Energy-only markets with high renewables

*Can they work? Models for resource adequacy*

Dr Jenny Riesz

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*Electricity Markets with a High Share of Renewables – Experiences and Future Challenges*

*Winterthur, Switzerland*
What makes renewables different?

Variability & Uncertainty

SRMC = $0/MWh

Non-synchronous
Reasonable evidence that 100% renewable systems are technically and economically viable.

But what about the *market*?

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

**SYSTEM ADEQUACY**

- How do generators recover costs?
- How do we maintain accurate investment incentives?
Merit Order Effect - Observed

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

Australian National Electricity Market (NEM)

- A useful case study?
- 15% RE at present (target 20% by 2020)
- Special market design features for integrating renewables
- Focus here on resource adequacy mechanisms (Energy-only Market)
- Will it be necessary to introduce a capacity market?

27% wind
4% rooftop PV
More than 85% instantaneous penetration
Managing resource adequacy in the Australian NEM

- Energy-only market
- Market Price Cap (MPC) = $13,500 AUD (9,800 CHF)
- Strategic offers are permitted (few limits on exercise of market power)

**Determine Market Price Cap (MPC)**

1. Simulate future market
2. Adjust installed capacity to meet 0.002% USE
3. Adjust MPC to allow last generator to meet costs

**Market participants make investment decisions**

- Higher MPC rewards more investment
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

Fixed payment ($/MW)

Retailer

$700 /MWh

Generator

Pool
$1,000 /MWh

$1,000 /MWh

$700 /MWh
Impact of renewables

Increase maximum allowed prices during scarcity events

Conventional market

100% renewables

Percentage of time (%)
How much would scarcity prices need to increase?

- Analysis for Australian NEM:

<table>
<thead>
<tr>
<th></th>
<th>MPC (AUD $/MWh)</th>
<th>MPC (CHF /MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Market Price Cap (MPC)</td>
<td>$13,500</td>
<td>9,800</td>
</tr>
<tr>
<td>To maintain historical aggregate revenues (with move to 100% renewables)</td>
<td>~$30,000</td>
<td>~22,000</td>
</tr>
<tr>
<td>Sufficient aggregate revenues to support 100% renewables</td>
<td>~$60,000 to $80,000</td>
<td>~43,000 to 58,000</td>
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Perhaps this isn’t crazy…

Process applied in the Australian NEM:

- Determine desired Reliability Standard (Unserved Energy)
- Modelling to determine MPC to achieve this level of USE
- Allow resulting cost of reliability to be passed on to consumers

Theoretical “best practice”:

- Determine value of customer reliability
- Apply as MPC
- Allow resulting USE levels to occur

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

<table>
<thead>
<tr>
<th></th>
<th>Value of Customer Reliability (AUD $/MWh)</th>
<th>Value of Customer Reliability (CHF /MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>20,710</td>
<td>15,000</td>
</tr>
<tr>
<td>Small business</td>
<td>413,120</td>
<td>300,000</td>
</tr>
<tr>
<td>Large business</td>
<td>53,300</td>
<td>39,000</td>
</tr>
<tr>
<td>Average</td>
<td>94,990</td>
<td>69,000</td>
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</tbody>
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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
Increasing importance of the contracts market

Consider:

- Close monitoring
- Mechanisms for increased transparency
- Disincentivise vertical integration?
  - Reduces liquidity and contracting options
Demand Side Participation

Why have a Market Price Cap?
- Demand is inelastic
- Need to protect consumers

Increase DSP sufficiently → True representation of “value of lost load” in market, for each consumer → No MPC required
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 the market work with high renewables?

- Significant market concentration?
  - YES: Market participants exercise market power to raise prices
  - NO: Significant DSP?
    - YES: Regulated market price cap becomes irrelevant
    - NO: Increase allowed scarcity prices?
      - YES: Strong contracts market?
      - NO: Investment incentives too low

- Constant monitoring is wise – new issues will arise over time

- Market continues to work effectively
- Market participants can’t manage risk
Caution around introducing capacity markets?

- Capacity markets have many challenges
  - Cross-border issues (many different designs, limited compatibility, double-counting capacity?)
  - Inter-regional issues (locational requirements for capacity due to network congestion?)
- May be especially poorly suited to renewable integration
  - How should variable renewables be valued? (changes with penetration level)
  - Assessment of total capacity requirement increasingly challenging (scarcity depends upon supply and demand, not only peak demand)
  - Remove or dilute incentives for flexibility (need to introduce explicit flexibility markets?)
Thank you

ceem.unsw.edu.au
jenny.riesz.com.au