Challenges of Renewables for climate change mitigation

ELEC5206: Sustainable Energy Systems

30th October 2013

Dr Jenny Riesz

Who am I?

Powerlink Queensland

ASI Australian Solar Institute

AGL

Ausgrid

ElectraNet electricity transmission

westernpower

Clean Energy Council

origin

Australian Coal Association

imo Independent Market Operator

RioTinto

Delta electricity

AEMC Australian Energy Market Commission

AEMO Australian Energy Market Operator

The University Of Queensland Australia

ROAM CONSULTING ENERGY MODELLING EXPERTISE

Centre for Energy and Environmental Markets

UNSW Australia

AECOM

Overview

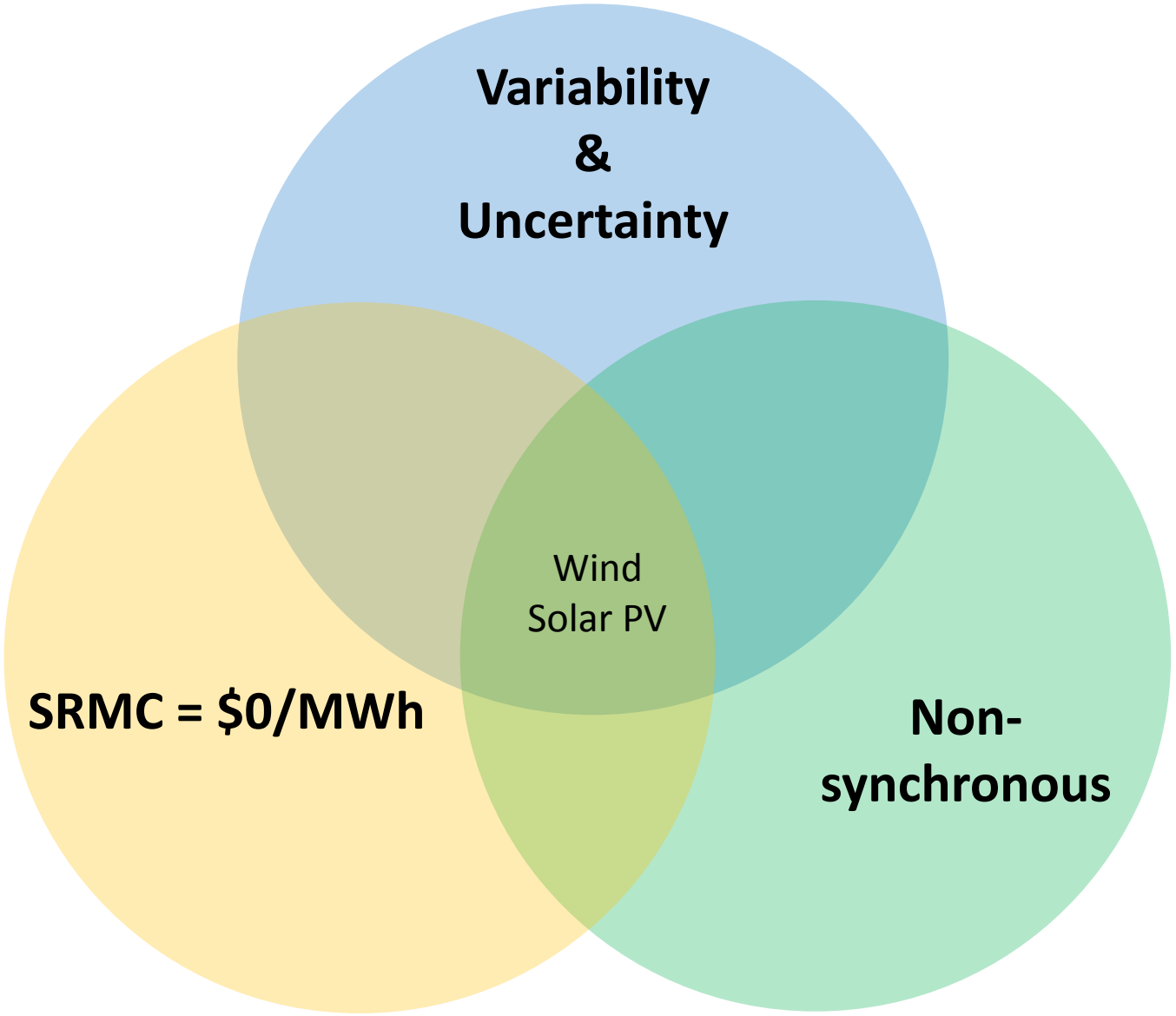
What makes renewables different?

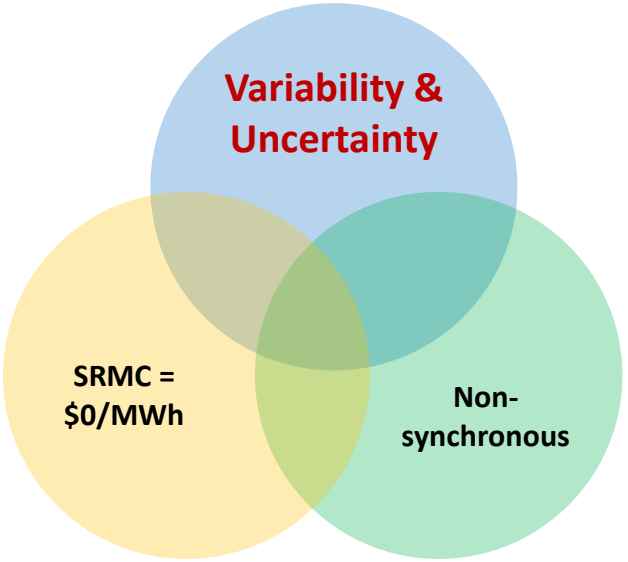
- Managing greater uncertainty and variability
- Managing non-synchronous generation
- Managing SRMC = $0/MWh

Policy mechanisms

- Renewable Energy Target
- Carbon Pricing

What makes renewables different?

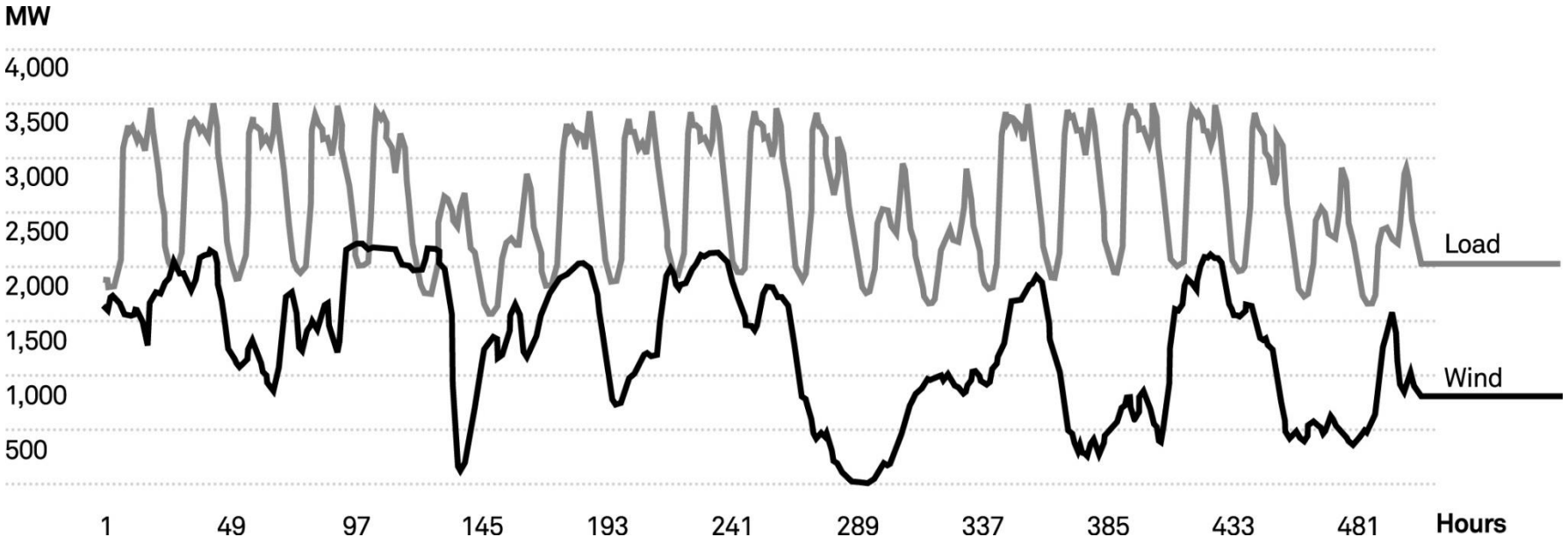




Managing Variability & Uncertainty

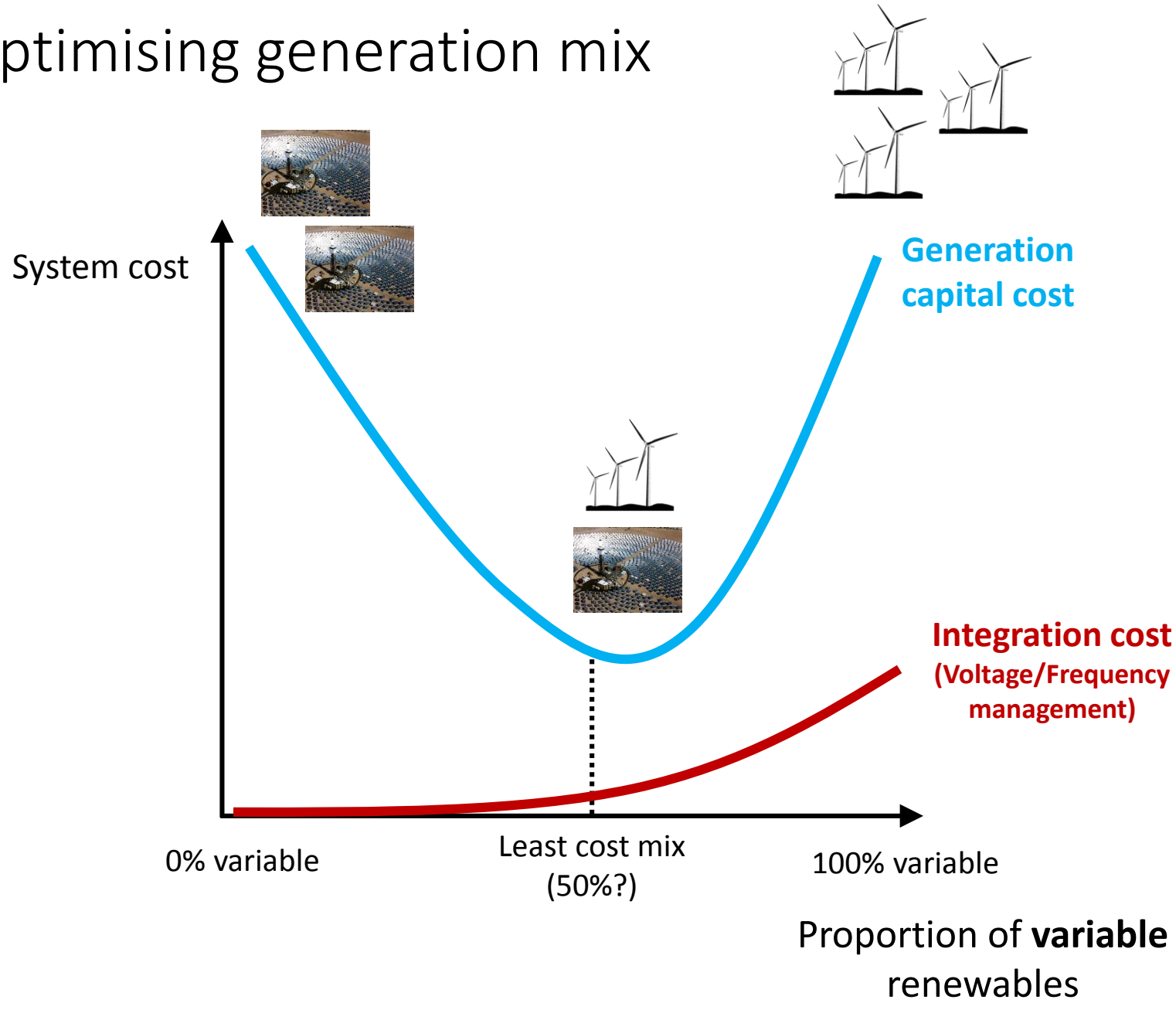
Variability and Uncertainty

- Wind and demand variability in West Denmark (Jan 2005)



Holttinen, H., Meibom, P., Orths, A., Hulle, F. v., & Lange, B. (2009). Design and operation of power systems with large amounts of wind power. Final report, Phase one 2006-08. IEA Wind Tas 25.

