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Wind as the new “Base Load”

The role of wind in future electricity markets

Dr Jenny Riesz

April 2014

Powerlink QUEENSLAND

ASI AUSTRALIAN SOLAR INSTITUTE

AGL

Ausgrid

ElectraNet electricity transmission

westernpower

origin

Clean Energy Council

Australian Coal Association

imo Independent Market Operator

RioTinto

Australian Energy Market Commission AEMC

AEMO AUSTRALIAN ENERGY MARKET OPERATOR

Delta electricity

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

ROAM CONSULTING ENERGY MODELLING EXPERTISE

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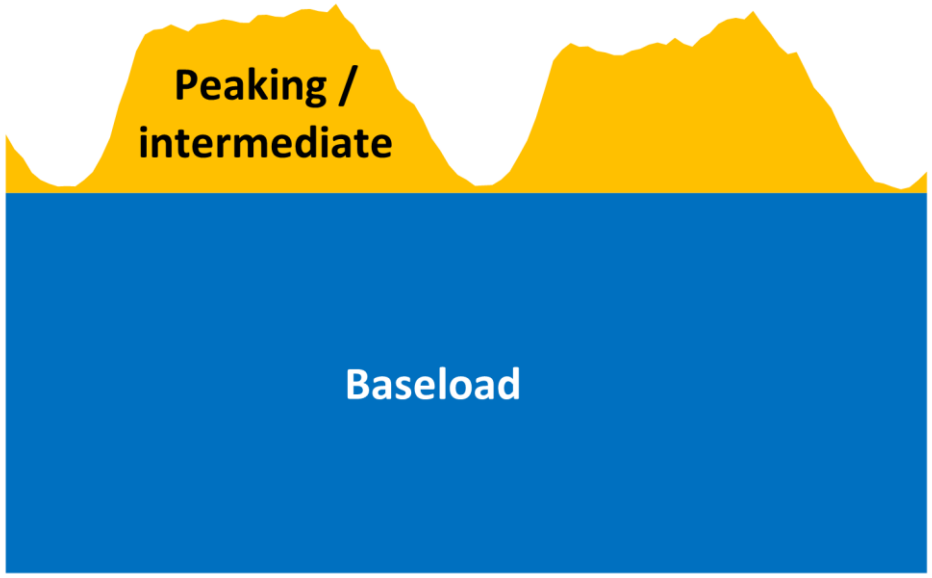
AECOM



