Submission on the **Draft Energy White Paper**[1] from **Climate Change Balmain-Rozelle Inc**[2].

Derek Bolton, 2/3/12

We find that the report is fatally flawed by taking too short a timescale. It does not consider the need to reach zero net emissions by any particular date, and so misses the implications this has for present policy.

The extensive reliance on market forces underappreciates known market shortcomings: externalities, and the high barriers to major transitions. Moreover, it bizarrely presumes that damaging emissions cease to be an externality the moment a carbon price is applied, no matter how low.

The relentless endorsement of gas as a cheap abatement option does not withstand analysis. CCS can be used with gas, and indeed would need to be, but the economic implications are not analysed, and the benefits of CCS with unconventional gas may be significantly undermined by well leakage.
We shall show that such analysis leads to the conclusion that renewables will provide the cheaper option for dispatchable power, and consequently for the entire supply.

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1 http://www.ret.gov.au/ENERGY/FACTS/WHITE_PAPER/Pages/energy_white_paper.aspx
2 *http://www.climatechangebr.org/*

1 Comments on the text of the Draft White Paper

p xii, footnote 4:

> *"The term 'clean and sustainable energy' refers to sources of energy, technologies or processes that produce lower or zero greenhouse gas emissions relative to conventional counterparts and that meet appropriate social, environmental, health and safety standards."*

Therein lie two key issues:

- *Lower* emissions is not clean, merely cleaner.
  It is not enough merely to reduce emissions. Long term, emissions have to get to zero. The dripping tap overflows the bath eventually. Any technology that progressively moves carbon that has been stored safely underground for millennia into the biosphere cannot be considered sustainable.
  On that test, gas and coal, even with CCS, both fail. The higher the fraction of CO_2 that CCS captures the more expensive it will be. On current showing, coal with CCS capturing 95% will never undercut renewables on price. Gas with CCS is surely more expensive again.
- Sustainability is also a question of resource exhaustion. Calling any fossil fuel sustainable demonstrates a certain limitation on perspective.

p xv, The need for an informed debate

> "*...the International Energy Agency (IEA) estimated that around 80 per cent of the world's allowable carbon dioxide emissions budget ... is already locked in through existing capital stock ...*
> *... but we are fortunate in having gas ..."*

The IEA further stated that at current build rates this would reach 100% in 5 years. Suppose that's based on new plant being 20% gas and 80% coal, by power output, but instead we instantly switch that to all gas. Since gas has half the emissions of coal (excluding fugitives), that would cut the emissions from new plant by 44%, giving us an extra four years – just one federal term. It is therefore too late for gas (without CCS) to play a role in reducing emissions, even as a bridging technology.
Indeed, the IEA stated of its Golden Age of Gas scenario[3]:

> *"the high gas scenario shows carbon emissions consistent with a long-term temperature rise of over 3.5°C "*

What of gas with CCS? If this is to play a major role then this must include unconventional gas. Each 1% leakage of the methane is equivalent (over a 20 year timescale) to failing to capture 7%[4] of the CO_2 produced. So with CCS technology that captures 95% and 2% well/pipe leakage the effective footprint is still 20%.
The persistent emphasis on gas development throughout the White Paper betrays a failure to comprehend the import of the IEA statements.

p xxi, External factors are impacting the market

> *"An emissions standard is unnecessary in the presence of carbon pricing"*

This is an egregious error. The statement will only be true if and when the carbon price fully internalises the externality of damage caused by the emissions. Meanwhile, emissions standards would be an entirely appropriate adjunct to the price.

p xxiii, Managing the growth in peak demand and improving energy productivity

3 http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=415
4 Although methane is generally stated to have 20 times the greenhouse effect of CO_2 over 20 years, that is tonne for tonne. For the present calculation the comparison needs to be in terms of carbon atoms.