Optimising generation mix

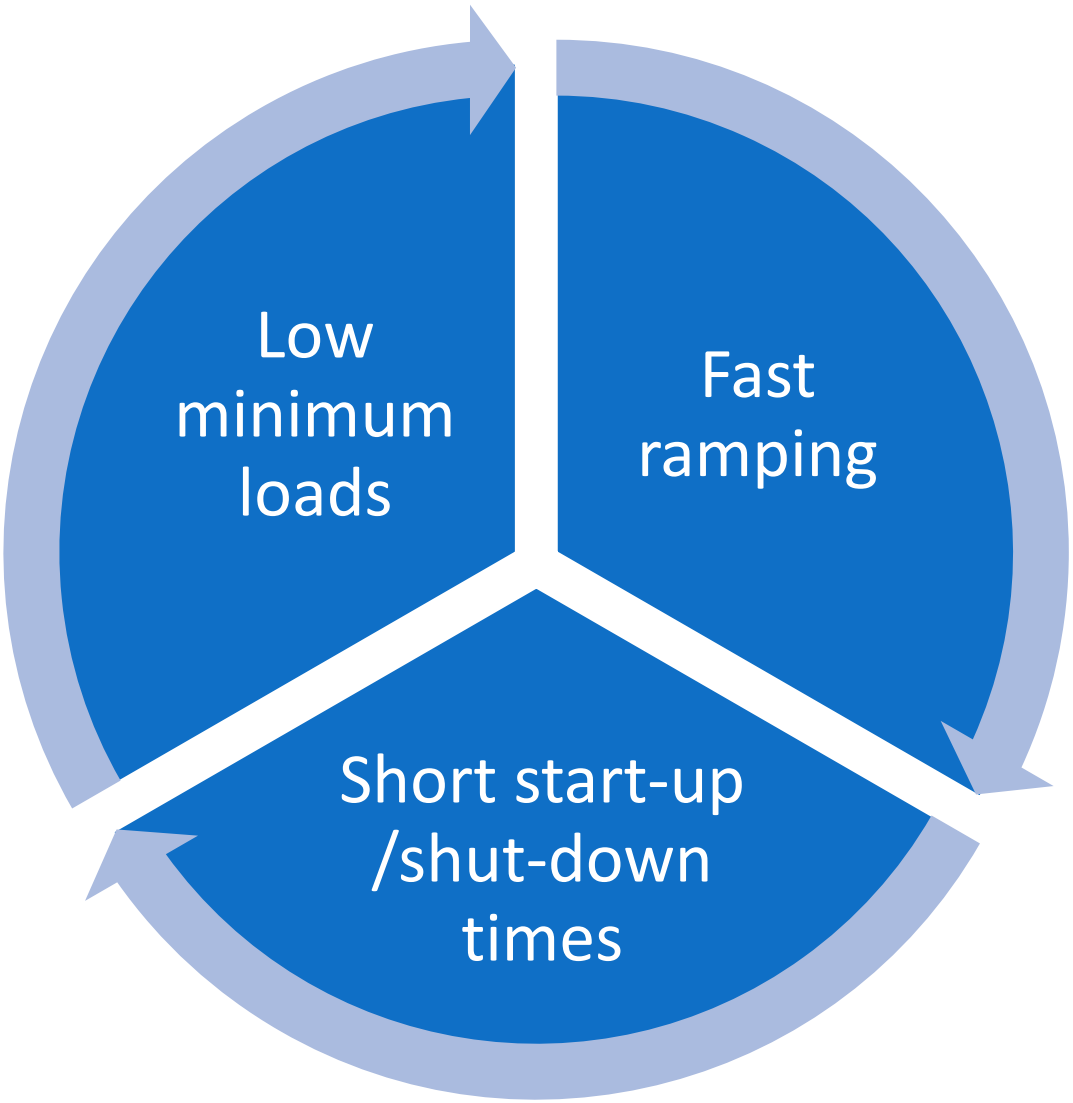


Flexibility

With more **variability** and more **uncertainty** we need more system flexibility.

Some comes from the normal operation of the electricity market (if well designed).

Some comes from dedicated "reserves" (Frequency Control Ancillary Services)

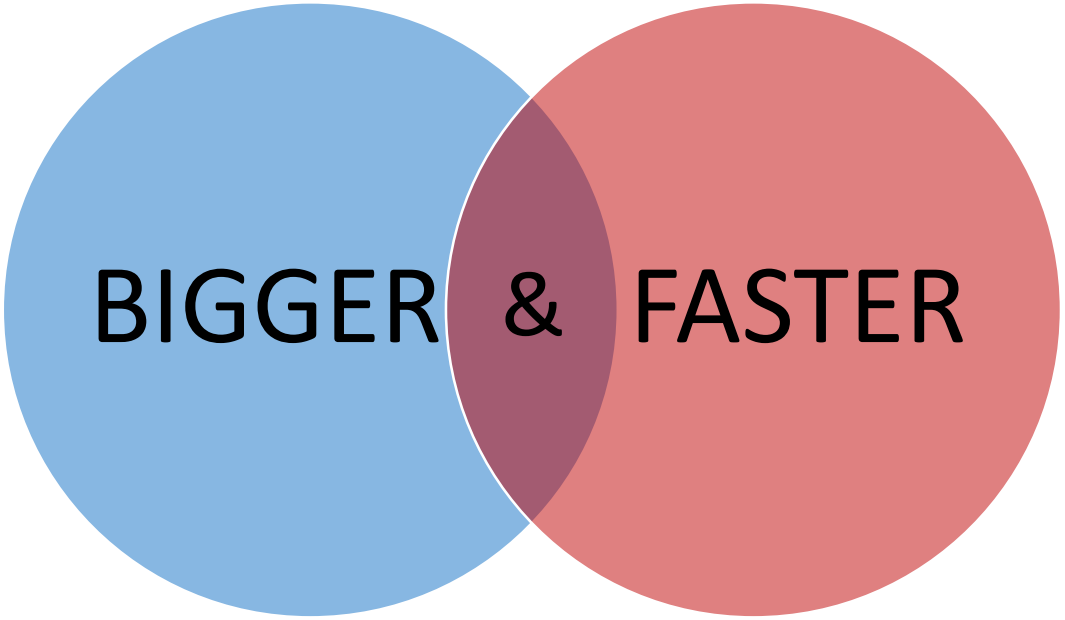


- Most power systems have significant flexibility…
- But market rules may inhibit access to it

IEA. (2011a). Harnessing Variable Renewables. International Energy Agency.

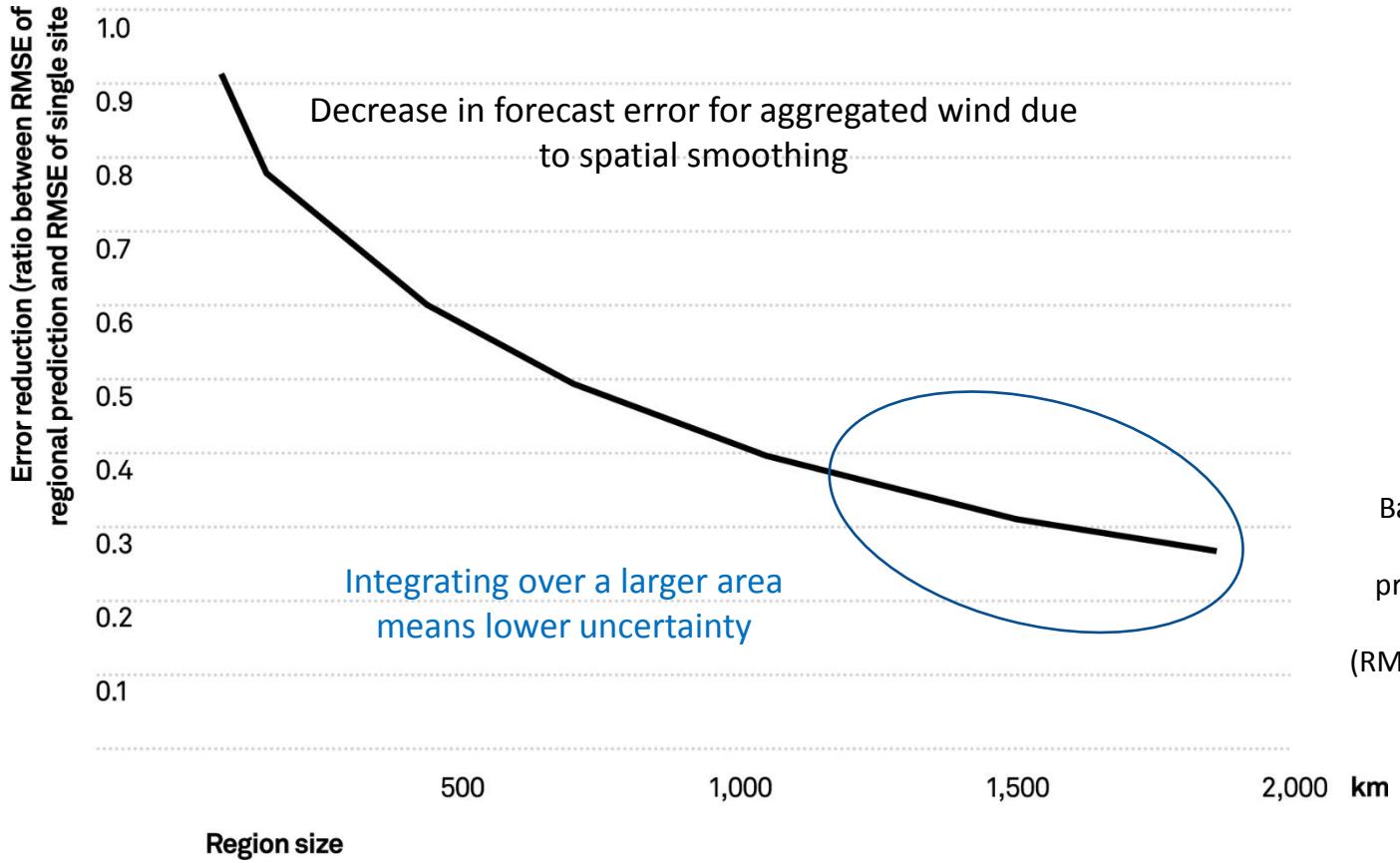
Designing electricity markets for variability

- To more cost effectively integrate more variable renewables, systems need to be:



Bigger: Greater geographical diversity

- Connecting renewables in more locations increases “smoothing” due to geographical diversity
- Therefore, “bigger” grids, coordinated together, reduce integration costs

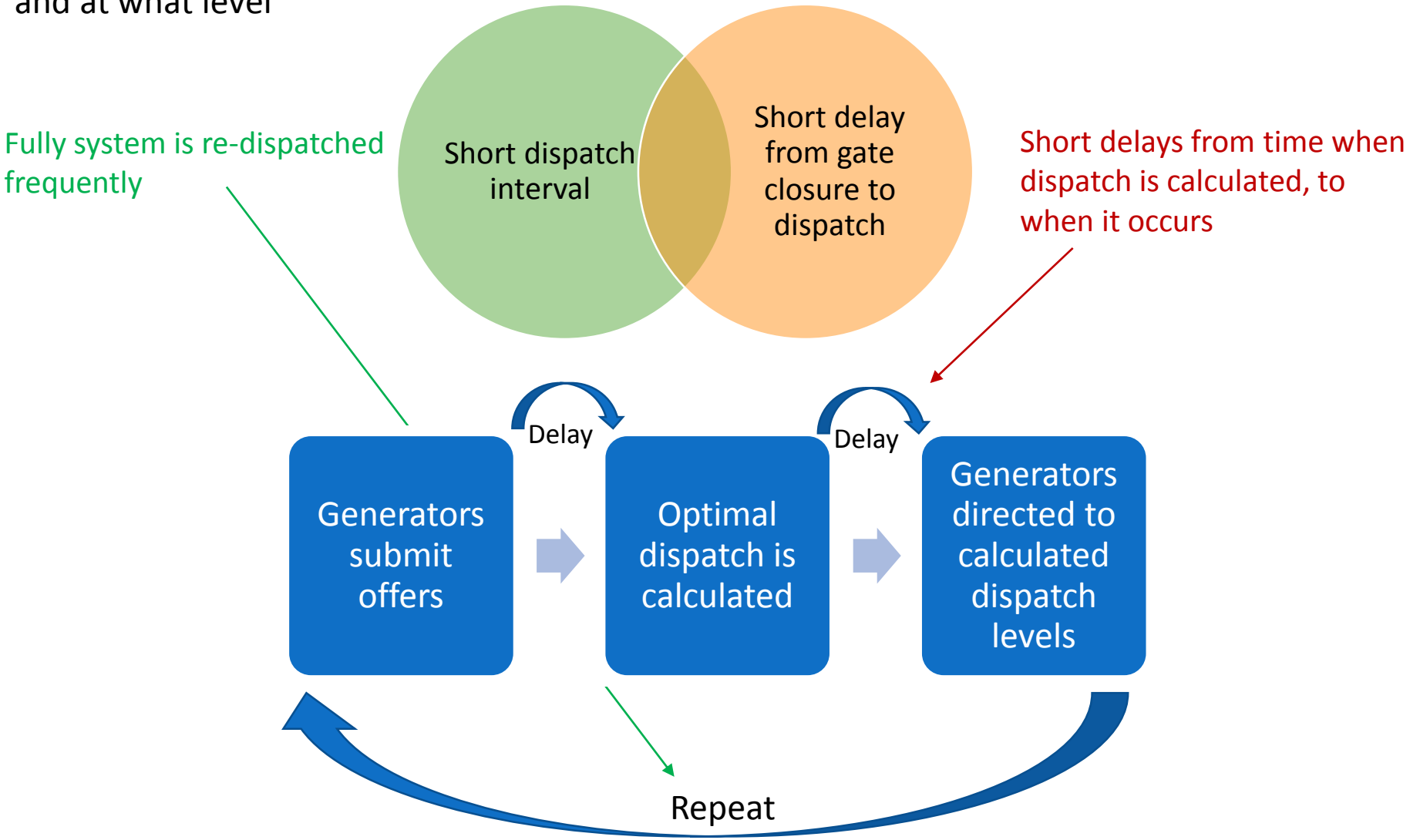


Based upon results of measured power production of 40 wind farms in Germany (RMSE: Root mean square error)

Holttinen, H., Meibom, P., Orths, A., Hulle, F. v., & Lange, B. (2009). Design and operation of power systems with large amounts of wind power. Final report, Phase one 2006-08. IEA Wind Tas 25.

What is a “Fast” market?

