Energy in Transition: Embracing Disruption

Dr Liam Wagner
Economics, Griffith Business School

5th IAEE Asian Conference, February 2016
The start of the global energy transition

- The World is undergoing an unprecedented energy transformation due to:
  - Climate change policies
  - Highly Volatile fossil fuel prices
  - Rise of solar, wind & battery technology
  - Rising electricity prices (Australian Electricity Prices now amongst worlds highest – risk and opportunity
  - Tesla Powerwall to Australia first
Australia’s Energy Landscape

- Potential Privatisation of Transmission and Distribution Networks in QLD and NSW
- Significant regulatory shifts in the last 10 years in energy policy
- Renewable energy sector evolution following the RET contraction
- Electricity price uncertainty and energy poverty
2013
Break-down of residential prices
Qld, NSW, VIC

<table>
<thead>
<tr>
<th>Category</th>
<th>Queensland</th>
<th>NSW</th>
<th>Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg gen mkt</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Environmental</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Network</td>
<td>13</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Retail and Margin</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Customer price</td>
<td>23</td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>
Disconnections per 100 customers
2008-09 to 2012-13 * Electricity customers only

Source: VCOSS
Total Participation in a Hardship Programs

Source: Queensland Competition Authority
Transformation of the electricity supply chain

From:
A few large fossil power stations sending power over long distances to the end consumer.

Consumer is a **passive participant** only responding slowly to price changes.

To:
A Mixture of large and small producers of energy.

Consumer (**Prosumer**) is an active participant responding quickly to price and system conditions. Makes investment and operational decisions (Buy Solar, Discharge battery)
Asking, WHY? – Dominant Trends

**Technological innovation**
- **Generation**
  - Wind
  - Solar
  - Wave
  - Other

  *Uncertain timing and cost of entry!*

- **Consumer tools**
  - Batteries
  - Electric Vehicles
  - Smart appliances (yes, they are coming!)

**Climate Policies**
- Carbon Pricing
- Renewable Targets
- Feed-in tariffs
- Energy Efficiency

*Uncertain outcomes and unintended consequences (e.g. interaction in 2009-10 between NSW feed-in tariffs and SRES)*
Fossil Fuels vs Solar
Australia’s Electricity Sector Competitiveness:

- Electricity systems are now facing their greatest challenges.
- But the fundamental questions haven’t changed, just their implications for industry.
- How do you evaluate a power system and its ability?
- During transition how do we promote the deployment of new technology?
DELLIVERING A COMPETITIVE AUSTRALIAN POWER SYSTEM

Part 1: Australia's global position
November 2011
Resilience and electricity systems: A comparative analysis

Lynette Molyneaux\textsuperscript{a}, Liam Wagner\textsuperscript{a,}\textsuperscript{*}, Craig Froome\textsuperscript{b}, John Foster\textsuperscript{a}

\textsuperscript{a} School of Economics, University of Queensland, Australia
\textsuperscript{b} Global Change Institute, University of Queensland, Australia

\textbf{HIGHLIGHTS}

\begin{itemize}
  \item We establish a resilience index measure for major electricity systems.
  \item We examine a range of OECD and developing nations electricity systems and their ability to cope with shocks.
  \item Robustness measures are established to show resilience of electricity systems.
\end{itemize}
The magnitude of the impact of a shift from coal to gas under a Carbon Price

Liam Wagner*, Lynette Molyneaux, John Foster

Energy Economics and Management Group, School of Economics, University of Queensland, Brisbane, QLD 4072, Australia

- Marginal cost pass-through rates of increasing cost of carbon are established.
- Market behaviour shifts to infra-marginal rent seeking under increasing carbon and natural gas costs.
- Strategic behaviour of generators is established under these shifting conditions.
Australian power: Can renewable technologies change the dominant industry view?