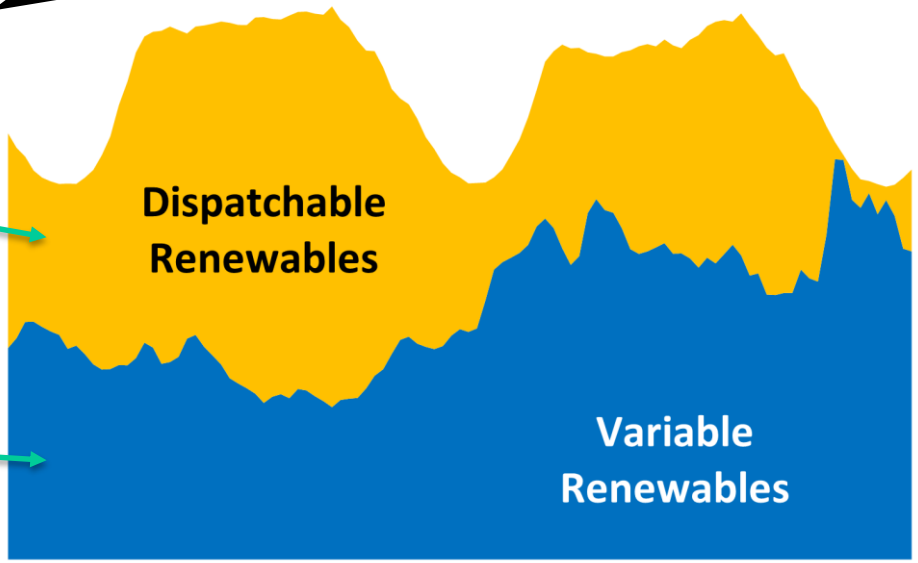
A new power system paradigm

Top up with dispatchable renewables

- Hydro with storage
- Geothermal?
- Biomass
- Solar thermal with storage

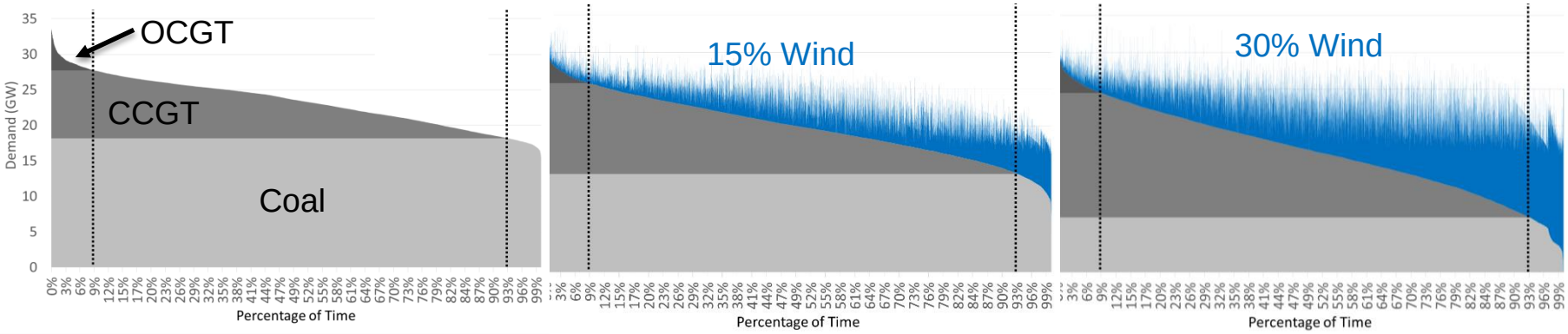
Use cheapest technologies first:

- Wind
- Solar PV
- Run of river hydro
- Geothermal?

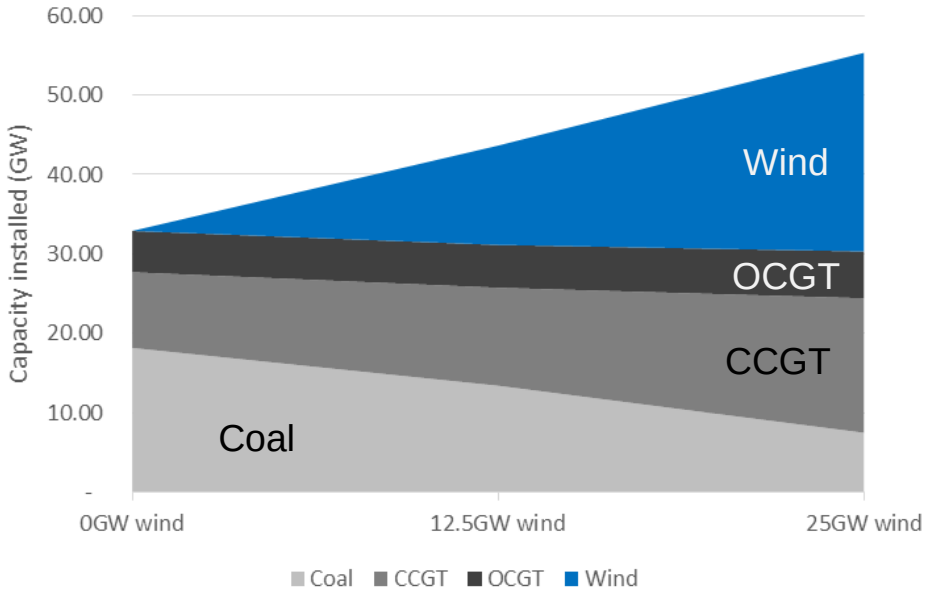


Wind displaces baseload generation

Least cost optimum generation mix:



Optimal capacity of coal-fired generation (baseload) declines as wind is added



J. Riesz, J. Gilmore, (2014) "Does wind need "back-up" capacity – Modelling the system integration costs of "back-up" capacity for variable generation". Accepted for presentation at the 2014 International Energy Workshop (Beijing)