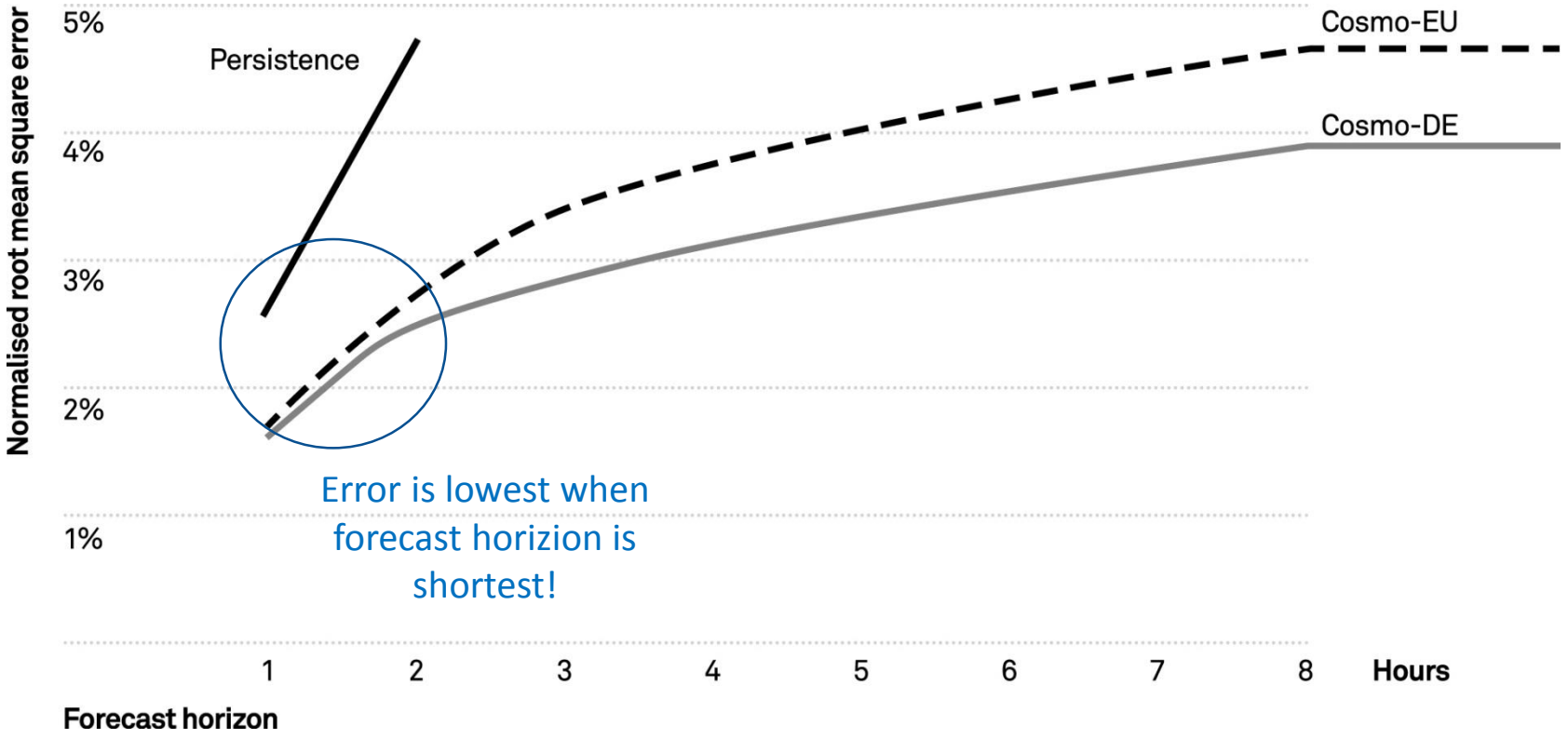
Dispatch: The decisions on which generators are operating, and at what level



Fast markets minimise impact of *uncertainty*

- Calculating dispatch closer to real time minimises errors (minimise time from “gate closure” to dispatch)

Forecast errors for wind power production forecasts for Germany using different forecasting models



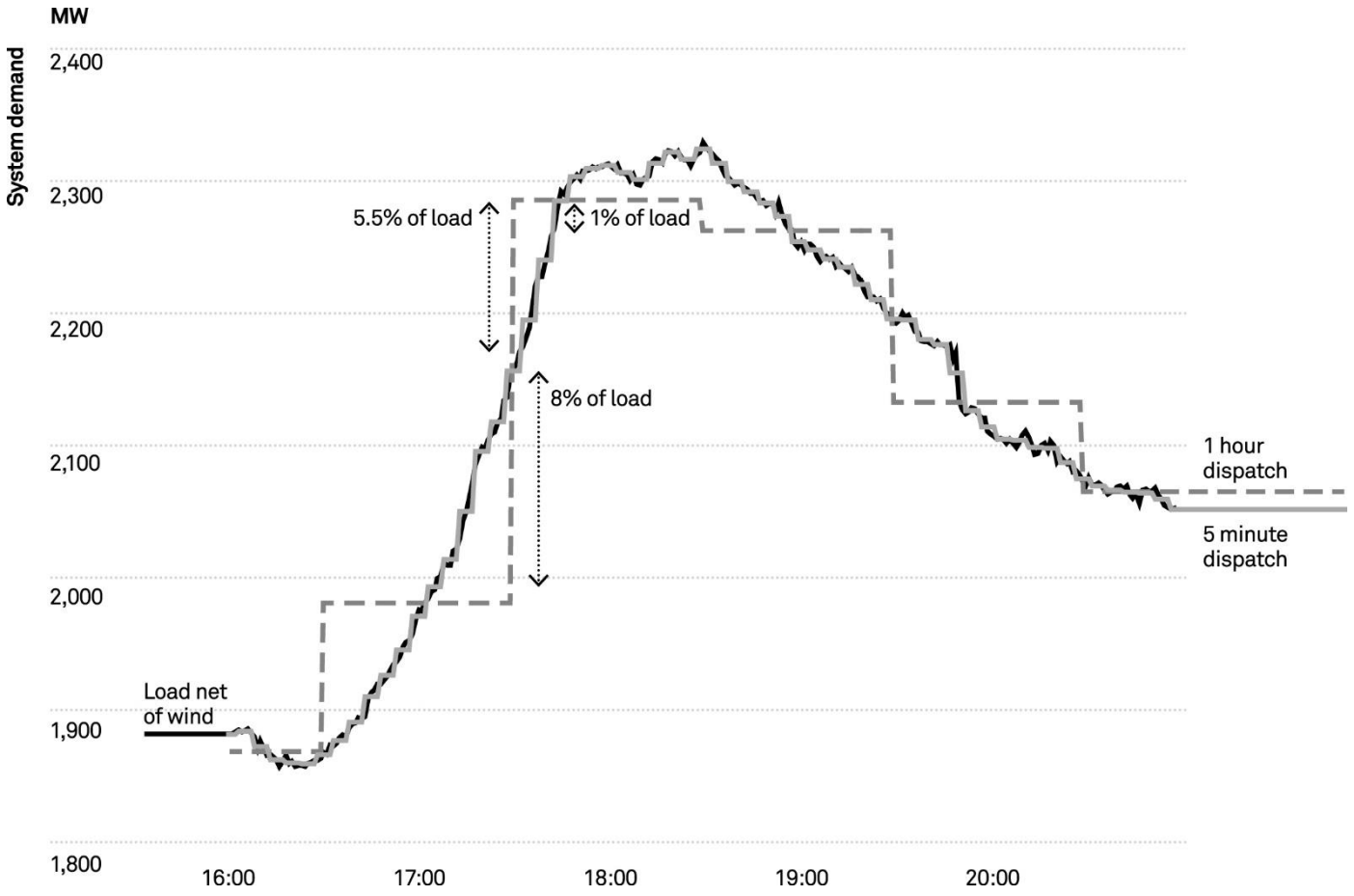
Holttinen, H., Meibom, P., Orths, A., Hulle, F. v., & Lange, B. (2009). Design and operation of power systems with large amounts of wind power. Final report, Phase one 2006-08. IEA Wind Tas 25.

Fast markets minimise impact of *variability*

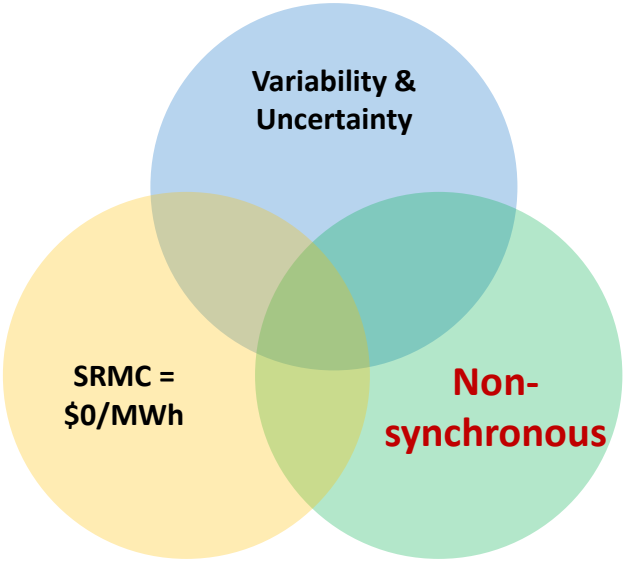
- Re-dispatching whole system more frequently gives more flexibility

Mismatch within dispatch intervals must be met by reserves (Frequency Control Ancillary Services).

Minimising the amount of FCAS required (via BIG and FAST markets) minimises costs.



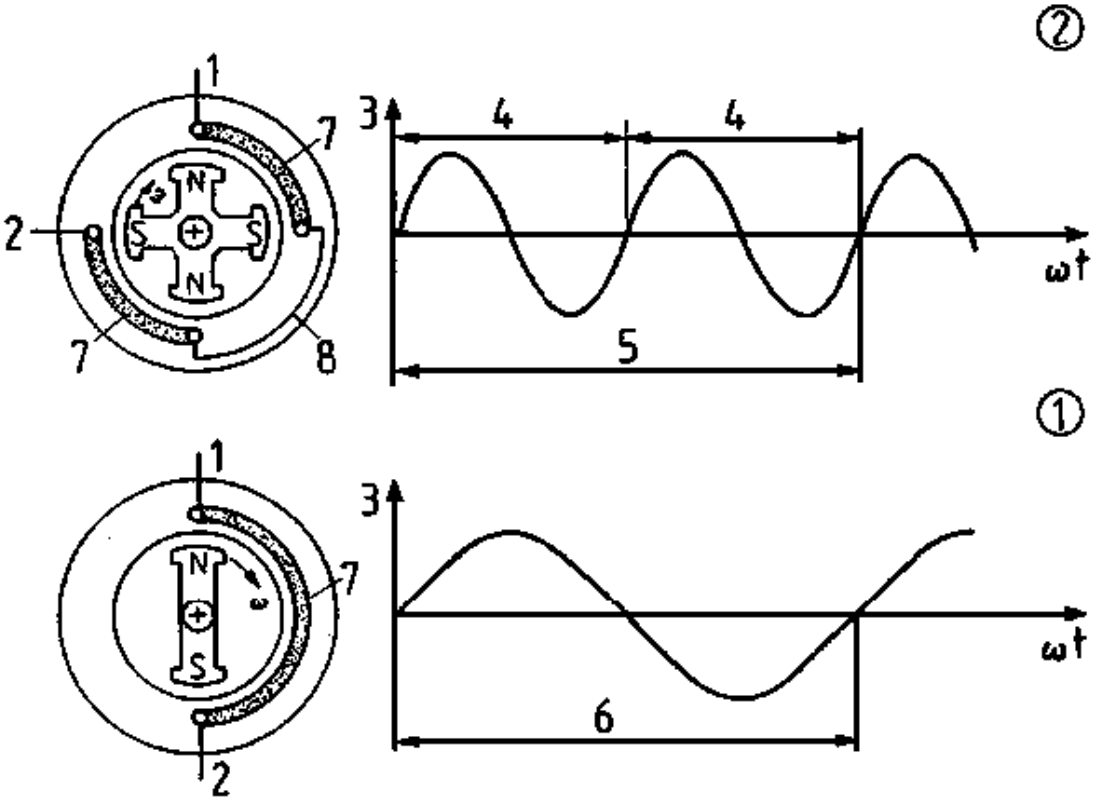
ROAM. (2010). Assessment of FCS and Technical Rules. ROAM Consulting report to Independent Market Operator of Western Australia.



Managing non-synchronous generation

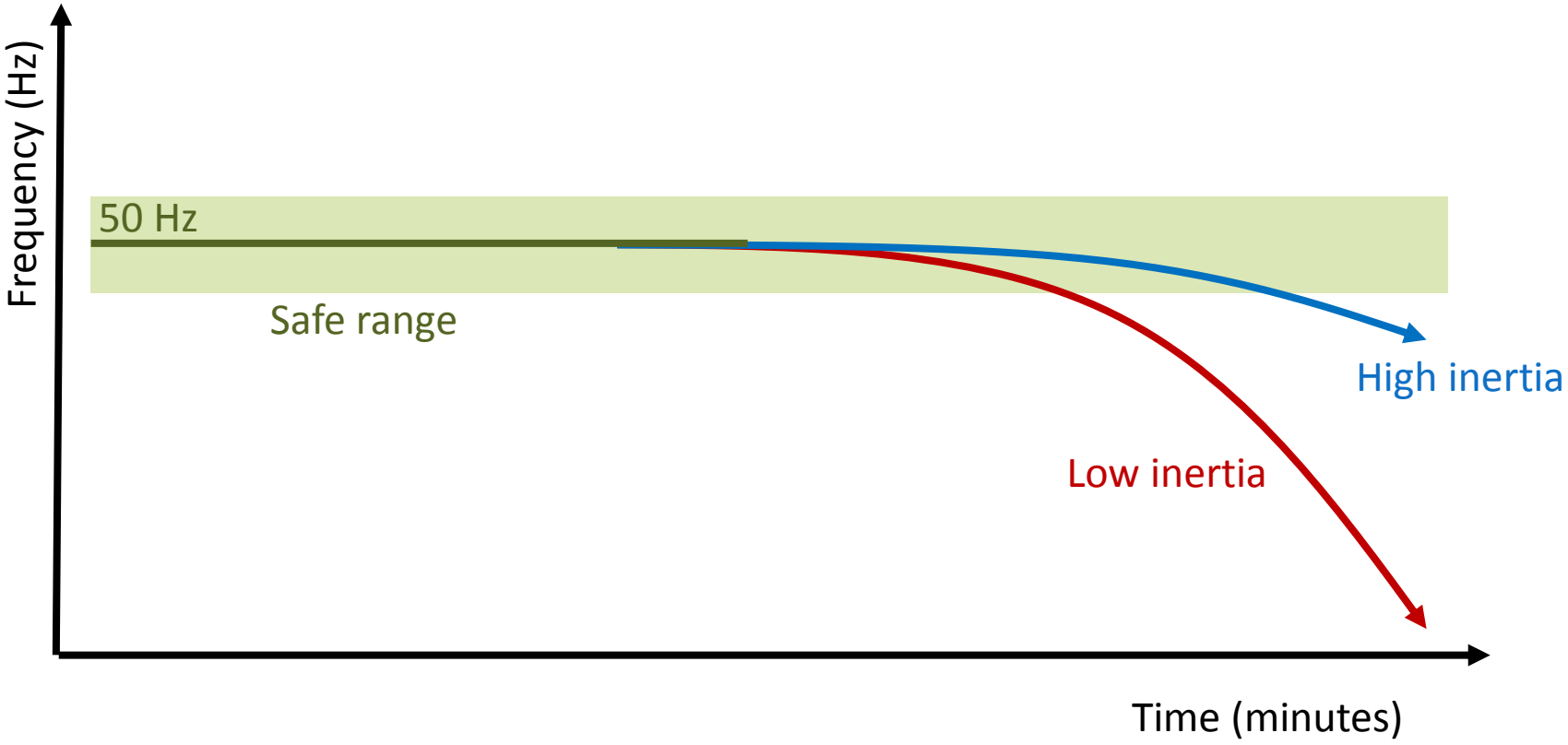
Inertia

- Synchronous generators have a rotor spinning at a rate corresponding to the frequency of the system
  - Automatically provide inertia when operating
- Wind and PV (non-synchronous generators) do not
  - Usually connected to the grid via power electronics (de-coupled from the system frequency)
  - Displace generators that do provide inertia
  - Can cause system to become unstable at high penetrations



