Energy Productivity & Pricing
Markets for energy, renewable energy and carbon

Dr Jenny Riesz
February 2014
Electricity price rises

Average electricity retail prices

<table>
<thead>
<tr>
<th>Year</th>
<th>2013 c/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>30</td>
</tr>
<tr>
<td>1960</td>
<td>25</td>
</tr>
<tr>
<td>1965</td>
<td>20</td>
</tr>
<tr>
<td>1970</td>
<td>15</td>
</tr>
<tr>
<td>1975</td>
<td>10</td>
</tr>
<tr>
<td>1980</td>
<td>5</td>
</tr>
<tr>
<td>1985</td>
<td>3</td>
</tr>
<tr>
<td>1990</td>
<td>2</td>
</tr>
<tr>
<td>1995</td>
<td>1</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
</tr>
</tbody>
</table>

Recent trend

Break point

Changes in residential retail electricity price components

Causes are complex, various and differ by state, but investment in the electricity distribution system played the largest role.

The market for

RENEWABLES
Renewable Energy Market

Renewables create certificates (1 MWh = 1 REC)

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

Retailers surrender the RPP of their electricity sales in RECs

Creates a REC market
Renewable Energy Target
Renewable Energy Target

- Pre-1997 baseline - 15,000 GWh
- Historical RECs
- MRET - 9,500 GWh
- SRES - 4,000 GWh
- LRET - 41,000 GWh
Renewable Energy Target

![Graph showing renewable energy targets and historical data over years from 1997 to 2029. The graph includes categories for Pre-1997 baseline, MRET (9,500 GWh), LRET (41,000 GWh), and SRES (4,000 GWh).]
Solar Photovoltaics drivers

| International                  | • Global oversupply of PV modules  |
|--------------------------------|• High Australian dollar           |
| Federal                        | • Solar 5x Multiplier (RET)       |
| State                          | • Generous FiTs                  |
| Individual                     | • Strong support                 |
Global PV module retail prices and Australian equivalent

Appreciation of Australian dollar

40% reduction in Australian module prices

13% reduction in global module prices
Oversupply until 2015-16?
Renewable project development

Long term PPA required to secure project financing (eg. $90/MWh for 15yrs)

PPA → Financing → Construction

2-3 years

For project commissioning in 2015-16 need a PPA in 2013-14
RET Review

- RET Legislation requires biennial review

Climate Change Authority Review – Dec 2012
  - Operational - is the scheme working?
  - Major lobbying – 8700 submissions, many seeking reduction
  - But CCA recommended minor changes only

Change of Government
  - Initiating another review!
  - Terms of reference released soon

Perpetual uncertainty
  - Detrimental to investment
RET may not function without the carbon price

If remove carbon price, need to:
- Increase shortfall charge
- Extend RET

CEEM Working Paper – Payments for closure: Should direct action include payments for closure of high emissions coal-fired power plants?
Mechanism and impacts of CARBON PRICING
PERFECT STORM impacts on electricity sector:
- Extreme demands
- Power station de-rating
- Transmission lines de-rating
- Increased forced outage probabilities
- Drought reducing cooling water supplies
- Increased temperature ratings for all equipment
- …
Carbon targets

Bipartisan support for -5% by 2020 target
Pathways to 2050 that meet recommended long term emissions budget

-5% by 2020 is likely to be impossibly steep post 2020 to meet recommended budget

-25% by 2020 or -15% by 2020 recommended by CCA
Policy mechanisms

<table>
<thead>
<tr>
<th>Mechanism type</th>
<th>Examples</th>
<th>ADVANTAGES:</th>
<th>DISADVANTAGES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory</td>
<td>Appliances – minimum star ratings</td>
<td>Good where market not effective</td>
<td>Can be haphazard</td>
</tr>
<tr>
<td></td>
<td>Building efficiency standards</td>
<td></td>
<td>Difficulties evolving with the market</td>
</tr>
<tr>
<td>Market-based</td>
<td>Carbon tax</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emissions trading</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mandating restrictions or banning particular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>items, technologies or techniques</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Market based approaches