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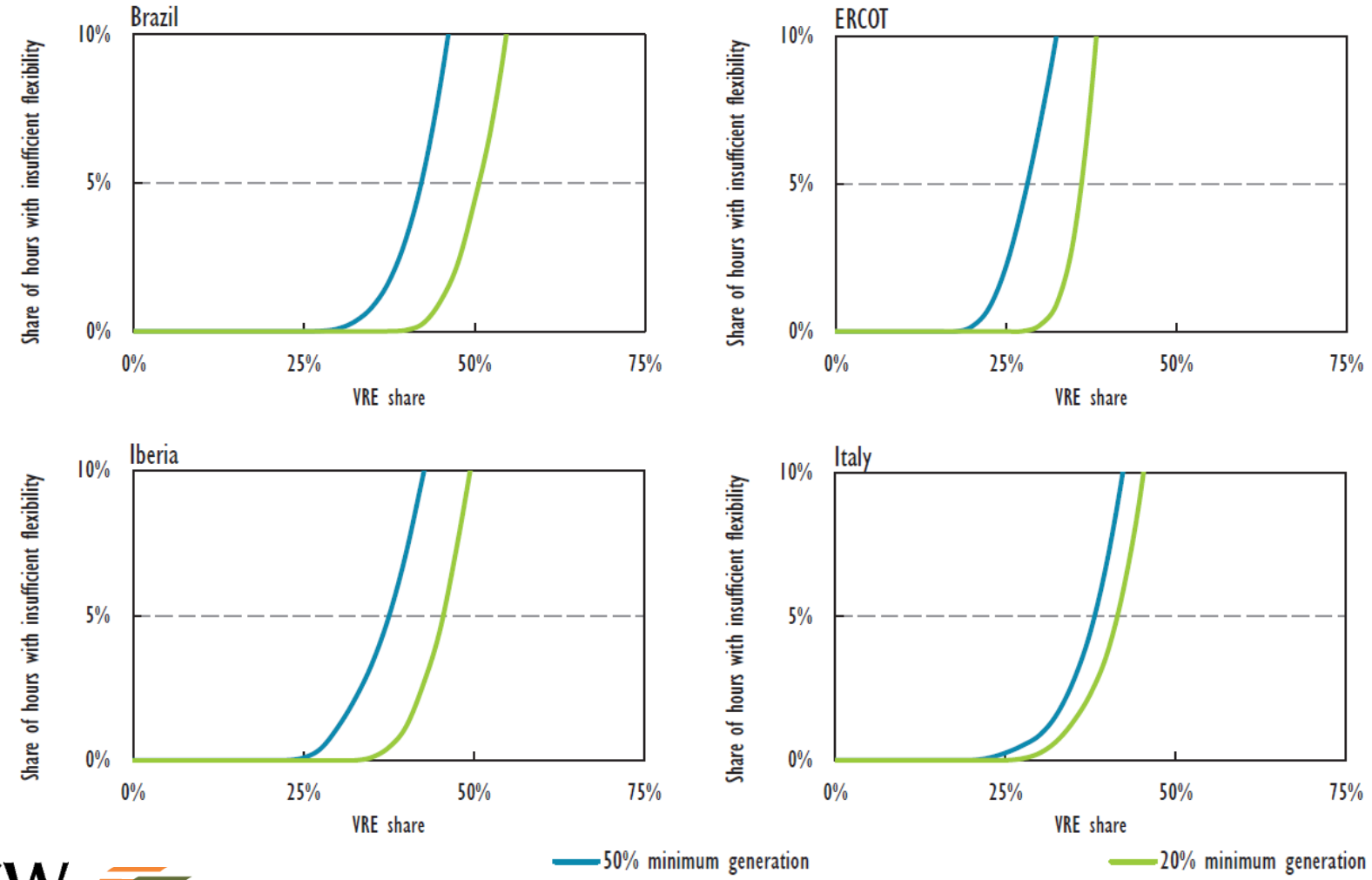
Flexibility of existing power systems

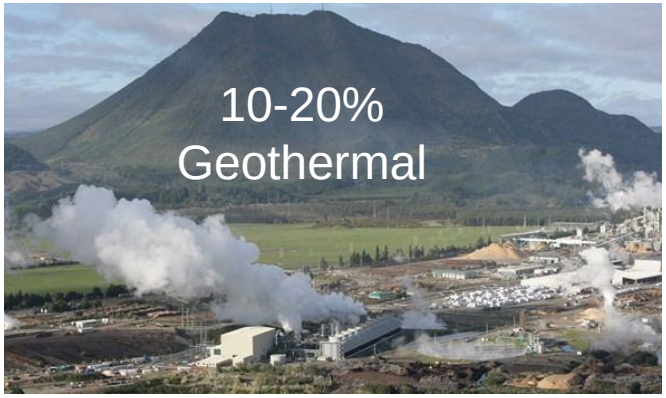
- IEA study: All regions studied have sufficient flexibility to support 25% - 40% variable renewables
- If accept a few hours of curtailment per year numbers increase considerably (>50% in some systems)
- Low “turn down” levels are important
- Increasing technical flexibility (eg. Batteries, flexible plant) increases potential penetration of VRE further

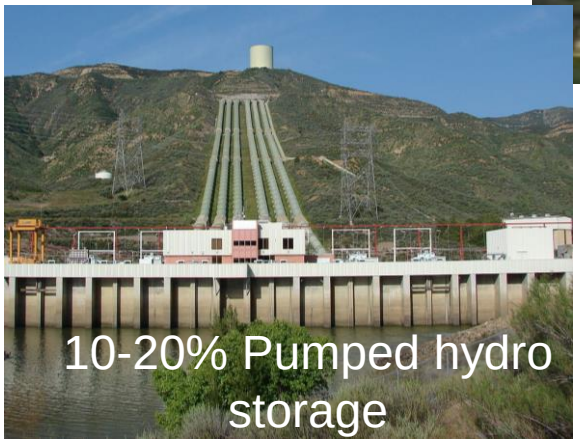


International Energy Agency (2014) “The Power of Transformation: Wind, Sun and the Economics of Flexible Power Systems”

Possible 100% Renewables technology mix (NZ)

(by capacity)





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Mason, I.G., Page, S.C., Williamson, A. G., (2013) "Security of Supply, energy spillage control and peaking options within a 100% renewable electricity system for New Zealand" Energy Policy 60, 324-333.