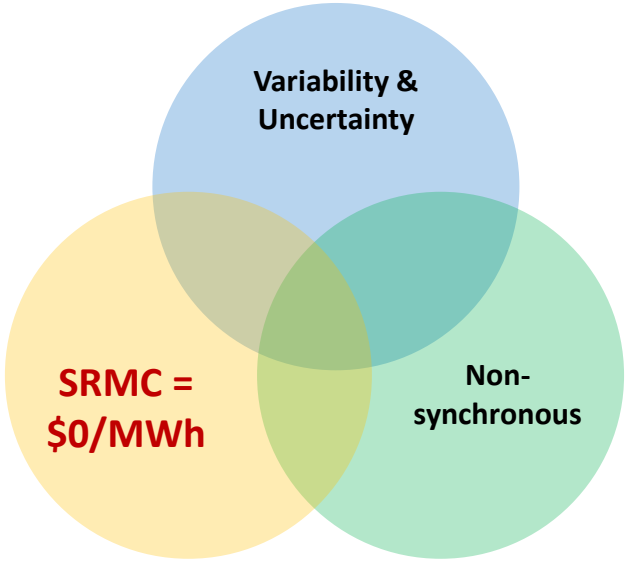
Inertia

- Inertia determines how rapidly frequency deviates when there is a mismatch
  - High inertia gives more time for ancillary services to respond



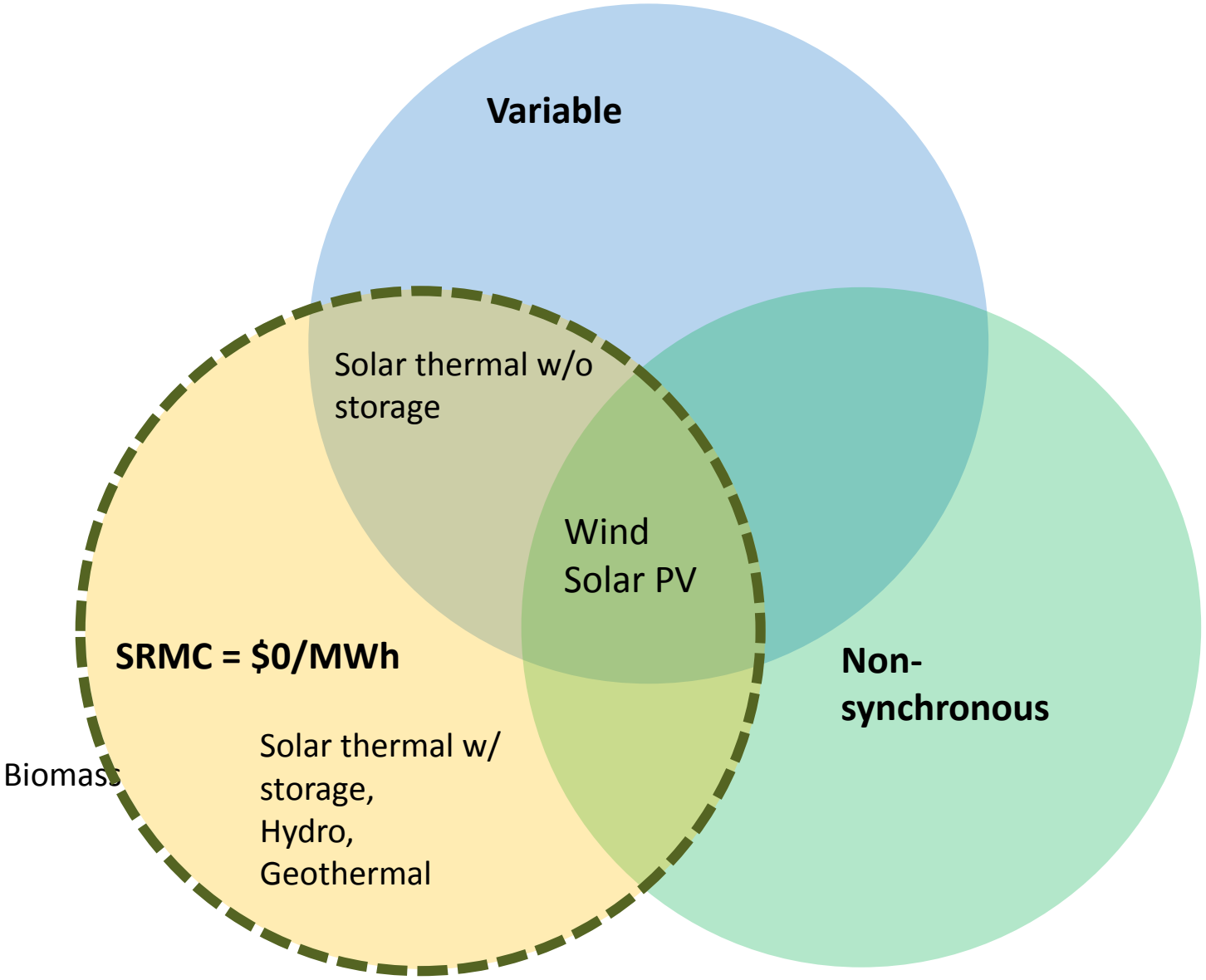
Managing non-synchronous generation

- AEMO 100% renewables modelling assumed minimum of 15% synchronous generation at all times
- Partly for inertia, partly for other grid stability issues
  - Fault detection, etc.
- Complex! Lots of further research required



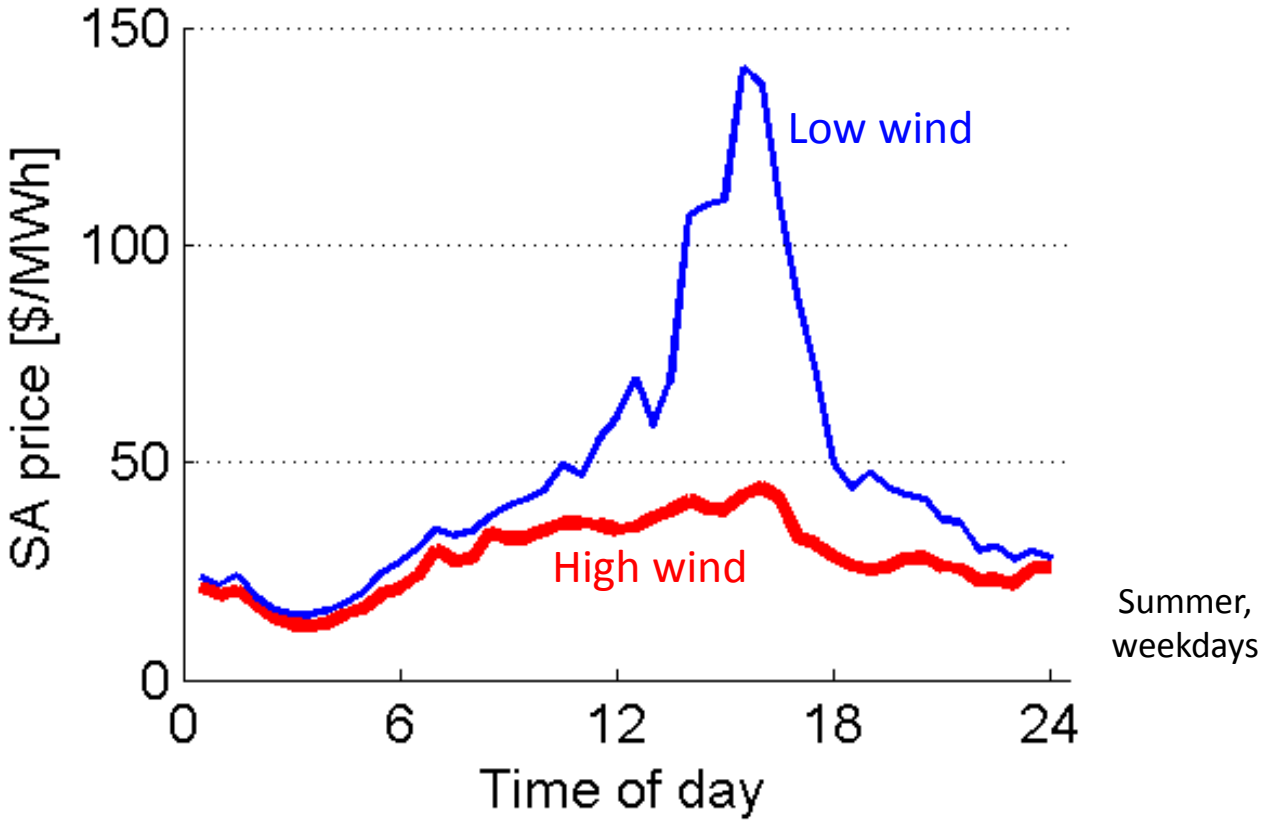
Managing low SRMC

Characteristics of Renewables



Market impacts of renewables

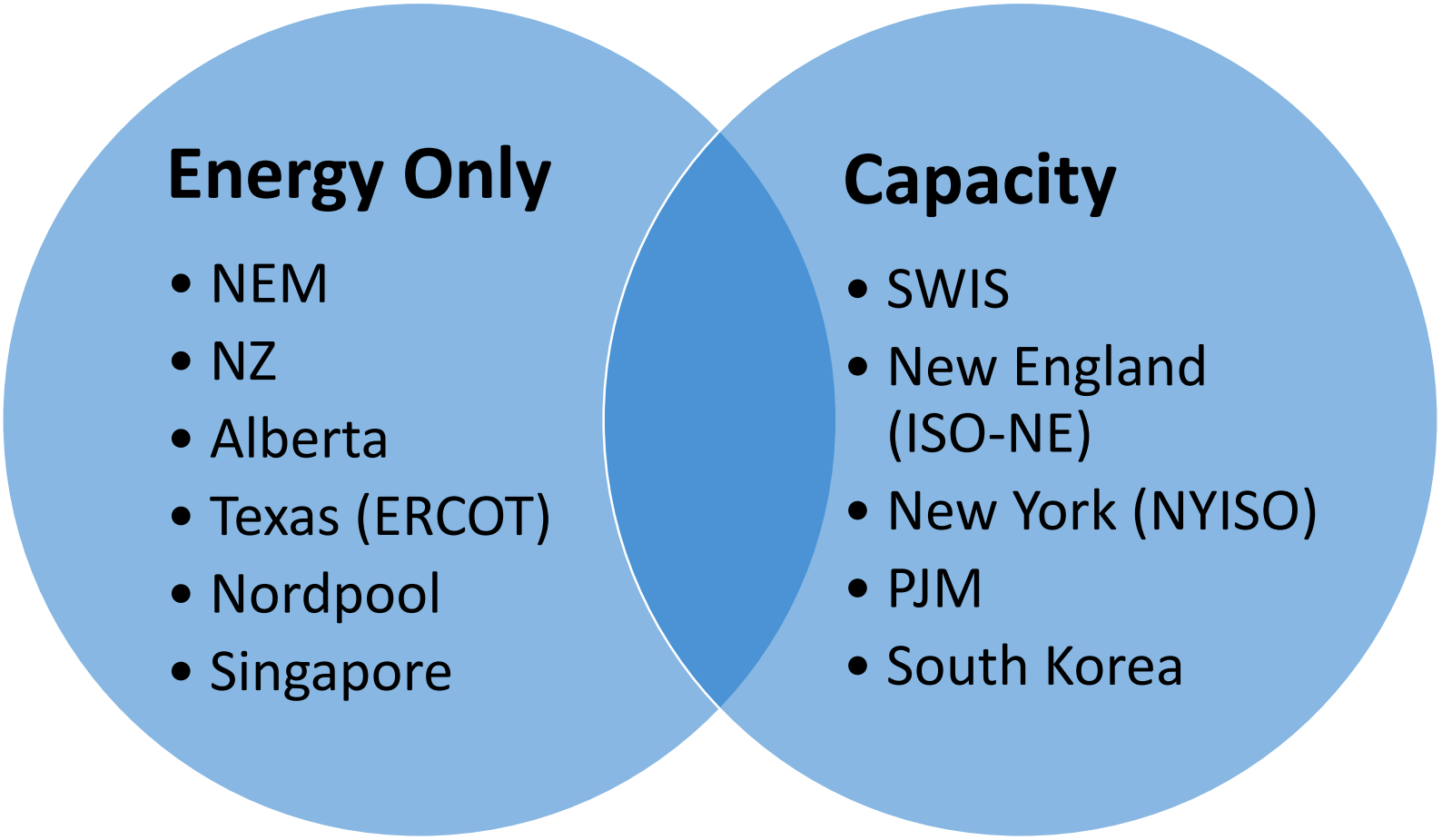
Merit Order Effect - Observed



- Also in international markets
  - Texas (ERCOT), Denmark, Spain, Ireland

Cutler NJ, Boerema N, MacGill IF, and Outhred HR, (2011). High penetration wind generation impacts on spot prices in the Australian national electricity market, Energy Policy 39, 5939-5949.