Tax cuts +$$

$/tCO_2$

R&D

Regulatory Approach

+$$

$
Creating a market for carbon

<table>
<thead>
<tr>
<th>Price ($)</th>
<th>Demand</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Demand**
- Cost of abatement options

**Supply**
- Dictated by Government

**Option 1:**
- Set the price (Carbon tax)

Market determines quantity

- Quantity (Q)
Creating a market for carbon

<table>
<thead>
<tr>
<th>Price ($)</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost of abatement options</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dictated by Government</td>
</tr>
</tbody>
</table>

Market determines price

Option 2: Set the quantity (Emissions Trading)
Creating a market for carbon

Set the price

Price ($)

Demand (uncertain)

Supply

Uncertainty in quantity

Quantity (Q)
Creating a market for carbon

Price ($)

Demand (uncertain)

Supply

Uncertainty in price

Set the quantity

Quantity (Q)

Uncertainty in price
Creating a market for carbon

<table>
<thead>
<tr>
<th>Which is most important?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
</tr>
<tr>
<td><strong>Carbon tax</strong></td>
</tr>
<tr>
<td>- Price certainty</td>
</tr>
<tr>
<td>- No guarantee of meeting emissions targets</td>
</tr>
<tr>
<td>- Price may require adjustment (removes price certainty benefits)</td>
</tr>
<tr>
<td>- Simpler</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
</tr>
<tr>
<td><strong>Emissions Trading</strong></td>
</tr>
<tr>
<td>- Guaranteed to meet targets</td>
</tr>
<tr>
<td>- No price certainty</td>
</tr>
<tr>
<td>- Can experience price volatility (especially at market start)</td>
</tr>
<tr>
<td>- Can link internationally</td>
</tr>
</tbody>
</table>
Clean Energy Future

- Emissions trading with initial fixed price period
- Commenced 1\textsuperscript{st} July 2012
- (note that it’s not actually a tax...)
Price of carbon

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2012</td>
<td>$23.00</td>
</tr>
<tr>
<td>July 2013</td>
<td>$24.15</td>
</tr>
<tr>
<td>July 2014</td>
<td>$25.40</td>
</tr>
<tr>
<td>July 2015</td>
<td>$25.40</td>
</tr>
<tr>
<td>July 2016</td>
<td>$25.40</td>
</tr>
<tr>
<td>July 2017</td>
<td>$25.40</td>
</tr>
<tr>
<td>July 2018</td>
<td>$25.40</td>
</tr>
<tr>
<td>July 2019</td>
<td>$25.40</td>
</tr>
</tbody>
</table>

Flexible price

Price depends upon targets ($30-60 /tCO₂ by 2020)

Fixed price

Nominal price $/tCO₂

Announce targets

July 2012 - July 2019
Can Abbott repeal the carbon price?

1. Waiting for Senate to change over in July 2014

2. Abbott likely to have numbers in the Senate to repeal (needs support of minor parties – Clive Palmer, Motoring Party)

3. Carbon tax removed from July 2014 (retroactive)

4. Emissions Reduction Fund?

UNCERTAINTY

- Inhibiting investment
- Sensible businesses factoring in a carbon price anyway
Emissions Reduction Fund

**Abatement buy-back** (specific abatement projects)

- Reverse auction/tender
  - Businesses submit tenders to reduce emissions
  - Govt selects lowest cost
  - Forward contracts
  - Commence July 2014
- Funds allocated in budget
  - $300 million, $500 million, $750 million to 2020
  - Long term this mechanism implies significant tax increases

**“Safeguard mechanism”** (large facilities)

- Mechanism to provide incentives not to exceed historical emissions baselines
- No Govt revenue
- Commence 1 July 2015
- New entrants?
- Non-compliance penalties?
- Electricity sector?
Impacts of the carbon price on electricity sector

+$$$

[Image of a coal-fired power plant emitting smoke]

[Image of a wind farm along a coastline]
Impacts of carbon price on electricity sector