What about the *market?*

Competitive market → Generators offer close to SRMC → Price close to zero in majority of periods

How do generators recover costs?

How do we maintain accurate investment incentives?

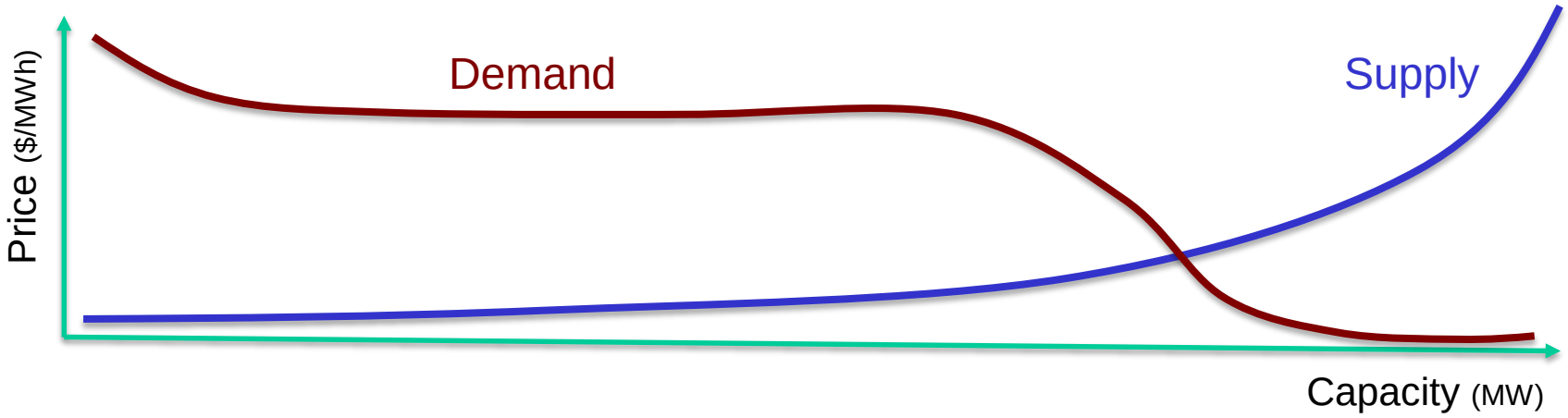
SYSTEM ADEQUACY

Managing system adequacy in energy-only markets

- In theory:

Customers individually choose desired level of reliability (price at which no longer prepared to pay) → Generators invest when prices sufficient for profitability → Shifts supply curve (prices fall) → New equilibrium (based upon customer willingness to pay for reliability)

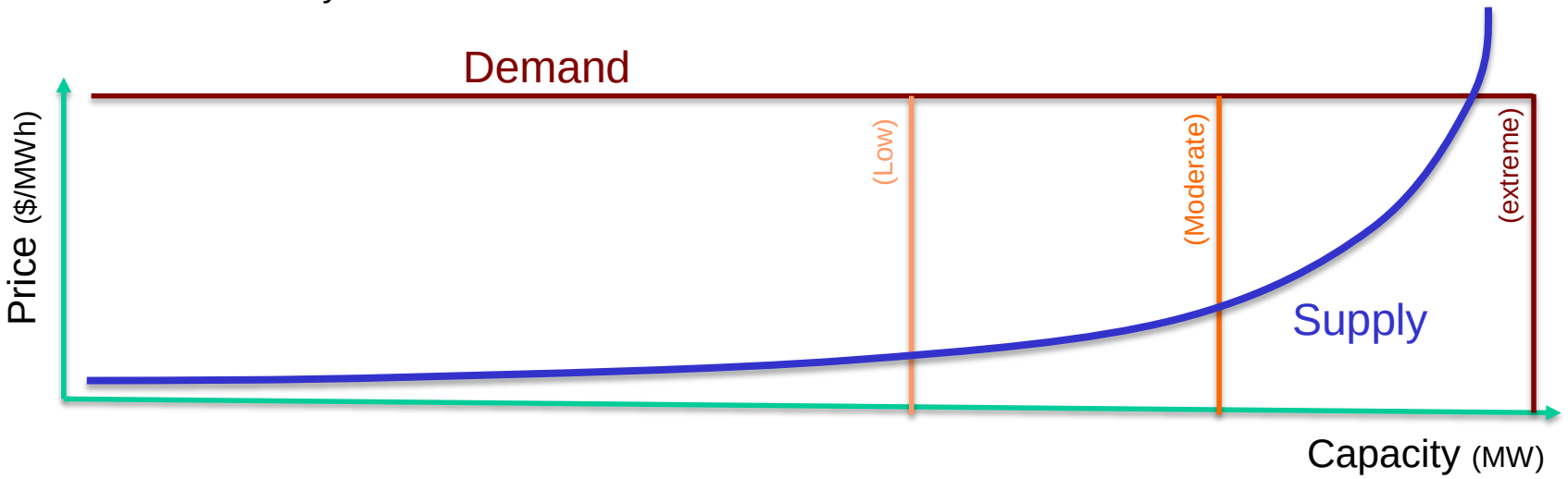
Contracting between customers and generators allows risk management
(more certain revenues for generators, and more certain reliability for customers)



