AGENDA

• Electricity 101 – a brief overview
• Microeconomic reform in the power industry
• Economic performance of the National Electricity Market
• Outlook for the economic and environmental performance of the power industry
Electricity 101 – a brief overview
POWER INDUSTRY DELIVERY PROCESS

Generation (manufacturing plant) → Transmission (high voltage transport) → Distribution (low voltage transport) → Consumer

Bulk supply point (injection) → Bulk supply point (extraction)
SUPPLY- AND DEMAND-SIDE STATISTICS

- The 41,000MW supply-side covers all of eastern Australia:
  - Queensland 10,400MW
  - New South Wales 12,300MW
  - Snowy Mountains 3,700MW
  - Victoria 8,600MW
  - South Australia 3,500MW
  - Tasmania 2,500MW
  - Coal 85%, 7% gas, 8% hydro, non-hydro renewable 0.2%.

- The demand-side:
  - Aggregate demand (simultaneous) 32,000MW
  - Aggregate energy 205,000GWh

- CO₂ emissions
  - Historically, about 35% of the national total
  - Circa 180Mt
“Base Energy” prices in Australia are the second lowest in the world, but it was quite a journey to get there.

ONE OF AUSTRALIA’S COMPARATIVE ADVANTAGES
50-YEAR PRICE HISTORY IN QLD (1955-2004)

Electricity price ($/MWh)

First OPEC Oil Shock

Second OPEC Oil Shock

Construction of Gladstone, Tarong and Wivenhoe power stations

Impact of Boyne Is Smelter

Impact of industry corporatisation

QEC commences ‘no more than half-CPI’ tariff reforms amid 7.5%+ inflation

Impact of industry restructuring and deregulation

Impact of GST

Financial year

50-YEAR PRICE HISTORY IN QLD (1955-2004)
POWER PRICES HAVE BEEN DECLINING IN REAL TERMS

Electricity has increased at only 44% of CPI using 1955 as the base year.
50-YEAR POWER PRICES IN CONSTANT 2004 $’s

Electricity price ($/MWh)

- First OPEC Oil shock
- Second OPEC Oil shock
- Major expansion
- Industry corporatisation
- Introduction of GST

Avg Qld Electricity Price (Constant 2004 Dollars)
Avg Qld Electricity Price (Nominal Dollars)
50-YEAR ELECTRICITY ACCOUNTS TO A.W.E.

Elec-to-AWE (%)

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Electricity as % AWE (based on 500kWh per month)</th>
<th>Electricity as % AWE (actual quantities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>8.3%</td>
<td>3.0%</td>
</tr>
<tr>
<td>1957</td>
<td>7.9%</td>
<td>2.4%</td>
</tr>
<tr>
<td>1959</td>
<td>6.9%</td>
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<td>4.5%</td>
</tr>
<tr>
<td>1965</td>
<td>6.0%</td>
<td>3.2%</td>
</tr>
<tr>
<td>1967</td>
<td>5.1%</td>
<td>2.6%</td>
</tr>
<tr>
<td>1969</td>
<td>4.5%</td>
<td>2.6%</td>
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</tr>
<tr>
<td>1995</td>
<td>2.3%</td>
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</tr>
<tr>
<td>1997</td>
<td>2.3%</td>
<td>2.0%</td>
</tr>
<tr>
<td>1999</td>
<td>2.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td>2001</td>
<td>1.8%</td>
<td>2.0%</td>
</tr>
<tr>
<td>2003</td>
<td>2.0%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>
WHAT MAKES UP THE AVERAGE COST OF POWER?
THE PRIVATE COST OF POWER GENERATION (2007 DATA)

Average unit cost ($/MWh)

- Black coal: $35.00
- Brown coal: $39.00
- Combined Cycle Gas: $43.00
- Landfill: $45.00
- Open Cycle Gas: $55.00
- IGCC+CCS: $120.00
- Nuclear: $75.00
- Hydroelectric (mini): $75.00
- Wind: $80.00
- Biomass: $90.00
- Solar: $120.00
Microeconomic reform in the power industry
ORIGINS OF REFORM

• Globally, restructuring and deregulation became a popular economic management policy due to the Electricity Supply Industry’s (ESI) poor track record of allocating capital stocks efficiently throughout the 1980s and 1990s.