Ongoing debate on electricity market design



Policies

Mechanism to achieve a sustainable transition

Two key policies

Renewable Energy Target

- Driving an increase in renewables

Carbon Pricing

- Driving a reduction in carbon

Renewable Energy Market

Renewables create certificates (1 MWh = 1 REC)

Australian Government
Clean Energy Regulator

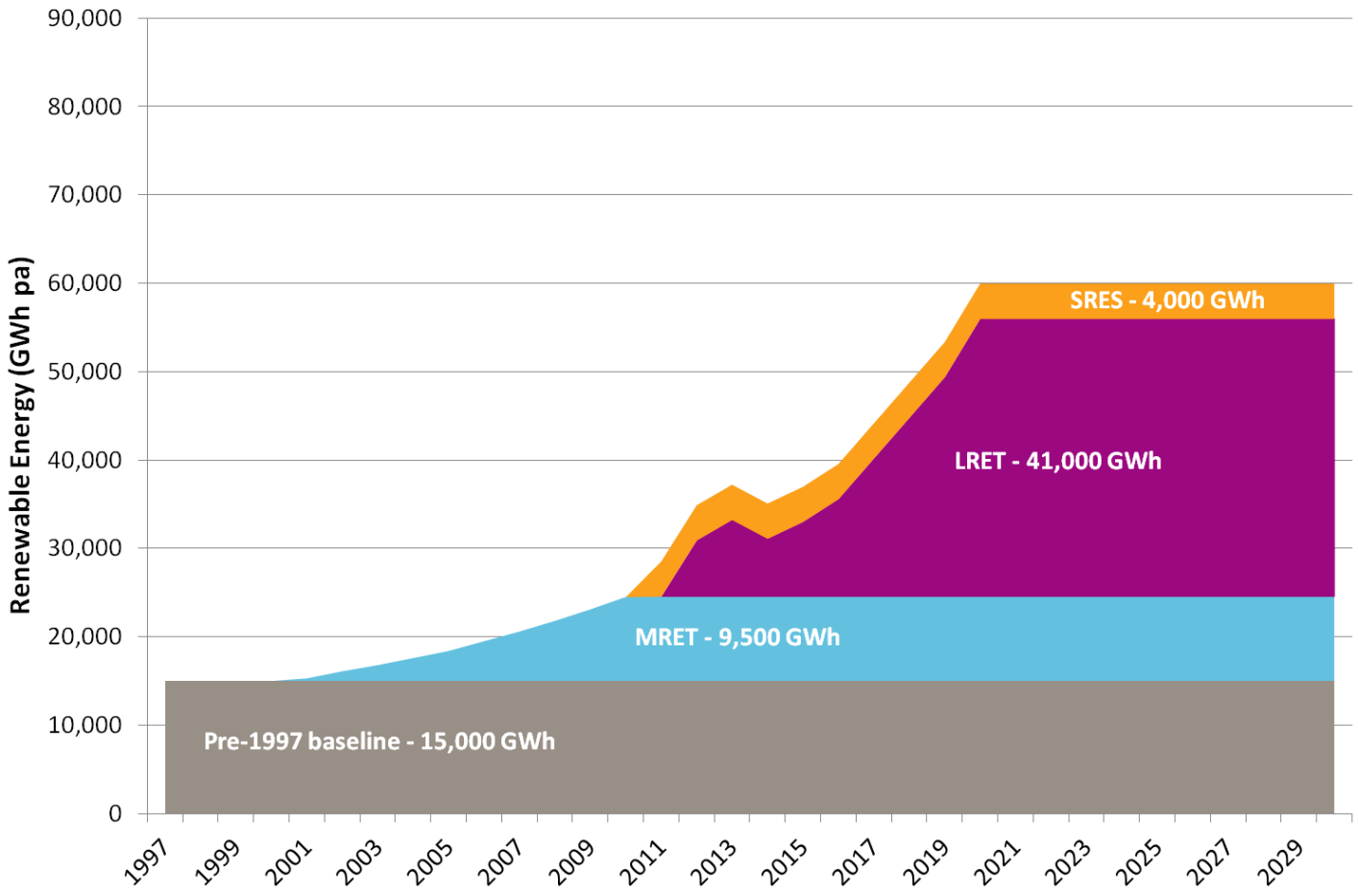
Clean Energy Regulator sets Renewable Power Percentage (RPP) – defines annual liability

TRU energy

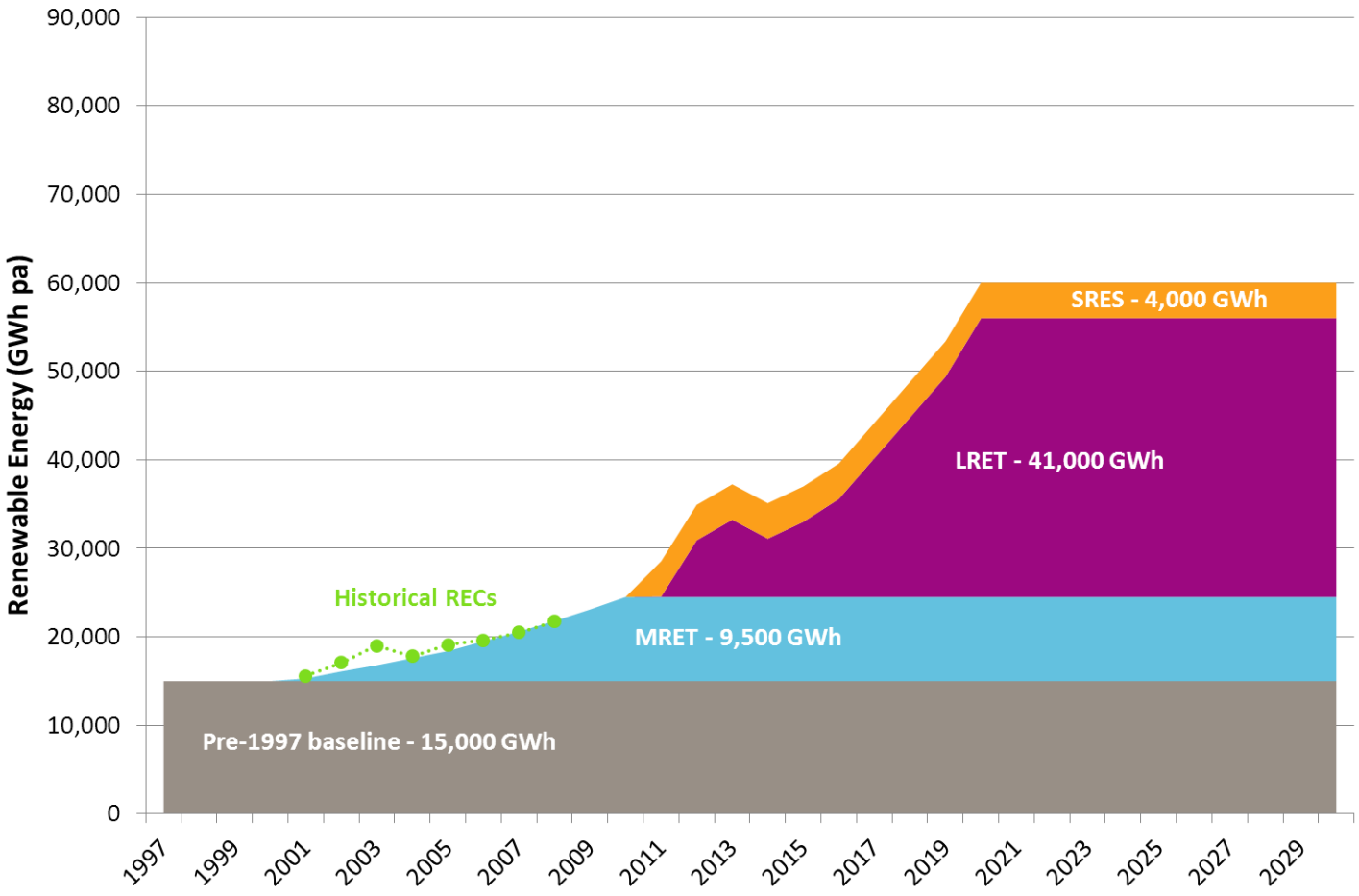
Retailers surrender the RPP of their electricity sales in RECs

Creates a REC market

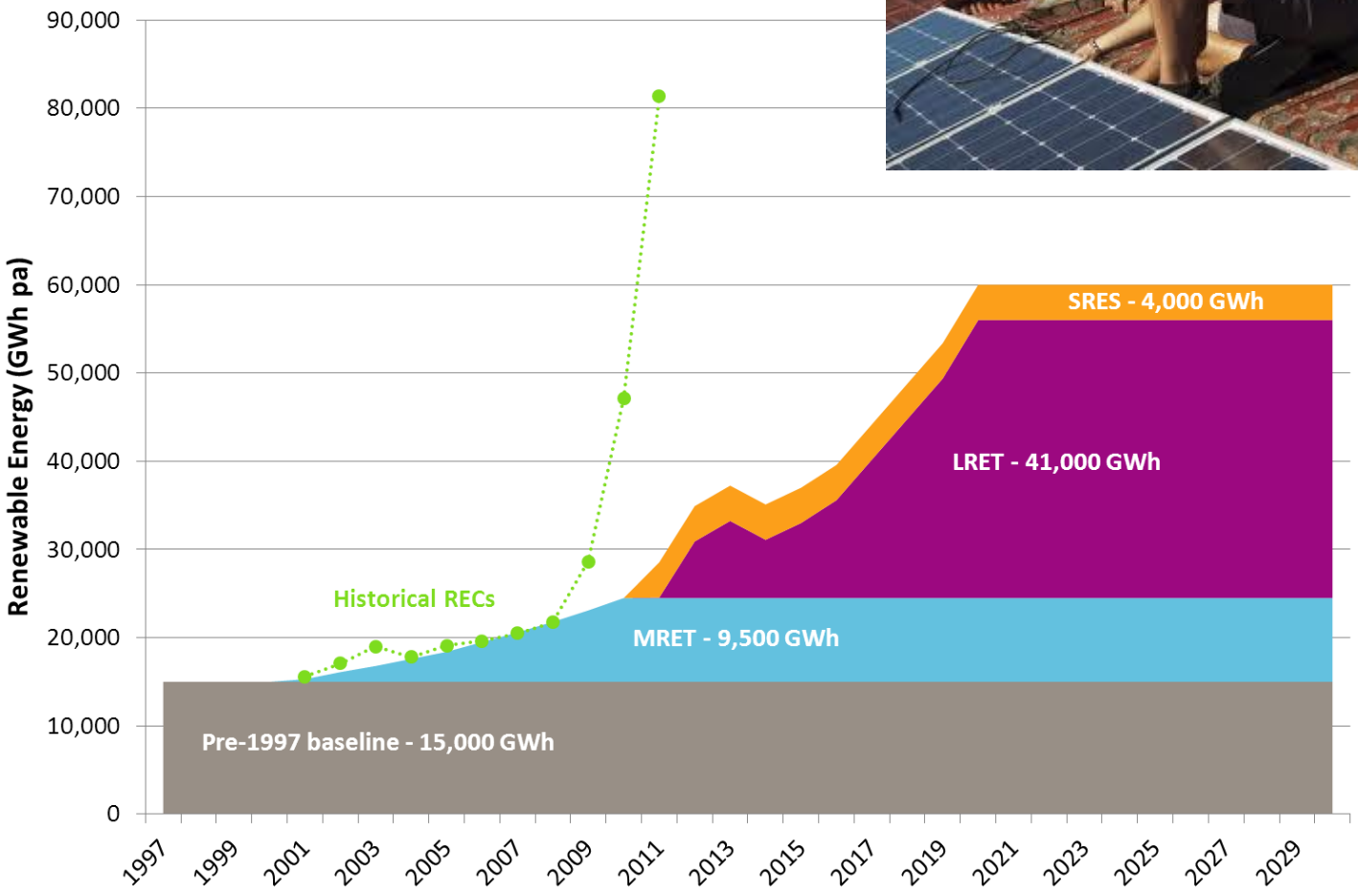
Renewable Energy Target



Historical RECs



Anticipate the unexpected



Solar Photovoltaics drivers

International	• Global oversupply of PV modules • High Australian dollar
Federal	• Solar 5x Multiplier (RET)
State	• Generous FiTs
Individual	• Strong support

Renewable market stalled

FINANCIAL REVIEW BRW. smartinvestor

FINANCIAL REVIEW

Solar deals face crunch

PUBLISHED: 06 FEB 2012 00:01:00 | UPDATED: 06 FEB 2012 17:23:34

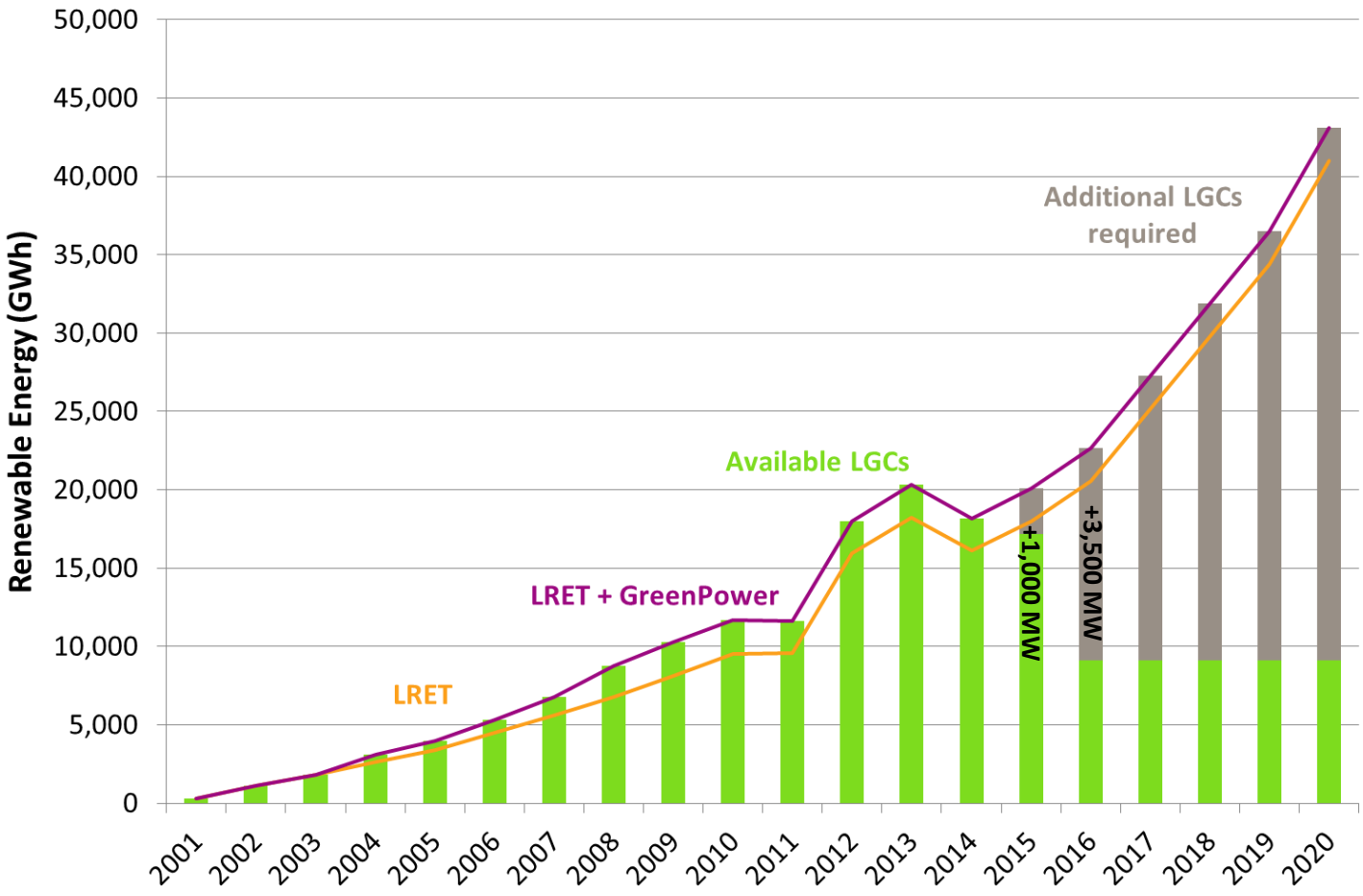
MARCUS PRIEST AND ANGELA MACDONALD-SMITH

When the two Solar Flagships projects were announced in July last year after an 18 month tender process, it was claimed by Mr Ferguson and Prime Minister Julia Gillard that the federal funding would help make industrial-scale solar power more viable.