Lynette Molyneaux*, Craig Froome, Liam Wagner, John Foster

Energy Economics and Management Group, School of Economics, and, Global Change Institute, The University of Queensland, St Lucia, Qld 4067, Australia

- The Australian government is committed to transitioning domestic power generation to lower-emissions intensive gas.
- Using PLEXOS we model what a transition to gas fired generation in the year 2035 would deliver.
- Compares a transition to power from gas to that from renewable technologies without total replacement of the existing fleet.
- Results show a transition to gas reduces emissions marginally but wholesale prices are higher than transition to renewables.
We examine Australia's renewable energy policy, regulatory frameworks and incentives.

This paper identifies the key barriers faced by the renewables industry.

We show that the current policy framework favours mature technologies at the expense of emerging options.
Australia’s Electricity Sector Performance

- Measure power system competitiveness by identifying resilience:
  - Efficiency \textit{(system integrity)}
  - Diversity \textit{(functional group variety)}
  - Redundancy \textit{(regenerative capacity)}

- Compare Australia’s power system to competitor countries
Non Renewable Energy Use
Carbon Intensity

$\text{CO}_2$ emissions (g/KWh)

- 1990
- 2008

<table>
<thead>
<tr>
<th>Country</th>
<th>1990</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD Eur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>World</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Generation Diversity

(probability of different fuel type)

Australia  Brazil  Canada  Chile  China  India  Russia  S.Africa  USA  OECDeuro  World

1990  2008
OWN USE, TRANSMISSION AND DISTRIBUTION EFFICIENCY

- 1990
- 2008
- T&D only
- Landmass

Loss from Supply to Enduser

- Australia: 7%
- Brazil: 15%
- Canada: 8%
- Chile: 8%
- China: 5%
- India: 23%
- Russia: 8%
- S.Africa: 9%
- USA: 6%
- OECDe: 6%
- World: 8%

km² (million)

- 1990 - 2008 - T&D only - Landmass
Security – Reliance on Imports

% of Electricity from Imports

-5% 0% 5% 10% 15% 20% 25% 30% 35% 40% 50% 55%

Australia  Brazil  Canada  Chile  China  India  Russia  S.Africa  USA  OECD Eur

1990  2008

Graph showing the percentage of electricity from imports for various countries and regions.
Security - Spare electricity for use in earning income
Cost of Electricity to Industry

- Chile
- Brazil
- OECD EU
- India
- Australia
- China
- USA
- Canada
- Russia
- S. Africa

US$/kWh

- 2008
- 1990
Country power profile: 2010

% of electricity generated (2010)

Coal  Gas  Nuclear  Hydro  Other renewable

Australia  Brazil  California  Canada  China  France  Germany  India  Italy  Japan  Korea  Russia  Sfrica  Spain  Texas  UK  USA  OECD Europe  World

Department of Account, Finance and Economics
Country power resilience: 1990

Power System Resilience 1990 vs. US$ 2010/kWh (industry)
Country power resilience: 2010

[Graph showing various countries and their power resilience with different symbols for energy types: Coal, Gas, Hydro, Renew, Nuclear, Mixed. Countries are plotted on a scale of Power System Resilience 2010 and $US 2010/kWh (industry).]

Department of Account, Finance and Economics
China more resilient than Australia?

Energy Use

Redundancy

Carbon

Imports

Diversity

DistEff

GenEff

Australia

Australia RI

China

China RI

0.35

0.44
Japan more resilient than Australia?

- Energy Use
- Redundancy
- Imports
- DistEff
- GenEff
- Carbon
- Diversity

Australia

Japan

Australia RI

Japan RI

0.35

0.39
Power Economy Competitiveness

- Aus
- Brazil
- China
- India
- Russia
- USA
- Chile
- S. Africa
- Canada
- OECDEu

Power Economy Resilience (2008 resilience thresholds)

US$2008/kWh (industry)
The impact of power resilience

Metal processing Market share loss

Australia  Brazil  Canada  Chile  China  India  Russia  South Africa  USA

-25% -15% -5% 5% 15% 25% 35%

2009 Steel  1990 Steel  2009 Aluminium  1990 Aluminium  2009 Copper  1990 Copper

Department of Account, Finance and Economics
This research has been funded by:

Australian Government
Australian Research Council

DP160102570: Transition to Customer Response driven Networks

Department of Account, Finance and Economics