• Primary source of inefficiency:
  – Monopoly structures
  – Political intervention
  – Sub-optimal regulation (Averch & Johnson, 1962)
LIKE MOST OTHER PARTS OF THE WORLD, EAST COAST AUSTRALIA BUILT LOTS OF PLANT...

Between 1979-1986:
- Capacity 13,500 to 22,250 MW
- Capital $6,800 to $15,800 million
AND SO RESERVE MARGINS WENT UP…

<table>
<thead>
<tr>
<th>Financial year</th>
<th>QLD</th>
<th>NSW</th>
<th>VIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>65%</td>
<td>44%</td>
<td>35%</td>
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<td>1989</td>
<td>59%</td>
<td>36%</td>
<td>36%</td>
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<td>1990</td>
<td>47%</td>
<td>38%</td>
<td>27%</td>
</tr>
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<td>1991</td>
<td>47%</td>
<td>34%</td>
<td>32%</td>
</tr>
<tr>
<td>1992</td>
<td>36%</td>
<td>36%</td>
<td>25%</td>
</tr>
<tr>
<td>1993</td>
<td>42%</td>
<td>48%</td>
<td>32%</td>
</tr>
<tr>
<td>1994</td>
<td>37%</td>
<td>37%</td>
<td>42%</td>
</tr>
<tr>
<td>1995</td>
<td>38%</td>
<td>36%</td>
<td>37%</td>
</tr>
<tr>
<td>1996</td>
<td>31%</td>
<td>27%</td>
<td>24%</td>
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<tr>
<td>1997</td>
<td>31%</td>
<td>27%</td>
<td>24%</td>
</tr>
<tr>
<td>1998</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Optimal reserve plant margin: 25%, down to 20%
AND PREDICTABLY, SO DID THE PRICES. AFTER ALL, THESE WERE MONOPOLIES...

Financial year:
- 1955
- 1957
- 1959
- 1961
- 1963
- 1965
- 1967
- 1969
- 1971
- 1973
- 1975
- 1977
- 1979
- 1981
- 1983
- 1985
- 1987
- 1989
- 1991
- 1993
- 1995
- 1997

QLD
NSW
VIC

Average end-user electricity price ($/MWh)
- 20.00
- 40.00
- 60.00
- 80.00
- 100.00
- 120.00

Victoria restructures and deregulates
Qld Restructure
NSW deregulates
THE POWER INDUSTRY: REFORM FATIGUED…

• The energy industry, being by far the world’s largest industry, faces continuously changing policy settings

• Until the mid 1990s, electricity supply was undertaken by vertically integrated, State-Owned monopolies, which had its consequences…

• In Australia, the policy settings and reforms over the past decade have focused largely on maximising:
  – Productive efficiency
  – Allocative efficiency
  – Dynamic efficiency
MICROECONOMIC REFORM

• Power Industry Reform requires a few basic steps
  – Industry restructuring
  – Industry deregulation

• The two concepts are quite separate

• Restructuring focuses on industry organisational design

• Deregulation focuses on opening up market mechanisms in product and capacity markets
VERTICAL RESTRUCTURING

Generation

Transmission & System Ops

Retailing

Dist Network

Electricity Consumers
Industrial, commercial, domestic
HORIZONTAL RESTRUCTURING

Gen1, Gen2, Gen3, Gen4, Gen5

System Ops

R1, R2, R3

Trans Grid

Dist Network

Electricity Consumers
Industrial, commercial, domestic
THE CURRENT INDUSTRY STRUCTURE

Regulated Monopoly

Wholesale Market

Hedge $  
Energy $  
Pool $ Connection $  
Bill $

Retail Market

Retailer

Generators

PX

Transmission Grid

Energy kWh  
Grid $  
Network $

Distribution Network

Retail Customer

Energy kWh  
Energy kWh  
Energy kWh  
Energy kWh
AN ACTIVE FORWARD MARKET IN DERIVATIVES

Hedge Contracts

They are financial instruments - not electricity supply contracts

Generator

Transmission Grid

Distribution Network

Retailer

Retail Customer

Pool $ → Retailer

Pool $ ← Retailer

Hedge $
SUPPLY-CURVE FOR THE QUEENSLAND REGION

The NEM is an Energy Only, Gross Pool, Uniform First-Price Auction market. Spot prices are set every five minutes based on the aggregate supply curve, which can and does change in each dispatch interval (5-min period).