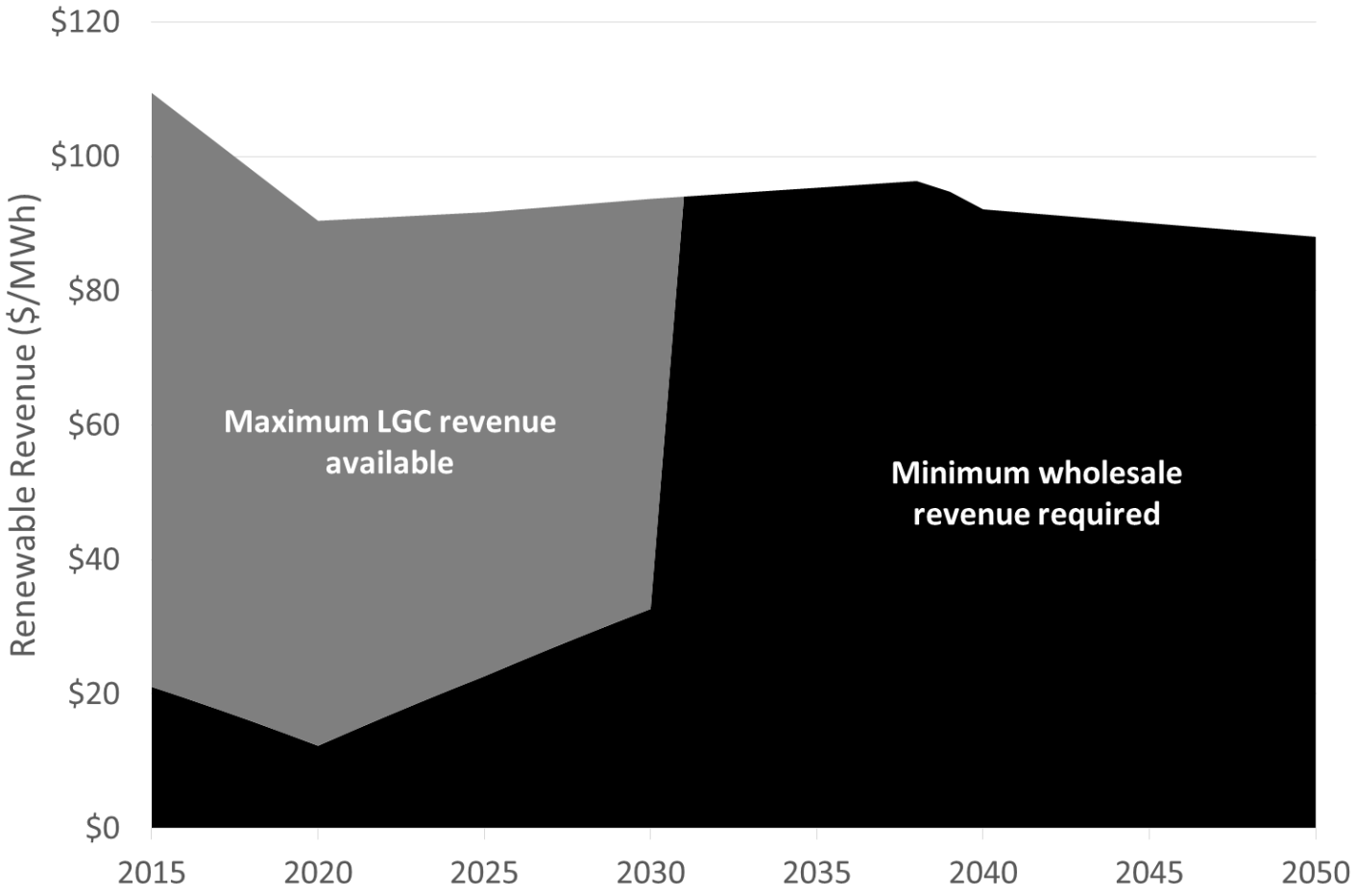
But since then both Solar Flagships projects have been unable to strike power purchase agreements (PPA) with an energy retailer and questions are now being raised about the process of awarding the contracts. A PPA is considered essential to securing financial backing.

An oversupply of renewable energy certificates created by the household solar scheme has been a main factor contributing to the difficulties facing the Solar Flagships projects, with energy retailers already easily able to meet their obligations under the Renewable Energy Target.

Demand in 2015-16?



But will retailers prefer to pay the shortfall charge?

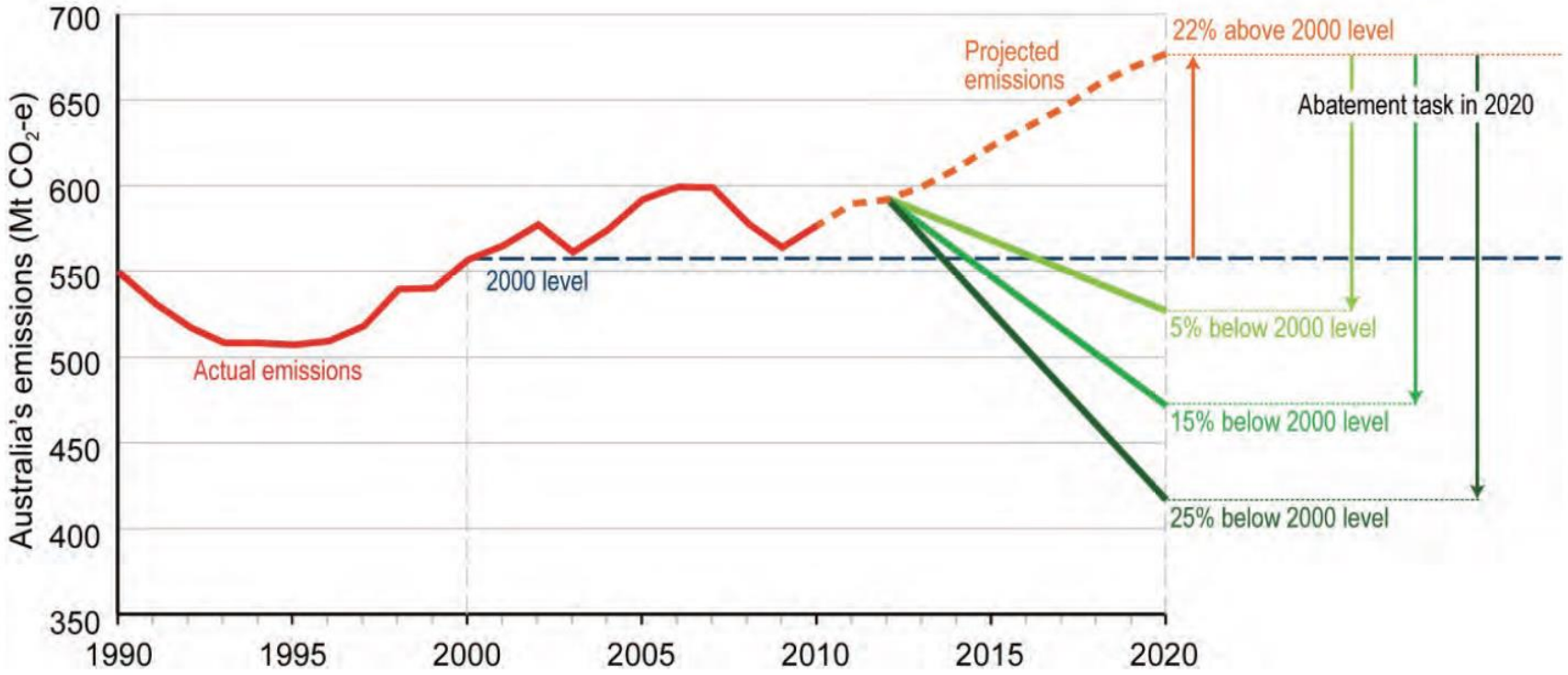


Riesz, Noone, MacGill, Working Paper, "Payments for Closure: Should Direct Action include payments for closure of high emission coal-fired power plants?