"Further efforts to address non-market barriers to the uptake of energy efficiency"

There is also a need to overcome transitional market barriers.
Existing grid was built to serve existing generators. Ideal sites for geothermal, wind and solar generators may be elsewhere, so incumbents enjoy a market advantage. Establishment of that grid occurred when there were no competitive power sources, so it was paid for by the public, as customers and/or taxpayers, at the time. The rental the generators now pay for their access links only covers maintenance and upgrades.

p xxvii, Strengthening the resilience of Australia's energy policy framework

"... information base on energy resources, technologies and fuels, including their comparative costs"

Given the desire to depend more on market forces, it is important to include all costs. We will return to this in *Current and Potential Externalities* on page 8.

p xxviii

"improving Australia's energy information base"

Some additional items for the information base:

- Estimates of all externalities associated with each technology, including but not limited to
    - Health costs
    - Other environmental costs (agriculture, amenity)
    - Underfunded insurance and remediation
    - Taxpayer-supported infrastructure
- Up-to-date assessments of costs of coming technologies.
  Government publications in recent years have a bad reputation for grossly overestimating these by using data that are years out of date[5].
- An independent study of the lifetime emissions of unconventional gas.
  Estimates from the gas industry see fugitive emissions as negligible, while a non-industry US study for shale gas deemed them so great that the lifetime GHG footprint is as high as for coal[6]. An NOAA study found shale gas wells with double the leakage industry claimed[7]. At 4%, it would boost the carbon footprint from 50% of coal's to 70%. While shale gas may not accurately represent CSG, an independent Australian study for CSG is essential.

5 http://www.theaustralian.com.au/national-affairs/climate/energy-white-paper-overstates-cost-of-renewables-study-finds/story-e6frg6xf-1226226197721

6 http://esciencenews.com/articles/2011/04/12/natural.gas.shale.contributes.global.warming

7 http://www.reuters.com/article/2012/02/10/australia-csg-idUSL4E8DA30020120210

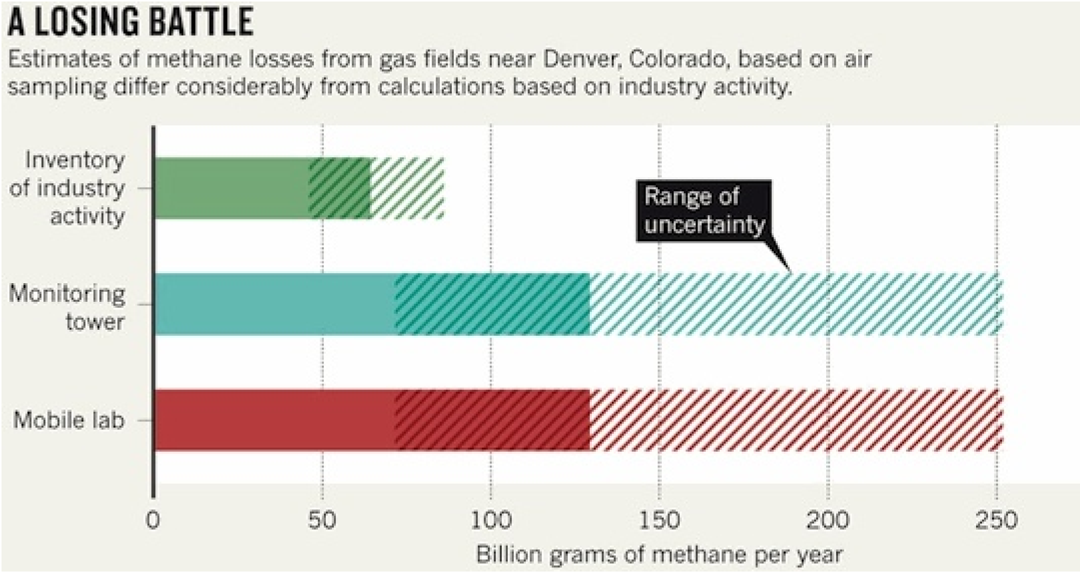

Illustration 1: Natural-gas operations could release far more methane into the atmosphere than previously thought. [Source: Nature]

- Expanding the scope of the Australian Energy Technology Assessment to specifically cover alternatives to liquid fuel technologies

p xxxii, Accelerating clean energy outcomes

> *"monitoring the impacts of increased levels of intermittent generation on network stability"*

There appears to be an implicit assumption here that all renewable power sources are intermittent. A further paragraph is needed on baseload renewables, such as geothermal and Concentrated Solar Thermal with Salt Storage ("CST+").

p 41, Electricity generation

> *"The range of modelling results also suggest that gas is set to play a pivotal role through baseload generation (CCGT and carbon capture and storage),"*

What cost is predicted (2012 dollars) for electricity from gas with CCS capturing 95%, by the time that becomes practical?

p 56, Addressing price pressures

> *"addressing ... non ‐ price barriers to energy efficiency and demand management"*

Is lack of smart metering considered a price barrier or a non-price barrier? If the former, why is it not to be addressed?