Derivatives market is strictly cash-settled.
QLD SYSTEM DEMAND – AN INTERESTING DAY…

Spot Price and System Demand for Tuesday 3/11/98 - Melbourne Cup Day

Spot Market Price

System Demand

QLD SYSTEM DEMAND – AN INTERESTING DAY…
Economic performance of the National Electricity Market

HAVE REFORMS BEEN SUCCESSFUL?

Recall from the earlier slide that the objective of reforms are to increase productive, allocative and dynamic efficiency. Thus we have three propositions to test:

1. Restructuring a generator will increase productive efficiency
   - Costs, plant availability

2. Deregulating the product market will increase allocative efficiency
   - Unit prices

3. Deregulating the capacity market will increase dynamic efficiency
   - Reserve margins and plant mix
PRODUCTIVE EFFICIENCY (QLD)

- Average cost (at 75% CPI)
- Average costs (pre-reform)
- Average costs (post-reform)

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Unit cost ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>40.07</td>
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<tr>
<td>1996</td>
<td>45.33</td>
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<tr>
<td>1997</td>
<td>44.96</td>
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<td>1998</td>
<td>45.60</td>
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<td>1999</td>
<td>45.84</td>
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<td>2000</td>
<td>46.77</td>
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<td>2001</td>
<td>48.87</td>
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<td>2002</td>
<td>50.01</td>
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<td>2003</td>
<td>51.02</td>
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<tr>
<td>2004</td>
<td>51.98</td>
</tr>
<tr>
<td>2005</td>
<td>51.98</td>
</tr>
<tr>
<td>2006</td>
<td>53.95</td>
</tr>
</tbody>
</table>

- Restructuring
- Deregulation

$2.7Billion

$560M
The improvement in plant availability in Vic & NSW had the equivalent effect of building 1,800MW of new base load capacity, a $2.7 billion capex saving, saving $216 million p.a. in carrying costs.
CONCLUSION ON PROPOSITION I

• Horizontal restructuring of a monopoly generator does increase productive efficiency:
  – Reason: Productive efficiency is a function of the efficiency of capital markets, product markets, or both (Kay & Thompson, 1986).
  – In NSW and in QLD, competitive equity market pressures are not observed under the Corporatisation framework, but a competitive product market is a reasonably good surrogate.
  – However, privatisation would certainly finish the job.
ALLOCATIVE EFFICIENCY IS EASY TO PICK

Wholesale electricity prices ($/MWh)

Optimal reserve
Moderate oversupply
Substantial oversupply

Monopoly price: increases as over-supply increases
Competitive price: decreases as over-supply increases

Competitive price: decreases as over-supply increases
Monopoly price: increases as over-supply increases

Average cost (monopoly price outcome)
Spot price (competitive price outcome)
ALLOCATIVE EFFICIENCY (PRICE)

Unit price ($/MWh)

Reserve plant margin (%)

Financial year


Restructuring
Deregulation
Interconnection with NSW & VIC

20.00 30.00 40.00 50.00 60.00 70.00 80.00

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50%

42.90 43.99 44.27 39.35 57.37 44.11 41.33 35.34 37.79 28.19 28.96 25.97 66.89

44% 37% 31% 43% 28% 34% 41% 26% 22% 18% 22%
CONCLUSION ON PROPOSITION II

• Deregulating product markets increases allocative efficiency:
  
  – Reason: Allocative efficiency is a function of the competitiveness of the product market.
  
  – But beware… Inadequate plant (transmission or generation) or inadequate restructuring (competition) will lead to the exercise of market power, and if it doesn’t, traders are asleep at the wheel.
  
