun.

NREL, E. Ela et al, 2011, Effective Ancillary Services market Designs on High Wind Power Penetration Systems

Dynamic regulation reserve



Wind turbine power curve – highest variability in the central region



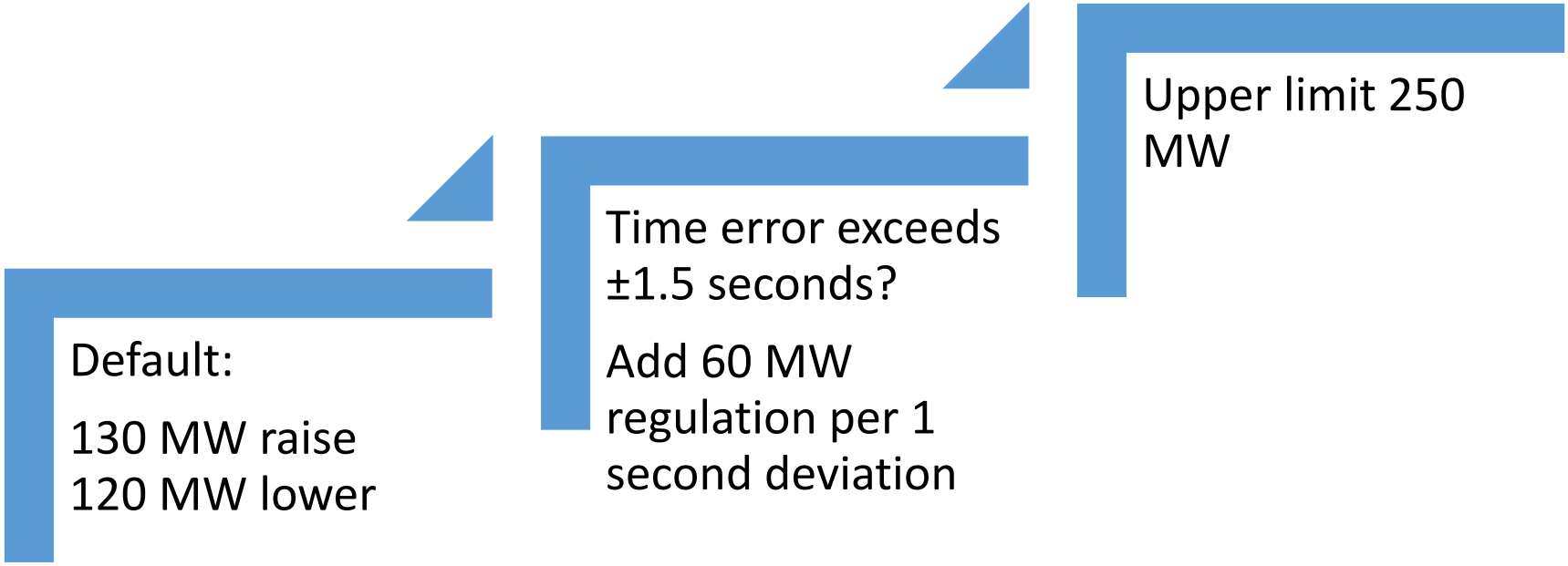
Wind likely to be most variable when operating in the central range

Set reserves dynamically to reduce costs

NREL, Enernex Corporation, Eastern Wind Integration and Transmission Study, 2011

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



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:

Paid for by:

Contingency Raise → Generators

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

Contingency Lower → Loads

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

Regulation → Causer Pays

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

Causer Pays

Attribution of regulation costs:

Contribution factors:
Deviation from expected dispatch
Positive – Assisting in correcting system frequency
Negative – Causing deviations in system frequency

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)

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

Technology neutral approach to provision of FCAS

- No barriers to provision by renewables, as long as they meet the technical requirements

Single platform market

- No day-ahead market (real-time only)
- FCAS reserves set dynamically in real time, based upon latest information

Adjustments that may be required in the NEM

Optimise contingency response times	Inertia	Following service
• 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?

- Primary frequency response market
- Dynamic reserve setting
- Causer pays payment recovery

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Thank you

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