p 59, Energy policy priorities

> *"emerging renewable technologies (solar thermal, geothermal and wind)"*

Odd to list those but not solar PV.

p 67, Box 4.2

> *"For a major global energy exporter like Australia, pursuing a goal of national energy self‑sufficiency is counterintuitive."*

No, what's counterintuitive is that there might be any need to pursue it, rather than its being an automatic consequence. But given that not all energy sources are readily convertible one to another, it might be quite appropriate to take some steps in the self-sufficiency direction.
One step would be further electrification of transport, whether that's more rail, EVs or both. Given the expected doubling of the oil price by 2038 (p 45), that would not *"impose unnecessary higher costs on consumers" (loc. cit.).*

p 108, section 6.1, Principles

> *"Energy market design should not give preference to particular technologies or fuel types."*

That bears some clarification. If a given technology has externalities borne by the taxpayer, does internalising it constitute giving preference to the others? If an existing technology enjoys an effective subsidy by virtue of infrastructure built while it had a *de facto* monopoly, is a balancing subsidy to new technologies favouritism?

p 121, Carbon pricing and fuel

> *"Transport fuel used in the rail, domestic shipping and domestic aviation sectors will be subject to an effective carbon price from 1 July 2012."*

So rail will be immediately subjected to a carbon price, whether for diesel or indirectly through use of electricity. Meanwhile, the road-based competition will be excused until 2014 or beyond. This does not seem to accord either with the principles previously outlined or with the goal of reducing GHG emissions.

p 144, Connecting remote generation

> *"A rule change was proposed to introduce a framework that would allow the sizing of connections to meet future expected generation capacity. The AEMC subsequently amended the rule..."*

A reference for this would be helpful.

p 161, Impact of other non-market interventions

> *"Therefore, the overall impact of the bipartisan expanded Renewable Energy Target has been to increase prices to consumers"*

That may or may not have been the overall impact. Whether it was cannot be deduced from the preceding statements. The Merit Order Effect is not new to the electricity market, and is well known in everyday life. A fruit with a short season temporarily displaces year-round offerings. If no subsidy is needed to maintain that product, the consumer gains overall. Therefore some level of subsidy can be supported without the consumers' suffering a net loss.

p 164, Market structure

> *"This has led to the rise of a number of so-called 'gen-tailors'* (sic) *as dominant business models and a form of risk management. Substantial vertical integration, however, reduces the liquidity of the contracts market, which could pose a potential barrier to the entry of new market participants.*

In noting this trend, there is no suggestion that current market structures are uncompetitive or causing economic harm."

The integration described has parallels. Microsoft had to be constraind by anti-trust legislation from selling an operating system that favoured Windows Explorer over competitive browsers. It is hard to see why the White Paper refrains from suggesting it poses a threat to proper operation of the market. It very clearly does.

p 206, Fig 7.1

There is a curious omission in the chart: OCGT + CCS.
Since peaking power will always be needed, and the EWP is promoting gas + CCS, the cost of the OCGT/CCS combination is a significant matter. The chart projects for 2030:

Technology	Dispatchable?	CCS?	$/MWh Low	$/MWh High	$/MWh mean
CCGT	No	No	60	100	80
CCGT	No	Yes	80	150	115
OCGT	Yes	No	170	240	205
Solar thermal, tower +storage ("CST+")	Yes	N/A	115	240	177

Table 1: Comparison of costs of dispatchable power

These datapoints imply OCGT+CCS would be around $240/MWh (mean). At the same time, the Solar thermal figures were already out-of-date[8], on the high side, when the chart was prepared.
We will return to this in *Providing Dispatchable Power* on page 10.

p 221, Stability and effectiveness of policy

"feed-in tariffs (which place open-ended and increasing cross-subsidies on a range of consumers who do not receive the material benefit of the subsidy)"

The paragraph as it stands implies that feed-in tariffs necessarily have that undesirable attribute. This is not so. IPART recently proposed[9] that a NSW feed-in tariff of 8-10c/kWh for domestic PV would be fair, and that it would not increase the costs for taxpayers or other electricity users.

p 221, Fundamentals for better support mechanisms

The listed desiderata for government support programs needs to be expanded in the light of the failure of the Solar Flagships program. Three flaws were exposed:

- The shortlisted projects included no zero-emissions dispatchable power. This shows that the objectives were insufficiently considered.
- The tenderers were not required to make any commitment as part of the tender. As a result, the tenders may have been made somewhat casually[10]. After acceptance, tenderers paying more attention to the details may have decided there wasn't enough in it for them.
- The tenderers were unable to secure power purchase agreements. This had two primary causes[11]:

8 This is disappointing since we are aware that this has been brought to the Minister's attention long since.
9 http://www.ipart.nsw.gov.au/files/Draft%20Report%20-%20Solar%20feed-in%20tariffs%20-%20November%202011.PDF
10 http://www.climatespectator.com.au/commentary/learning-mistakes-solar-flagships
11 http://www.electronicsnews.com.au/news/Flagship-collapse-only-part-of-Australias-solar

- The collapse of the REC market, following the 5x multiplier and ensuing stockpiling of cheap certificates.
- The growth of vertical integration, producing "gen-tailers" that have little incentive to purchase power from other generators.

pp 222, 223, Technology prioritisation framework

A difficulty with the framework as laid out is that it treats the technologies independently and interchangeably. In practice, technologies have attributes that may complement or conflict with each other. The mix must include dispatchable power and cheaper baseload or intermittent power. See "*Providing Dispatchable Power*" and "*Baseload and Intermittent Sources*" below.

p 273, Table C.1: Comparison of model inputs and outputs, Treasury and BREE, 2011

What were the model inputs for cost of electricity from each renewable resource at each date?

pp 275-276, Table D.1: Australian Government clean energy programs

This table reveals some interesting totals:

Technology	Program	$m
CCS, $2586m	Flagships	1680
	Low Emissions Technology Demonstration Fund	160
	Low Emissions Coal Initiative	370
	National CO_2 Infrastructure Plan	61
	Global Carbon Capture and Storage Institute	315
All Renewables, $3344m	ARENA	3200
	Solar Cities	94
	Solar Schools	50
Efficiency	Low Carbon Communities Program	330

Table 2: Federal Expenditures on "Clean Energy"

Spending over 40% of the total on CCS smells of a picked winner.

2 Current and Potential Externalities

- **Health**
  Various US research has indicated significant health and agriculture costs from the use of fossil fuels. In 2009 the NRC attributed $62bn a year in externalities to the use of coal-fired electricity[12] in producing 2 PWh[13], i.e. 3c/kWh.
  A European report ascribed 25 deaths per TWh to emissions from coal-fired power stations[14]. Putting the economic cost of that mortality and corresponding morbidity (including non-fatal morbidity) at $1m each per death produces a cost of 5c/kWh.
  In the absence of any specifically Australian study, it would be reasonable to assume around 3c/kWh here too.

- **Insurance**
  With nuclear, a commonly overlooked cost is insurance. In every country with nuclear power the government caps the liability of the nuclear companies, thereby effectively subsidising them. With CCS there is potentially a similar situation. The repositories must be required to have insurance, in perpetuity, against leaks. The cost of the insurance, structured as an annuity to fund the premiums forever, must be fully taken into account as a cost of the technology. Anything less is a taxpayer-funded subsidy. Setting the sum insured is a challenge since the carbon price at the time a leak occurs needs to be predicted. If the resulting premiums are prohibitive the conclusion has to be that the technology is not yet proven adequate.
  According to the principles of the technology, the CO2 is progressively absorbed by the minerals, so the risk of a leak declines. Arranging that the risk is fully covered by the industry will be a measure of that claim.

- **Climate**
  As remarked, having a carbon price does not of itself render emissions no longer an externality. That will only be true when the price is the lower of the dollar cost of the damage or of remediation. In the extremely long term, any net transfer of carbon from geological measures to the biosphere is cumulative, so the damage is unlimited. The correct price is therefore the cost of remediation: what it costs to draw the CO_2 back out of the atmosphere and sequester it mineralogically. With current technology that would be hundreds of dollars/tonne.

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12 http://thinkprogress.org/romm/2009/10/22/204843/nrc-burning-fossil-fuels-costs-120-billion-a-year-mercury-climate/?mobile=nc
13 http://en.wikipedia.org/wiki/Coal_power_in_the_United_States
14 http://www.world-nuclear.org/sym/2000/pdfs/devezeaux.pdf Devezeaux J. G., (2000): Environmental Impacts of Electricity Generation. 25th Uranium Institute Annual Symposium. London, UK (September, 2000)

3 Short Term Success driving Long Term Failure

Inadequate market signals, such as a slowly rising price on carbon, may promote reduced but non-zero emissions technologies, such as gas without CCS, in the short term. As the price rises in order to achieve the long term need of zero emissions, resulting infrastructure may be stranded. The resources diverted into the short term fix will have been denied to, and thereby delayed, the solutions for the long term.