  – Perhaps most importantly, as the former Commissioner of the QEC (‘85–’91) once said in passing, product market deregulation shifts the (price) risk of oversupply from the consumer to the stockholder, which is where it belongs.
DYNAMIC EFFICIENCY (RESERVE PLANT MARGINS)

- QLD Reserve
- Optimal reserve margin (QLD)
- NSW reserve
- VIC Reserve
- Optimal reserve margin (NSW & VIC)

Reserve plant margin (%)

- 50%
- 45%
- 40%
- 35%
- 30%
- 25%
- 20%
- 15%
- 10%
- 5%
- 0%

Financial year

- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007

QLD-NSW Interconnection

Kogan Creek

22%

9%

7%
Long range outlook for the economic and environmental performance of the NEM

THE CHALLENGES FACING POWER GENERATION IN AUSTRALIA

• Australia has one of the lowest cost power systems in the world and is key comparative advantage for the economy
  – Largely driven by Australia’s vast low cost thermal coal reserves (A$1.00/GJ)
  – Coal fired generation accounts for 80-85% of energy generated
  – Australia also has substantial low cost natural and coal seam gas (A$3.00/GJ)

• The near-term challenge facing the power generation industry in Australia
  – Capacity stocks are largely exhausted
  – New capacity required is largely intermediate/peaking, thus Australia has a ‘stay of execution’ from an emissions perspective (gas generation being the lowest cost int./peak solution)
  – But by early/mid next decade, new base capacity is required, and Australia’s supply-side must make the structural adjustment to the transitional fuel (viz. gas-fired generation) for base load duties – for this to occur, CO2 must carry a price
  – This implies Emissions Trading, permit allocation must ensure that energy security is not violated and that the system’s world class economic performance is maintained

• The long-term challenge facing the power generation industry
  Australia’s power system will double between 2005 and 2030
  – By 2050, the incumbent thermal plant stock must be completely turned over
  – And gas is only a transitional fuel. Ultimately new technologies must be introduced to the Australian power system, and make the final transition to clean coal, nuclear and renewables, and reserve gas for intermediate and peaking duties
Graphically, this challenge looks as follows...

Unit cost of base load power applications ($/MWh)

- Black Coal SCpf: 0.9t
- Gas NGCC: 0.4t
- Clean Coal, Nuclear, Renewables: 0.1t

Emissions intensity of base load power (t/CO2)

Data Source: BBP
THE NEAR-TERM CHALLENGE

• The near-term challenge for industry is to build new capacity in a timely manner to ensure security of supply at economic rates in light of CO2 uncertainty (both regime and price)

• The near-term challenge for policy makers is to ensure that by the time new base capacity is actually required, the uncertainty associated with “CO2 regime” has been substantially resolved

• Any “ticking devices” attached to either challenge?
  – For industry, investing in technologies that will not be long-term stranded
  – For policy makers, the vexed question of permit allocation policy, and its impact on the stability of wholesale electricity/commodity prices over the next 10 years.
SO WHAT MAKES UP THE COST OF ELECTRICITY AND WHAT WILL IT LOOK LIKE AFTER CO₂ IS PRICED IN?

Data Source: BBP

- At $25/t, wholesale prices would increase by 50%
- But at $25/t the average end-use price increases by only 25%
WHY DON’T WE JUST GO RENEWABLE? COST & AVAILABILITY…

**IGCC+CCS excluded in near-term analysis**
WHEN CO2 IS PRICED, IT HELPS….BUT EAST-COAST COAL IS VERY VERY CHEAP, SO RENEWABLES WILL ALWAYS STRUGGLE...

<table>
<thead>
<tr>
<th>Technology</th>
<th>Unit cost ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black coal</td>
<td>$60</td>
</tr>
<tr>
<td>NGCC</td>
<td>$80</td>
</tr>
<tr>
<td>Geothermal</td>
<td>$100</td>
</tr>
<tr>
<td>Black coal</td>
<td>$60</td>
</tr>
<tr>
<td>OCGT</td>
<td>$80</td>
</tr>
<tr>
<td>Brown coal</td>
<td>$100</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$120</td>
</tr>
<tr>
<td>Wind</td>
<td>$120</td>
</tr>
<tr>
<td>Mini Hydro</td>
<td>$120</td>
</tr>
<tr>
<td>Biomass</td>
<td>$120</td>
</tr>
<tr>
<td>Solar</td>
<td>$140</td>
</tr>
</tbody>
</table>