- **Capital cost ($)**
  - Initial installation cost

- **Fixed costs ($ pa)**
  - Fixed operations and maintenance

- **Operating costs ($/MWh)**
  - Fuel
  - Variable operations and maintenance
  - Carbon

- **Long Run Marginal Cost (LRMC)**
  - Investment decisions

- **Short Run Marginal Cost (SRMC)**
  - Operational decisions
Dispatch impacts

Outcome depends strongly upon gas prices

- Braemar (OCGT) 0.68 tCO2/MWh
- Loy Yang A (Brown coal) 1.22 tCO2/MWh
- Darling Downs (CCGT) 0.42 tCO2/MWh
- Tarong North (Black coal) 0.86 tCO2/MWh
- Wind 0 tCO2/MWh
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 ≈ 1tCO₂/MWh, anticipate 1:1 pass through of $23/tCO₂ carbon price

Cost passed through to consumers
Impact of carbon price on electricity market

Average wholesale price (Jul-Jan) ($/MWh)


QLD  VIC  NSW

Extreme summer +$17
Mild weather

+$30  +$17
Electricity sector emissions

- September 2008: Global financial crisis
- 2008–09: States introduce solar feed-in tariffs
- 2010–11: States significantly reduce or close solar feed-in tariffs
- Strongest La Nina weather pattern 'in living memory'
- June 2012: Yallourn coal mine flooded
- July 2012: A $23/tCO₂e carbon price comes into effect
- 2012–13: Increased hydro electricity output

8.6% reduction
Investment decisions

- No carbon price
- -5% by 2020
- -25% by 2020

Source: Treasury, Strong Growth Low Pollution Modelling, 2011
Impacts of LNG
Anticipated LNG exports compared to domestic market
USA and Canada

Shale rock gas reserves

Gas Prices 80%
Significant uncertainty over future gas prices

The uncertainty is material
## New generation options

<table>
<thead>
<tr>
<th>Generation technology</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>High investment capital risk</td>
</tr>
<tr>
<td>Nuclear</td>
<td>Highly politically sensitive</td>
</tr>
<tr>
<td>Hydro &amp; Biomass</td>
<td>Resource limitations</td>
</tr>
<tr>
<td>Geothermal, tidal, wave, CCS</td>
<td>Not commercially viable prior to 2030</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>High cost</td>
</tr>
</tbody>
</table>

**RET**
Proposed new capacity

- Bayswater B (2GW), NSW
- Munmorah Rehabilitation (0.7 GW), NSW
- Arckaringa IGCC (0.6 GW), SA

![Pie chart showing energy sources:
- Wind (45%)
- Gas (37%)
- Coal (11%)
- Other (7%)](Image)
A portfolio approach to risk management

RET → PEAKING → Domestic gas prices

BASELOAD → Electricity prices

Domestic gas prices

Electricity prices
Comparing portfolios of renewables vs gas (2030)


Renewables reduce cost risk
(and also reduce total cost up to a point, depending upon CO_2 and gas prices)

Percentage variable renewables:
0%
15%
30%
50%
70%
90%
Comparing portfolios of renewables vs gas (2030)

International experiences

California

33% Renewable Energy by 2020

“promoting stable electricity prices by hedging against volatile natural gas prices”

UK

15% Renewable Energy by 2020

“[Renewables] will be crucial to help protect consumers from fossil fuel price fluctuations”
Conclusions – Outlook for the electricity sector

Time

Impact

RET?

Gas market?

Carbon price?

PEAKING
Thank you
What about nuclear?
Nuclear costs are increasing

Investment in nuclear has slowed
Levelised cost of nuclear is high

<table>
<thead>
<tr>
<th></th>
<th>Levelised cost ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear (UK)</td>
<td>$154 (£92.50) (Hinkley C, 35yr PPA)</td>
</tr>
<tr>
<td>Wind (Australia)</td>
<td>$80 - $100 (10-15yr PPA)</td>
</tr>
</tbody>
</table>

- Cost of establishing a nuclear industry?
- Also:
  - No export industry in renewable technologies
  - Inflexible – poor partner with variable renewables