Carbon Pricing

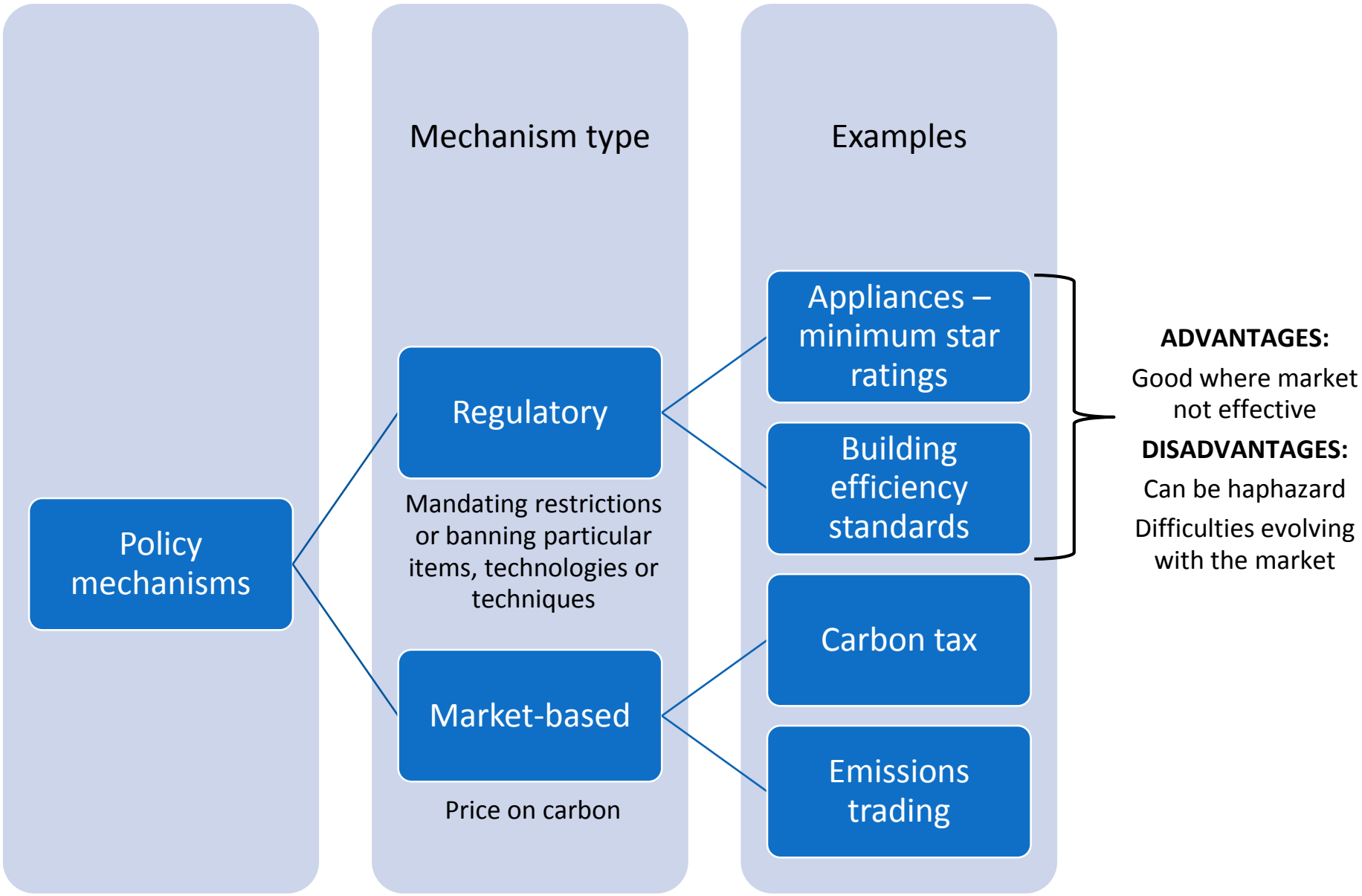
Carbon targets

Bipartisan support for -5% by 2020 target

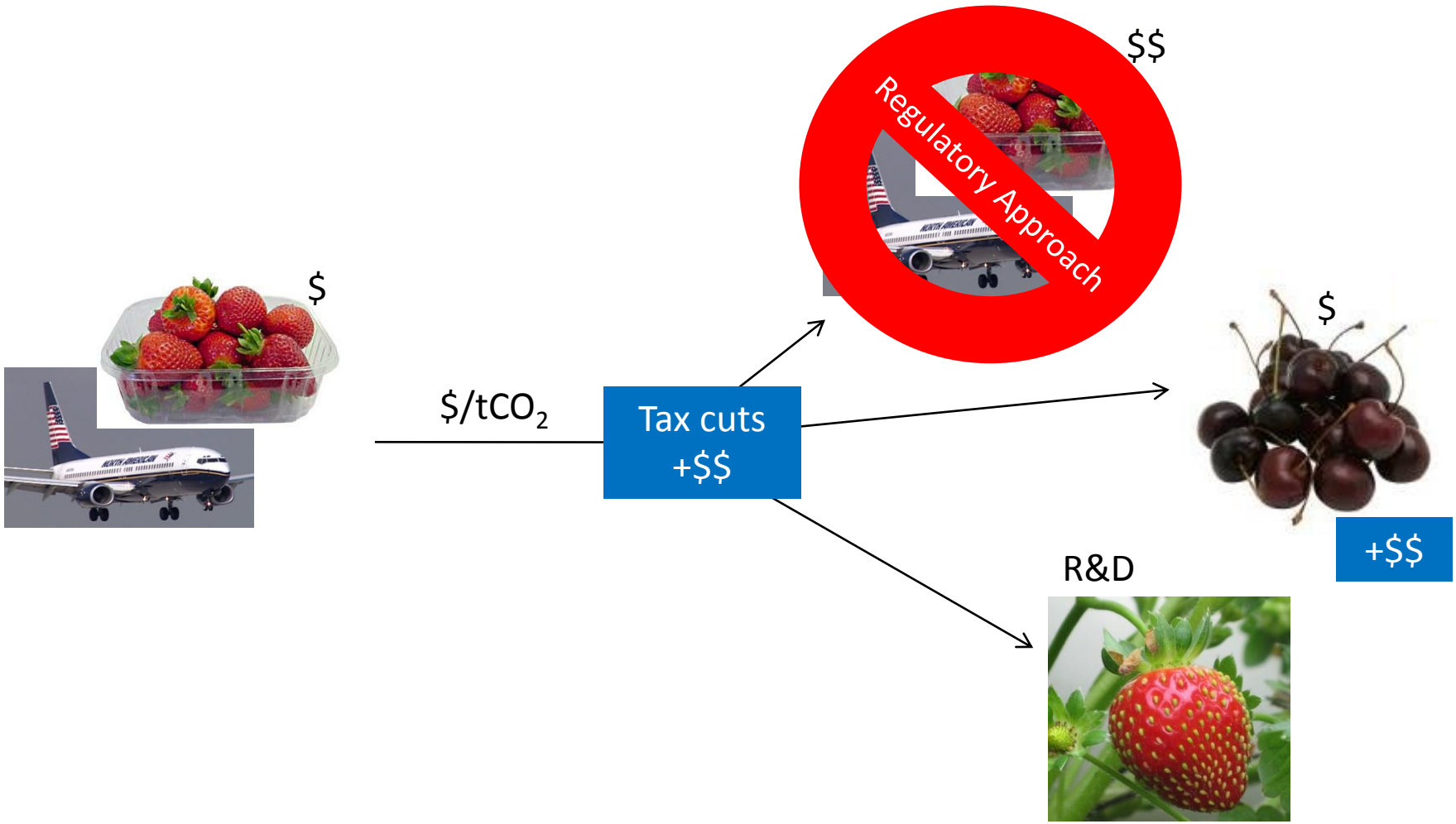


Source: Treasury modelling, 2011 (medium global action scenario).

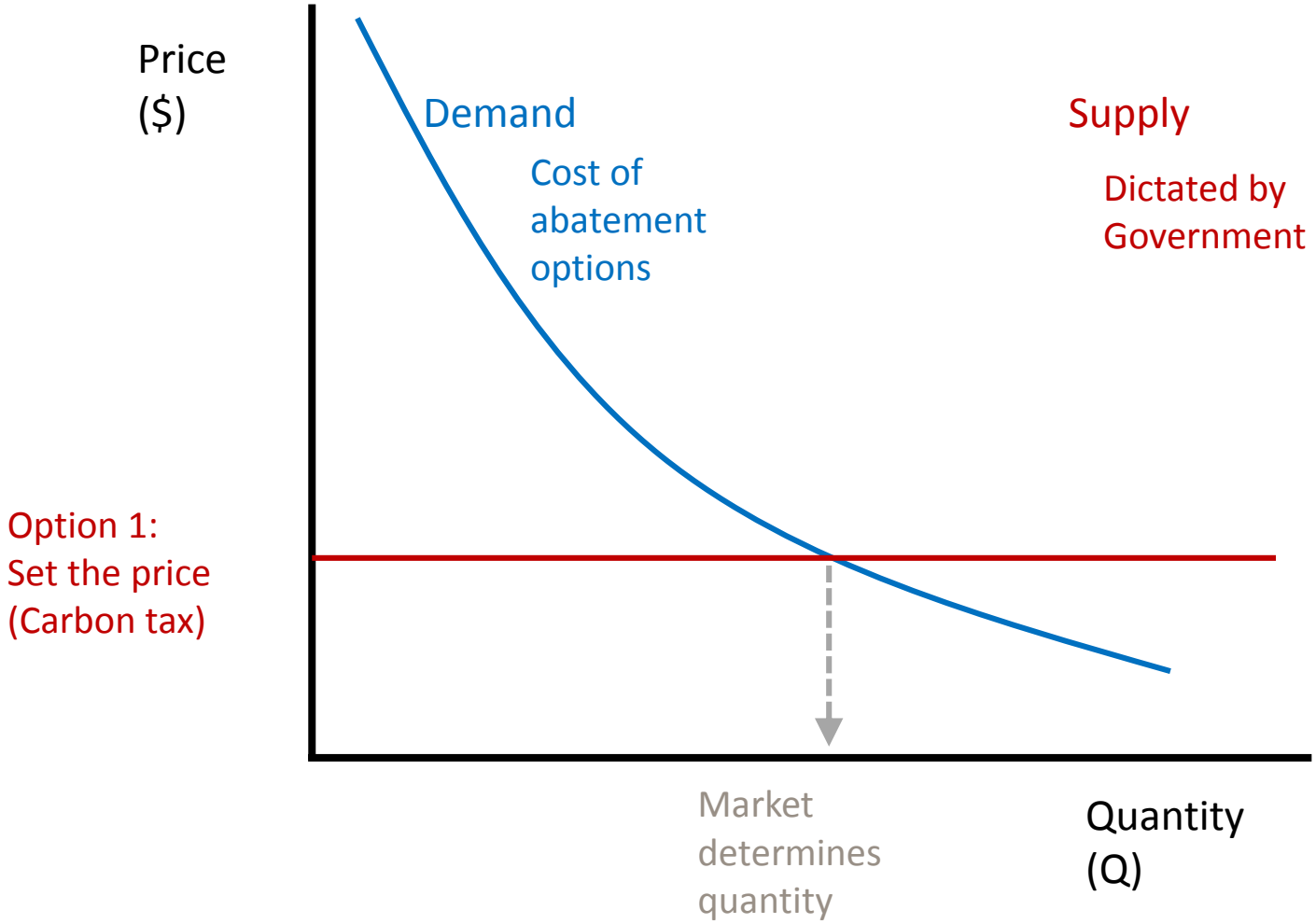
Policy mechanisms



Market based approaches



Creating a market for carbon



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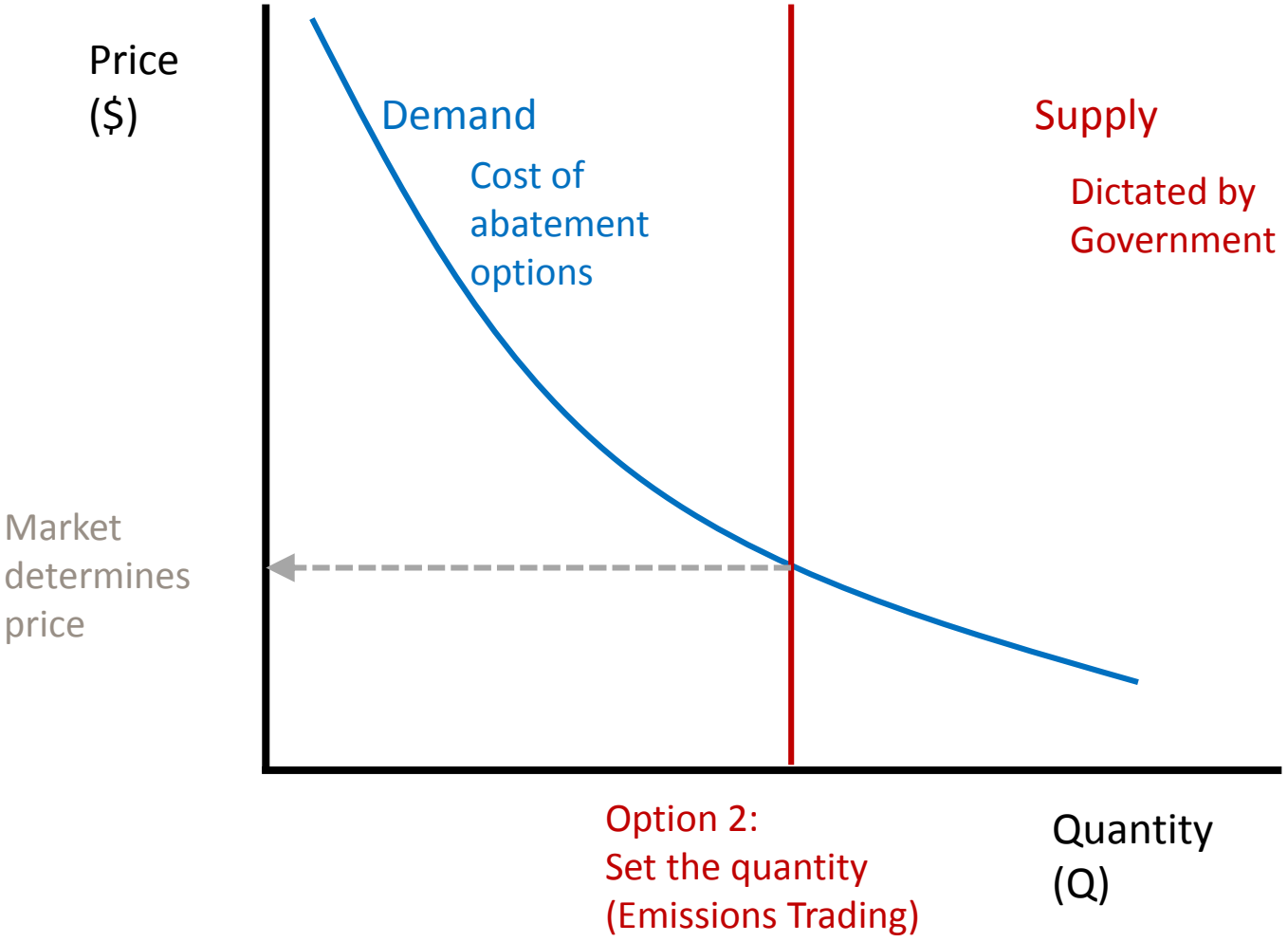
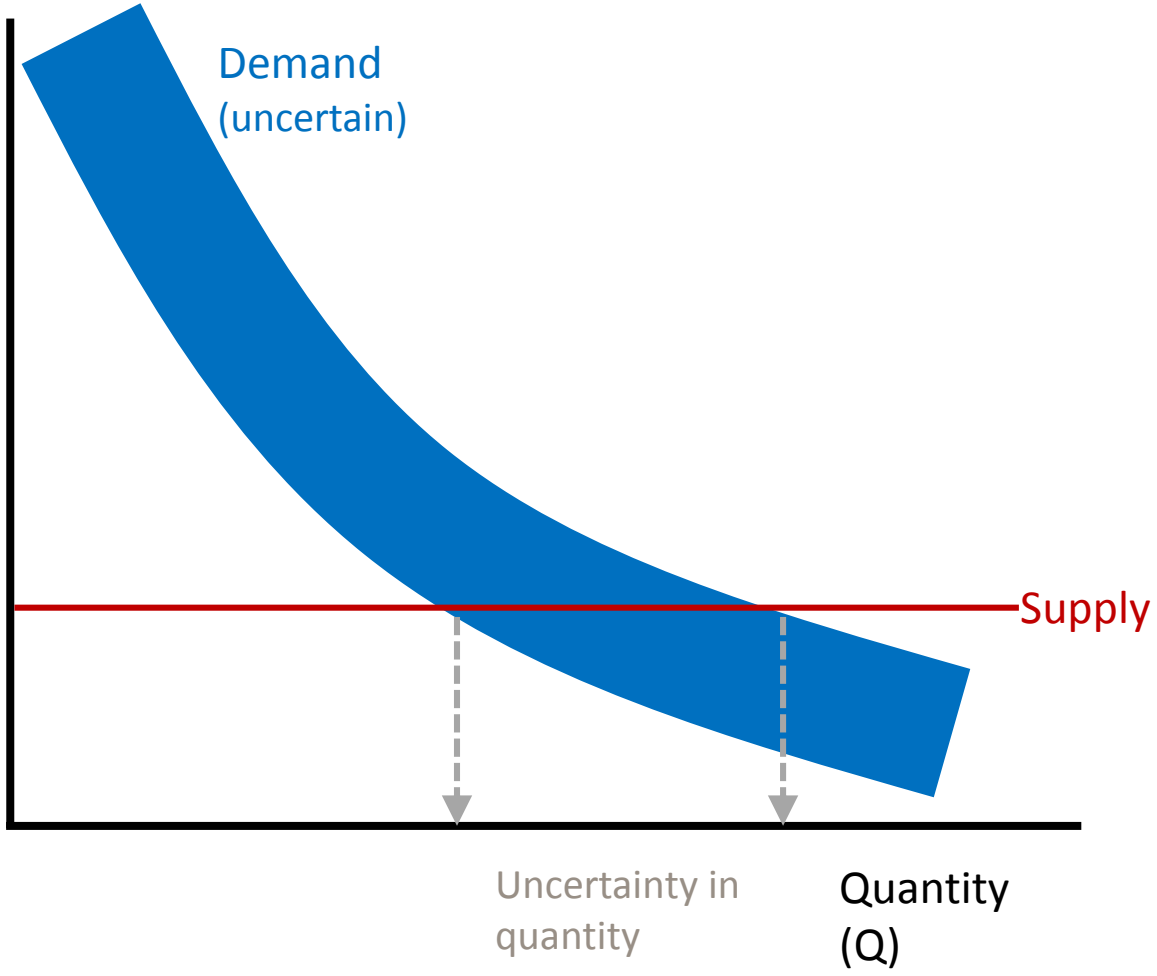
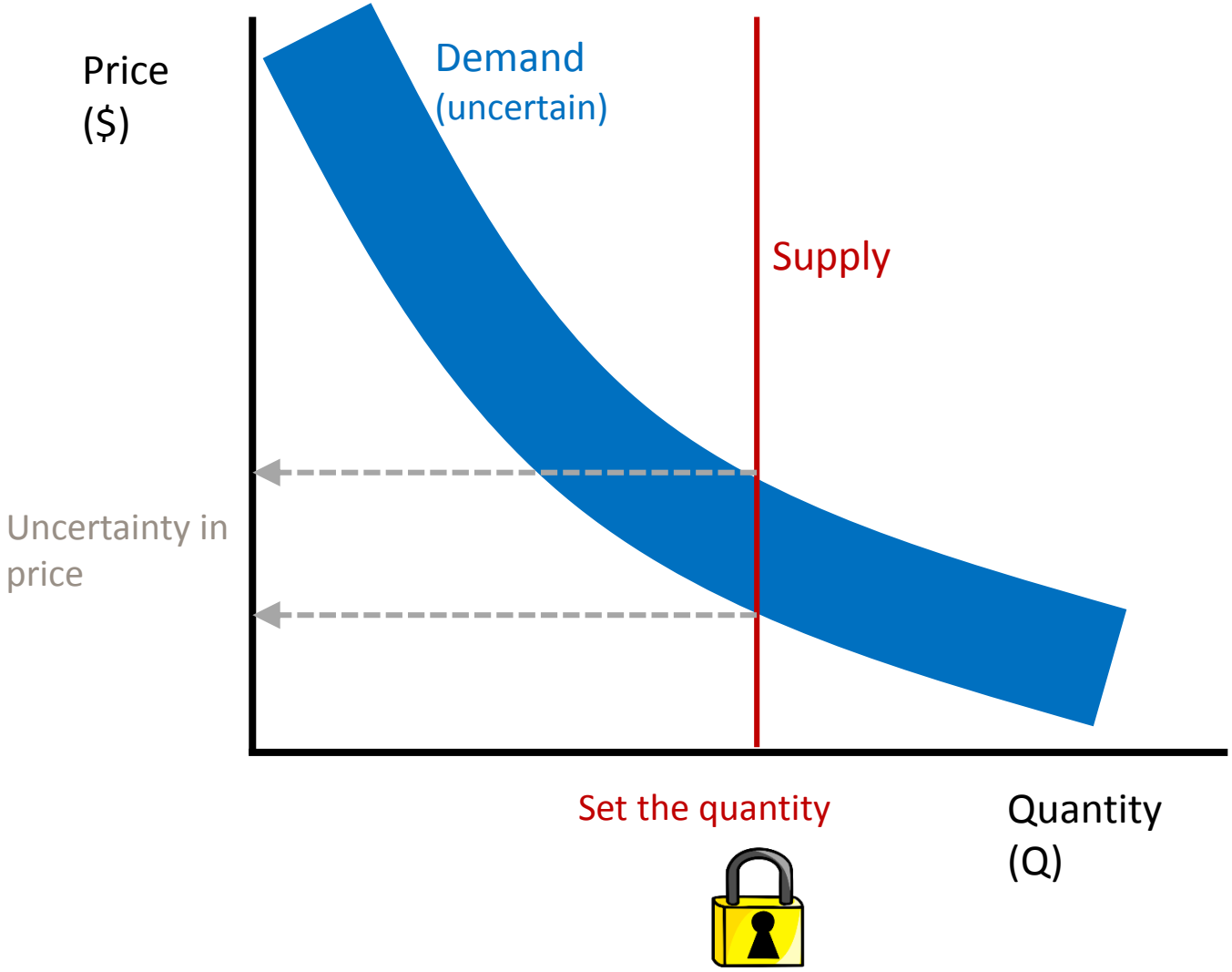