Data Source: BBP
GETTING EMISSIONS TRADING POLICY SETTINGS RIGHT

• Emissions trading, by way of auction allocation, necessarily brings about very substantial wealth transfers
• In the Euro-Zone, permits were “Grandfathered” (i.e. allocated for free) to power generators in order to minimise wealth transfers
• This led to so-called ‘windfall profits’ in the generation sector and hence the policy of Grandfathering has since become exceedingly unpopular with policy makers
• But it is important to examine EU15 results carefully, they don’t translate to Aust “neatly”:
  – In Germany, the Bundeskartellamt claimed that if work-on rates exceeded 25% then windfall gains existed because permits were allocated for free
  – In Germany, permits allocated (382mt) were greater than production (373mt) because policy makers included plant earmarked for closure in the allocation process
  – In Spain, the two dominant generators (80% market share) control all of the nuclear and hydro power, which constitutes 50% of energy… under such conditions, supra-normal profits would arise whether emissions were Grandfathered or Auctioned
  – In Europe, natural gas prices went from €3.05 to €5.70 (i.e. $5/GJ to $9/GJ) just as emissions trading was implemented
  – Windfall profits must be gauged against a suitable time dimension: If the economic (as opposed to technical) life of a generator reduces from 30 years down to 5-10 years, benchmark WACC returns rise from 11%pa to 23%pa
  – Coal in EU15: 28% market share. Coal in Australia: 85% market share. This is a very important difference
COAL-FIRED GENERATION: MARKET SHARE IN THE EU15

Market share of coal (%)

Luxembourg  Sweden  France  Austria  Italy  Finland  Belgium  Netherlands  EU15 Avg  UK  Portugal  Ireland  Spain  Denmark  Germany  Greece  Australia

Data Source: Simshauser & Doan (2007), “On emissions trading, wealth transfers and the wounded-bull scenario”, Oz Carbon Trading Conference, Sydney June 2007. Available from paul.simshauser@babcockbrown.com or thao.doan@stanwell.com
NON-FOSSIL GENERATION: MARKET SHARE

Market share of non-fossils (%)

Data Source: Simshauser & Doan (2007)
NEAR-TERM IMPLICATIONS

• For an industry that is naturally long GHG, emissions trading is a logical policy option and has the support from most in the power generation industry provided allocation policy deals with asset values.

• Over the next 40 years, Australia’s thermal plant stock will need a complete turnover, but the current class of coal technologies need a transitional glide path, and right now, 80-85% of power comes from coal.

• This invariably means a careful policy of Grandfathered emission permits to ensure ongoing system security and electricity price stability over this lengthy transitional period.

• As one of the bigger developers of new gas-fired generators, BBP sees no problem with incumbent coal generators being ‘ushered’ into the GHG world if it means stability and reliability/security of supply is be maintained.

• No generator wants to see the sustained price spikes through continuous economic withholding of capacity, but in the absence of Grandfathering, such an outcome is probably inevitable, and tragically, justifiable.

• The longer term welfare implications of a *Wounded-Bull Scenario* far out-weight an incorrectly generous allocation system to incumbent coal generators.
THE LONG-TERM CHALLENGE

• Between now and 2030, the Australian power system will virtually double: load from 31,000MW to 63,000MW, and generation from 40,000MW to 73,000MW

• While gas fired generation provides an elegant near-term solution, there are simply insufficient gas supplies to power Australia’s base load over the very long run

• Investment required in new plant between now and 2030; somewhere between $45-$80 billion depending on the technology set:

<table>
<thead>
<tr>
<th>Plant</th>
<th>Actual 2005 (MW)</th>
<th>Retirements (MW)</th>
<th>Optimal 2030 (MW)</th>
<th>Shortfall (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseload</td>
<td>27,700</td>
<td>10,400</td>
<td>44,000</td>
<td>26,700</td>
</tr>
<tr>
<td>Intermediate</td>
<td>2,000</td>
<td>600</td>
<td>8,600</td>
<td>7,200</td>
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<tr>
<td>Peak</td>
<td>7,900</td>
<td>800</td>
<td>20,400</td>
<td>13,300</td>
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<tr>
<td>Total</td>
<td>37,600</td>
<td>11,800</td>
<td>73,000</td>
<td>47,200</td>
</tr>
</tbody>
</table>

IF WE DO NOTHING, THIS IS THE OUTLOOK...83% COAL AND HIGH EMISSIONS

Data Source: Simshauser, Doan & Lacey (2007)
AND CO₂ EMISSIONS FROM THE POWER INDUSTRY RISES SHARPLY

NEM CO₂ emissions (Mt)