This requires full demand side participation!

Managing system adequacy in energy-only markets

- In reality:
  - No market has widespread demand side participation
    - Although growing in some (eg. PJM)
  - Regulator sets market price cap, based upon assumed customer willingness to pay (eg. Australian NEM)
  - Price cap must be high enough to ensure sufficient generation investment, even when scarcity occurs rarely

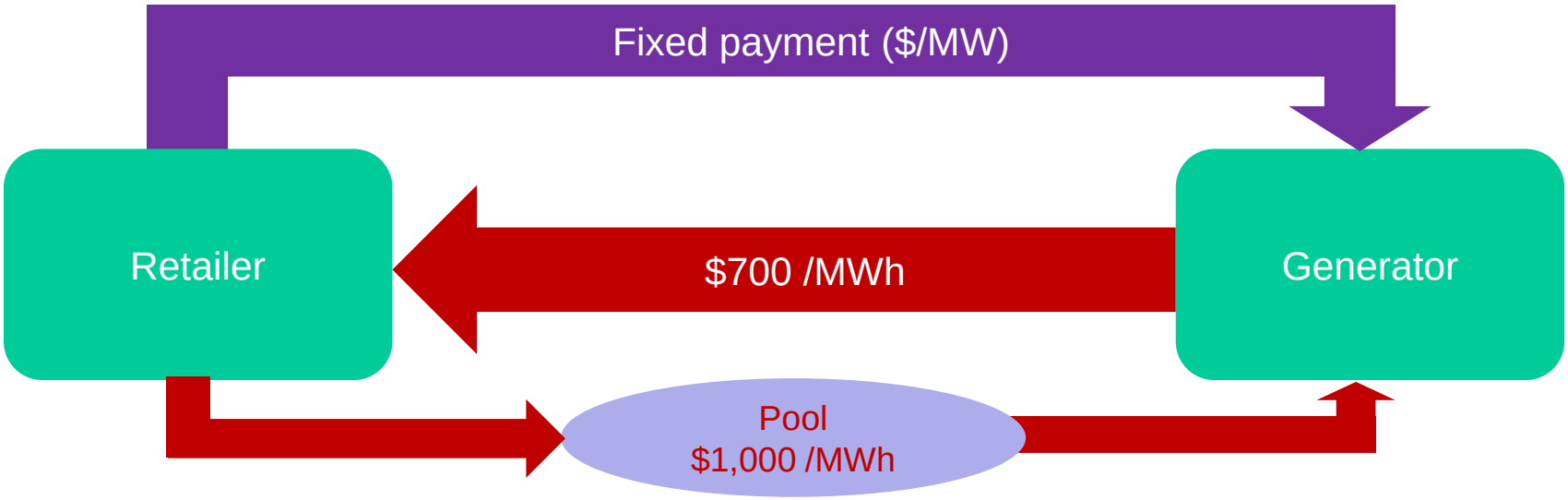


Managing price volatility

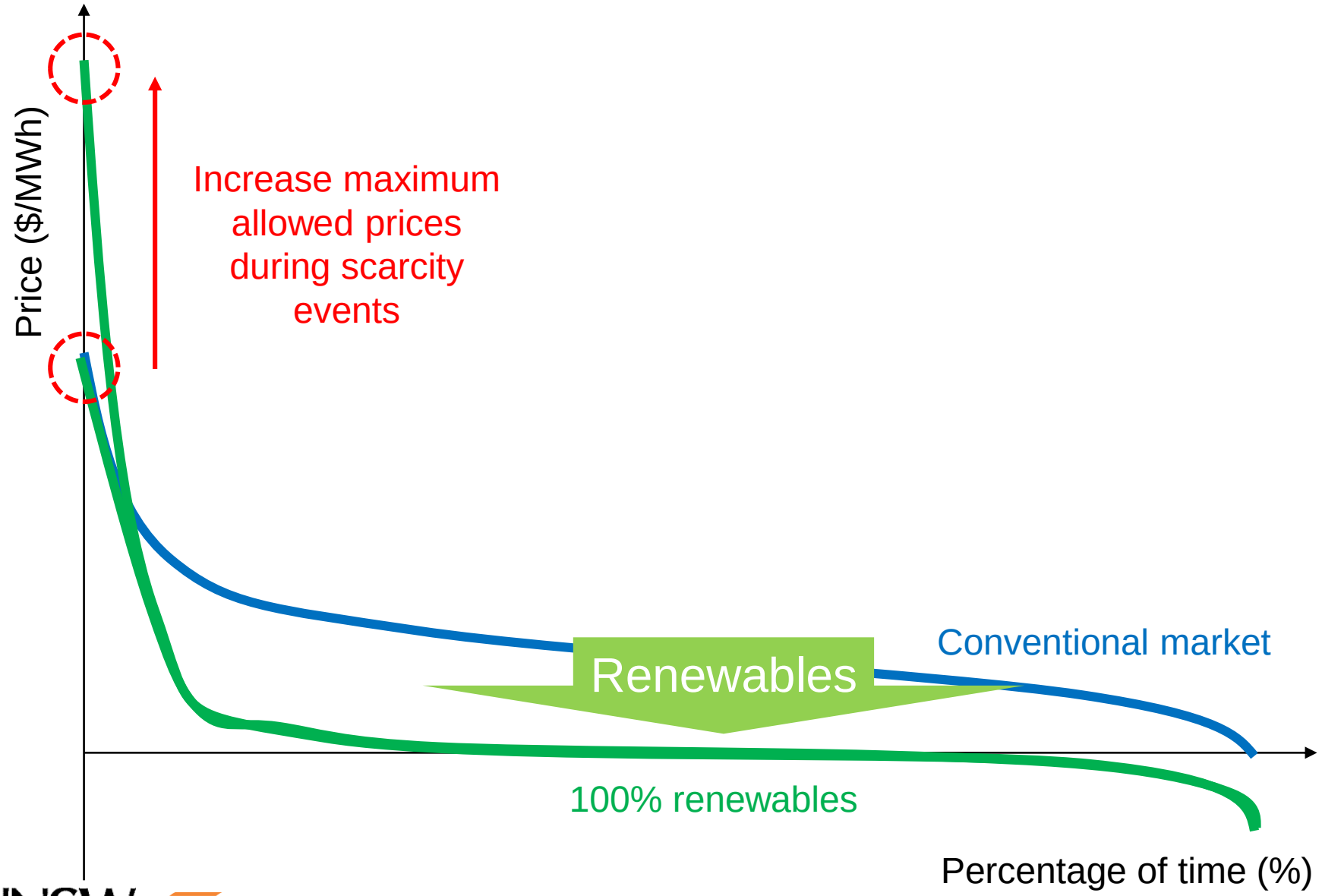
- Energy-only markets should exhibit high price volatility
  - Periods of extreme prices necessary for recovery of fixed costs
- Market participants manage price volatility via:
  - Contractual arrangements – mature derivatives market, or
  - Vertical integration

Cap contract:
($300 strike price)

Provides many of the benefits of a capacity market, but market participants retain decision making



Impact of renewables



How much would scarcity prices need to increase?

- Analysis for Australian NEM:

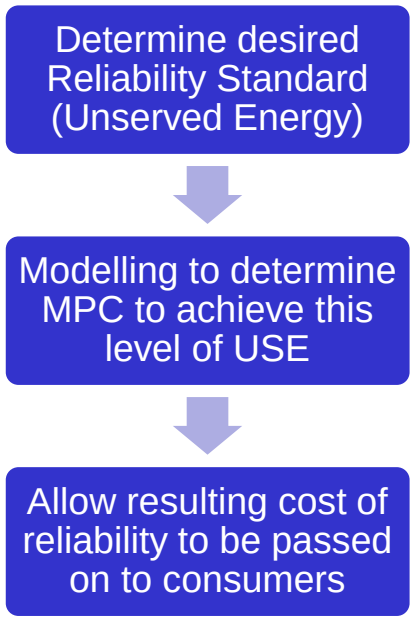
	MPC ($/MWh)
Present Market Price Cap (MPC)	$13,100
To maintain historical aggregate revenues (with move to 100% renewables)	~$30,000
Sufficient aggregate revenues to support 100% renewables	~$60,000 to $80,000

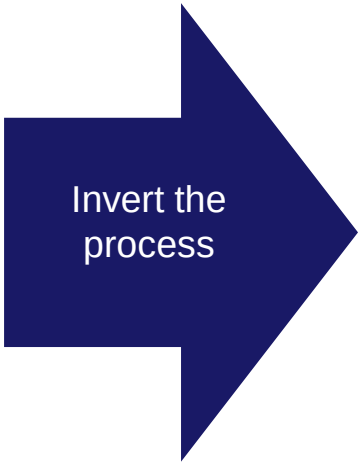
For New Zealand – will need to accept increasingly extreme scarcity prices

J. Riesz, Iain MacGill, "100% Renewables in Australia – Will a capacity market be required?" Proceedings of the 3rd International Workshop on the Integration of Solar Power into Power Systems, London, October 2013.