Creating a market for carbon

the price



Creating a market for carbon



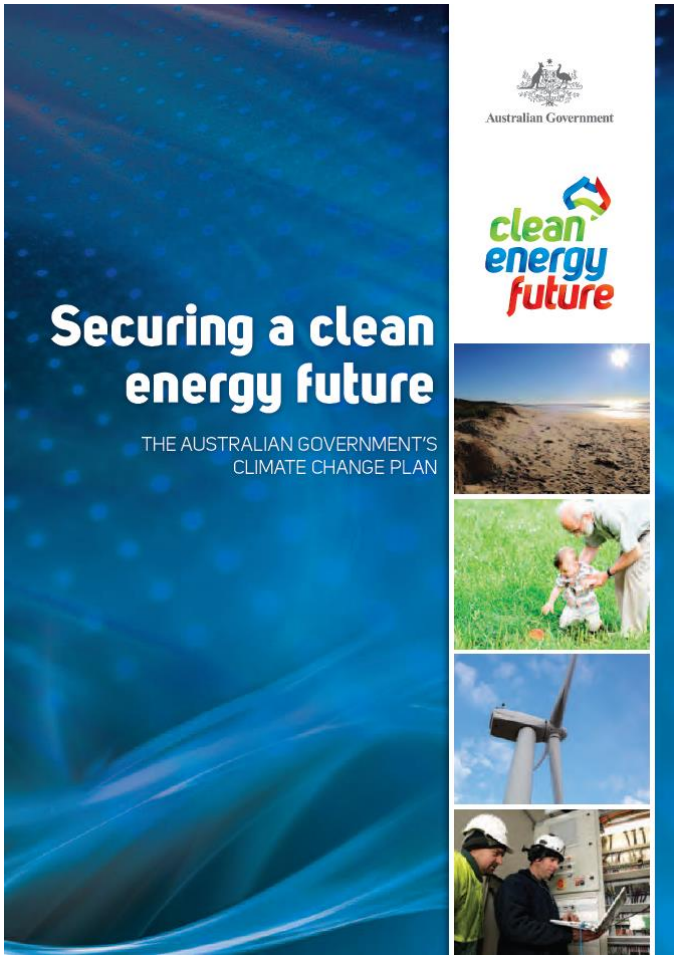
Creating a market for carbon

Which is most important?

Price	Quantity
Carbon tax	**Emissions Trading**
✓ Price certainty	✓ Guaranteed to meet targets
✗ No guarantee of meeting emissions targets	✗ No price certainty
✗ Price may require adjustment (removes price certainty benefits)	✗ Can experience price volatility (especially at market start)
✓ Simpler	✓ Can link internationally

Clean Energy Future

- Emissions trading with initial fixed price period
- Commenced 1st July 2012



Price of carbon

Public consultation – repeal of carbon price

Australian Government
Department of the Environment

Cleaner Environment Plan

Repealing the Carbon Tax - Call for public comment

The Australian Government will abolish the carbon tax from 1 July 2014. This will lower costs for Australian businesses and ease cost of living pressures for households.

Public consultation

The Government invites submissions on the exposure drafts of the carbon tax repeal bills. The Government encourages submissions by 29 October 2013.

Key dates	
Tuesday 15 October 2013	Draft carbon tax repeal bills published
5pm (AEDT) Monday 4 November 2013	Final date for submissions

Find out more

The Australian Government will introduce the carbon tax repeal legislation as its first item of business for the new Parliament.

See: carbon tax repeal »

Direct Action – Emissions Reduction Fund

Emissions Reduction Fund

The Emissions Reduction Fund (the Fund) is the centrepiece of the Australian Government's Direct Action Plan. The Fund will work together with other incentives under the Direct Action Plan and the Renewable Energy Target to help meet Australia's target of reducing emissions by 5 per cent below 2000 levels by 2020.

Through the Fund, the Government will purchase low-cost abatement through reverse auctions - an 'abatement buy-back'.

The Fund will provide incentives for abatement activities across the Australian economy and work in conjunction with the Carbon Farming Initiative.

The Fund will have an initial allocation of $300 million, $500 million and $750 million over the forward estimates period.

Community input will be invited on potential sources of low-cost abatement and on key design features such as auctions, baselines and contract arrangements.

Consultation now open

The Government invites public comment on Terms of Reference on the design of the Emissions Reduction Fund by **5pm (AEDT) Monday 18 November 2013.**

See: call for public comment »

- Abatement "Buy back" (reverse auctions)
- Baseline and credit (emissions trading?)
- Short term policies only (what will happen long term?)

Impacts of the carbon price on electricity sector

+$$

Impact of carbon price on electricity market

Generator costs increase

- Proportional to emissions intensity

Increase bid prices

- Assuming a competitive market

Wholesale electricity prices increase

- Average emissions intensity ~1tCO_2/MWh, anticipate ~1:1 pass through of \$23/tCO_2 carbon price

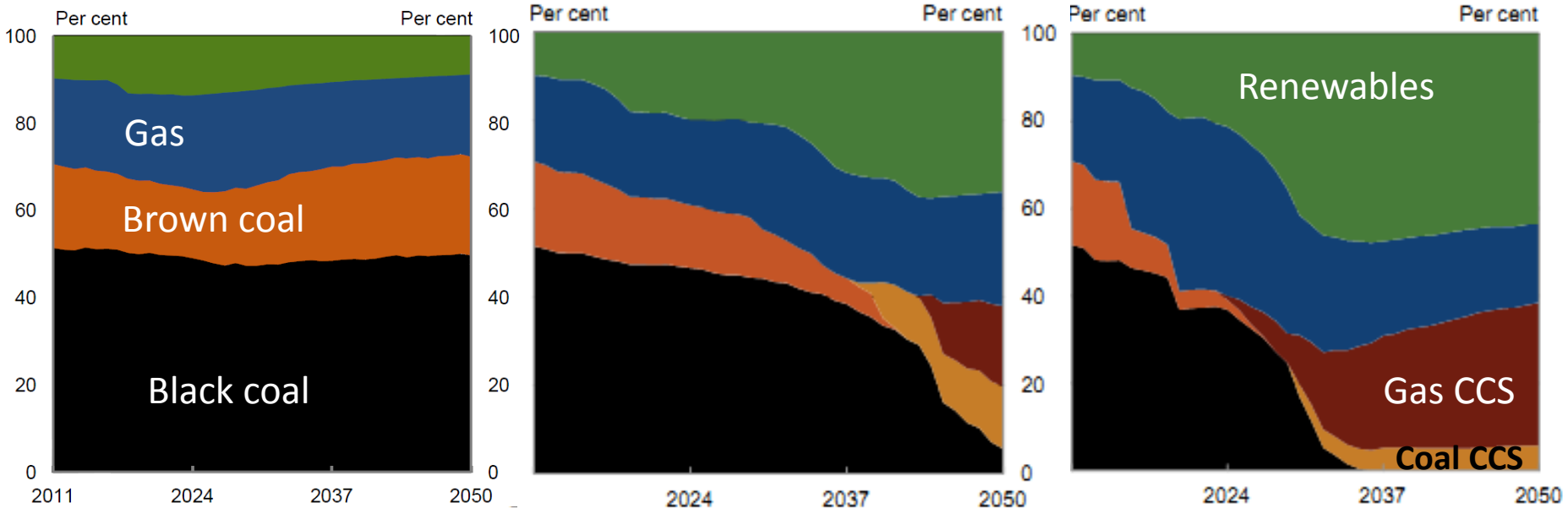
Cost passed through to consumers

Investment decisions

No carbon price

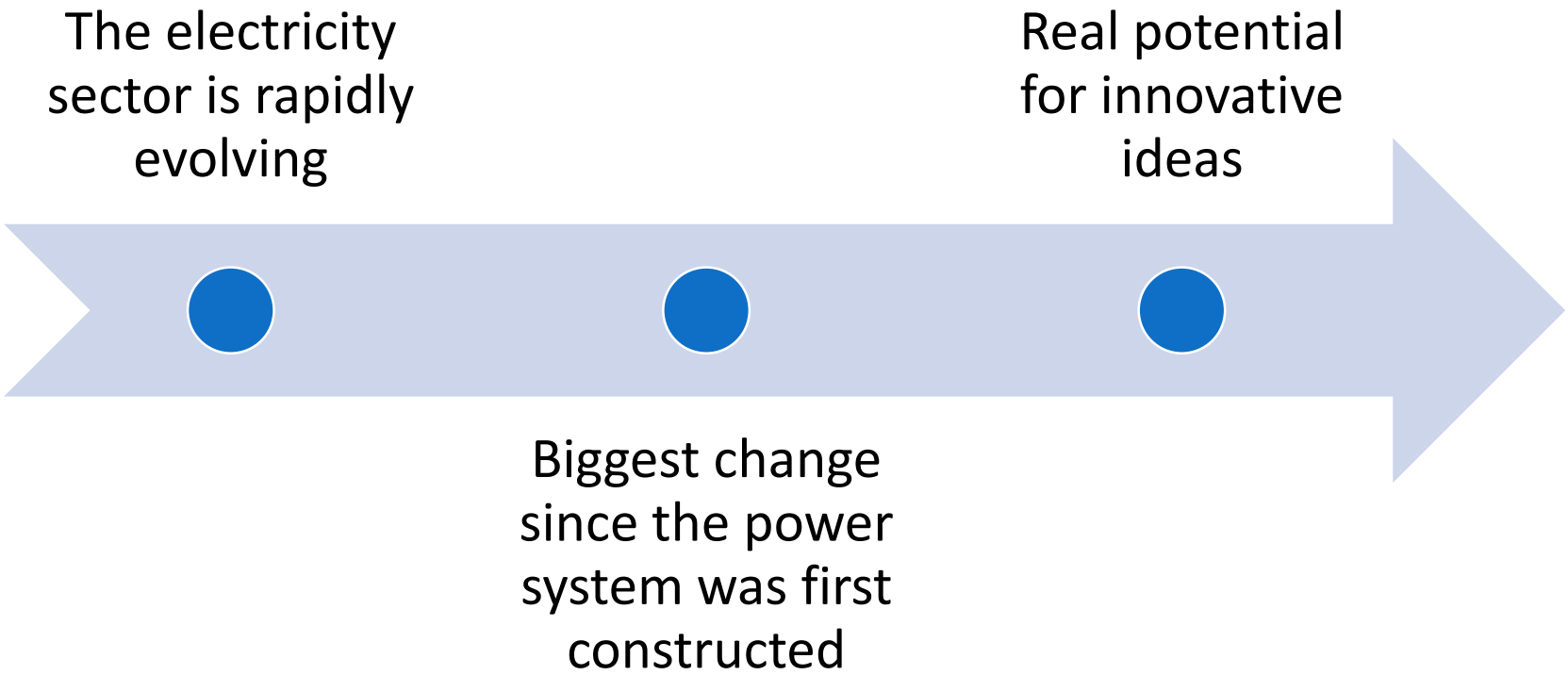
-5% by 2020

-25% by 2020



Source: Treasury, Strong Growth Low Pollution Modelling, 2011

Exciting times ahead



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