<table>
<thead>
<tr>
<th>Financial year</th>
<th>NEM CO₂ emissions (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>177</td>
</tr>
<tr>
<td>2015</td>
<td>208</td>
</tr>
<tr>
<td>2020</td>
<td>229</td>
</tr>
<tr>
<td>2025</td>
<td>249</td>
</tr>
<tr>
<td>2030</td>
<td>265</td>
</tr>
</tbody>
</table>

Data Source: Simshauser, Doan & Lacey (2007)
GAS FROM 2010, IGCC+CCS FROM 2020 – A GOOD MIX…

Energy generated (GWh)

2015

- 9,626
- 17,125
- 28,063
- 49,697

2020

- 9,618
- 17,128
- 26,617
- 46,122

2025

- 9,267
- 17,125
- 25,487
- 91,019

2030

- 8,919
- 17,128
- 17,729
- 145,058

Renewable
Hydroelectric
Conventional brown coal
Conventional black coal
Natural gas
IGCC+CCS

Data Source: Simshauser, Doan & Lacey (2007)
EMISSIONS REDUCE SUBSTANTIALLY…

Data Source: Simshauser, Doan & Lacey (2007)
GAS FROM 2010, NUCLEAR FROM 2025- THIS WORKS TOO…

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Renewable</th>
<th>Hydroelectric</th>
<th>Conventional brown coal</th>
<th>Conventional black coal</th>
<th>Natural gas</th>
<th>Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>9,650</td>
<td>17,127</td>
<td>28,041</td>
<td>135,686</td>
<td>49,696</td>
<td>56%</td>
</tr>
<tr>
<td>2020</td>
<td>9,655</td>
<td>17,128</td>
<td>27,228</td>
<td>128,174</td>
<td>86,491</td>
<td>32%</td>
</tr>
<tr>
<td>2025</td>
<td>9,833</td>
<td>17,124</td>
<td>29,437</td>
<td>109,006</td>
<td>78,374</td>
<td>4%</td>
</tr>
<tr>
<td>2030</td>
<td>7,916</td>
<td>17,125</td>
<td>21,252</td>
<td>75,882</td>
<td>176,785</td>
<td>22%</td>
</tr>
</tbody>
</table>

Data Source: Simshauser, Doan & Lacey (2007)
EMISSIONS REDUCE EVEN FURTHER…

Data Source: Simshauser, Doan & Lacey (2007)
UNDER VARIOUS SCENARIOS, THESE ARE THE ALL-UP COSTS IN 2030

Underlying power system cost ($/MWh)

- Gas+Renewables: $66.75
- Nuclear: $66.68
- Gas: $64.12
- IGCC: $59.50
- Base case: $51.31

Data Source: Simshauser, Doan & Lacey (2007)
AND THESE ARE THE CO₂ EMISSIONS IN 2030…

Power system emissions (Mt CO₂ pa)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Emissions (Mt CO₂ pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>265</td>
</tr>
<tr>
<td>Gas</td>
<td>177</td>
</tr>
<tr>
<td>Gas+Renewables</td>
<td>165</td>
</tr>
<tr>
<td>IGCC</td>
<td>128</td>
</tr>
<tr>
<td>Nuclear</td>
<td>109</td>
</tr>
</tbody>
</table>

Data Source: Simshauser, Doan & Lacey (2007)
LONG-TERM IMPLICATIONS

• From 2020 onwards, technologies that are ‘new to Australia’ must be introduced to the power system to deal with CO2 constraints

• There are no incumbent technologies in Australia that can optimise the very long-term economic and environmental trade-off in power generation
  – Continued deployment of NGCC would exhaust economic gas stocks and ultimately lead the industry back to conventional coal
  – Requires addition of Nuclear and/or Clean Coal in the long run
  – And renewables should be maximised to the extent practical (especially wind, biomass and geothermal)

• The usual message applies to Australia, i.e.. there is no silver bullet and quantitative modelling results currently confirm this to be the case

• For industry, the challenge is to marshal resources away from immediate business pressures to the long-term focus

• For policy makers, this means ‘stay the course’ and continue to drive RD&D, and innovative entry policies, because left to its own devices, the market will fail.
  Economic theory has long been relaxed with the notion that the presence of very large–externalities are a predictable cause of market failure
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