Perhaps this isn't crazy…

Process applied in the Australian NEM:





Theoretical "best practice":

Renewables don't affect VCR, so shouldn't affect MPC

	Value of Customer Reliability ($/MWh)
Residential	20,710
Small business	413,120
Large business	53,300
Average	**94,990**

Oakley Greenwood, "NSW Value of Customer Reliability", Australian Energy Market Commission, 2012

Issues with allowing higher extreme prices

Increased costs of hedging

Increased prudential obligations

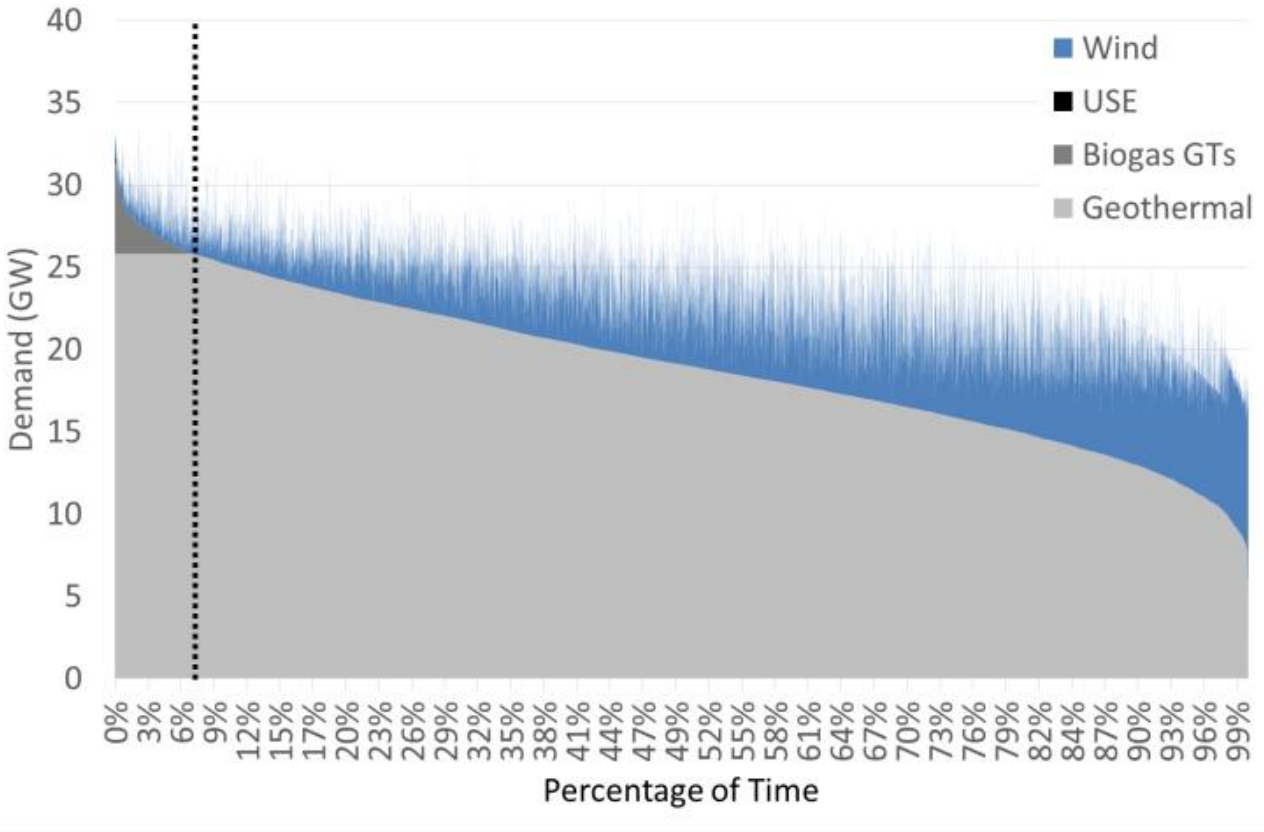
- Increased barriers to entry for retailers

Discouragement of inter-nodal contracting

- May interfere with generation locational decisions in the absence of perfect hedging with FTRs

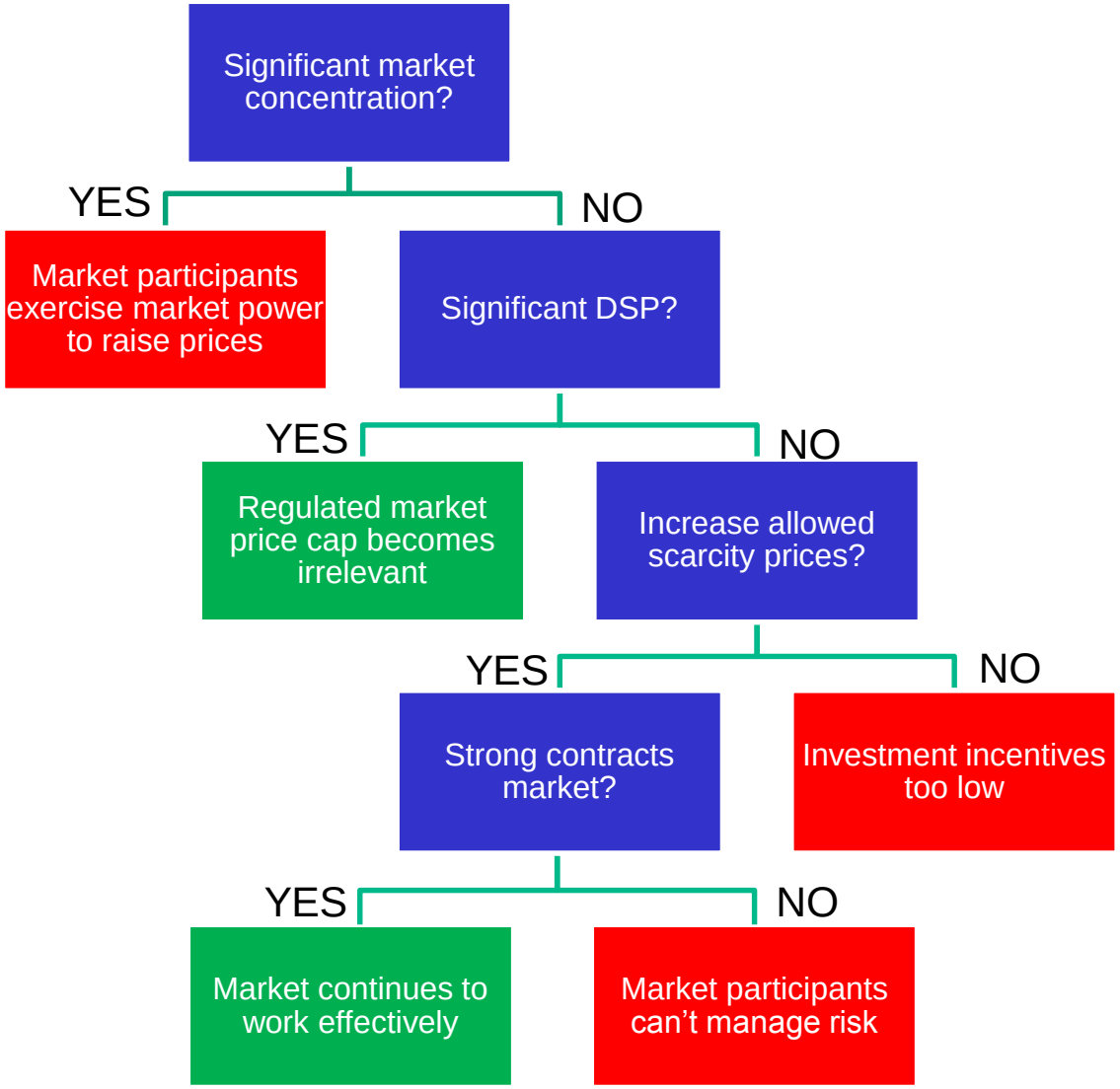
Cost recovery – variable renewables?

If generation mix is least-cost optimised, all generator types earn revenues that precisely cover costs (in theory)



J. Riesz, I. MacGill, J. Gilmore, "Examining the viability of energy-only markets with high renewable penetrations", Accepted for presentation at the IEEE Power and Energy Society meeting, Washington DC, July 2014.

Will energy-only markets work with high renewables?



Constant monitoring is wise – new issues will arise over time

Issues for New Zealand

Increasing importance of contracts/futures market

- Consider mechanisms to increase participation in futures markets
- Disincentivise vertical integration? (reduces liquidity and contracting options)

Increasing importance of Demand Side Participation

- DSP allows customers to individually choose their desired level of reliability – reduces need for regulatory intervention

Operational considerations – market design

- Lots of other considerations in market design for integrating variable renewables
  - Accessing flexibility on operational and investment timeframes

- Discuss at 1.45pm
  - "The Market & Wind" parallel session

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Thank you

jenny.riesz@gmail.com

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