It is more important to cut emissions for the next 10 years than to make the same cut for the following ten instead. This is because of the lag in absorption by oceans.
The charts below model the oceans as being currently in equilibrium with a pre-industrial level of 300ppm. The emissions rate is taken as equivalent to adding 0.5ppm/year (low). The oceans are assumed to absorb in proportion to the excess atmospheric content, with that rate taken to be currently 40% of emissions. Both cases assume no emissions after 20 years. In the first scenario, there are no emissions for the first 10 of those twenty, and in the second there are, instead, no emissions for the second ten.

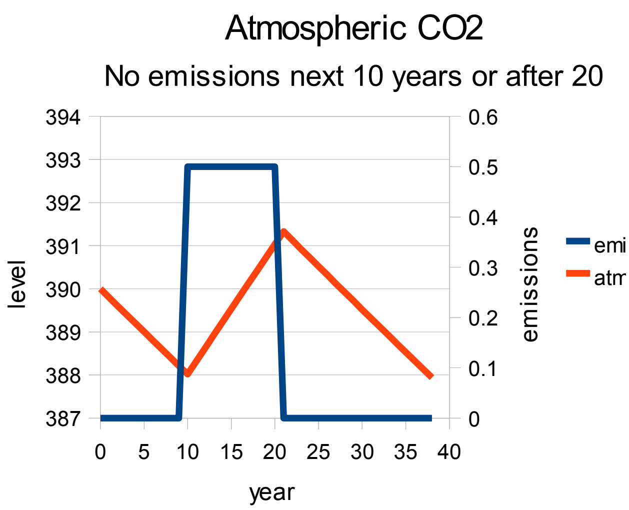

Illustration 3: The immediate cut limits the peak to 391ppm

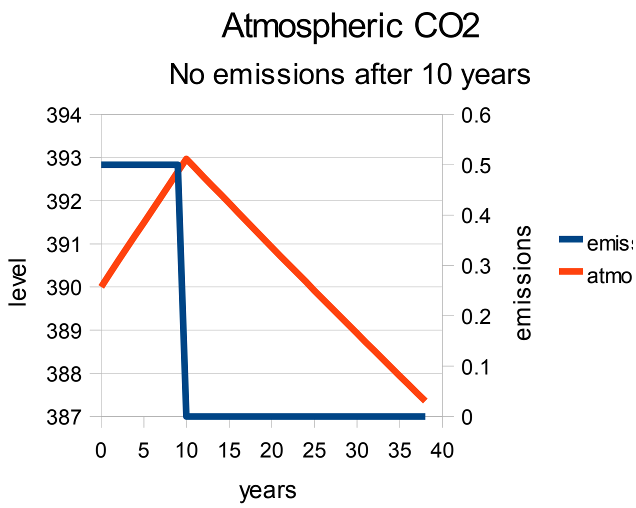

Illustration 2: The delayed cut leads to a peak of 393ppm instead

It follows that to get the right result from the market the carbon price ought to go straight to its maximum value. That would prevent diversion of resources into inappropriate short term responses. Given the pragmatic difficulties of such an arrangement, other measures are needed. This may include making benefits such as feed-in-tariffs and CEFC support available to zero emissions technologies only.

4 Providing Dispatchable Power

Dispatchable power will always be needed. The cheapest option is Hydro, but the potential for that in Australia is already largely exploited. Open Cycle Gas (OCGT) provides most peaking power today. A newly commercial alternative is Concentrated Solar Thermal with storage (CST+). Geothermal may become so in the future.

The future cost of OCGT is subject to great uncertainty around the international price of gas. The price is quite low now, partly as a result of a recent US study claiming 100 years of supply. A closer reading[15] reveals that most of that is speculative, that the reliable figure is more like 20 years. Since gas is fairly readily exported, building an energy future on gas will expose Australia to considerable upside price risk. That the export of our gas will earn more than expected will be of little consolation to those in the wrong half of an even more unbalanced two-speed economy than we have today.

Most projections put the LCOE of CST+ below $150/MWh by 2025 [See Illustration 4]. This puts it ahead of OCGT, even without CCS.

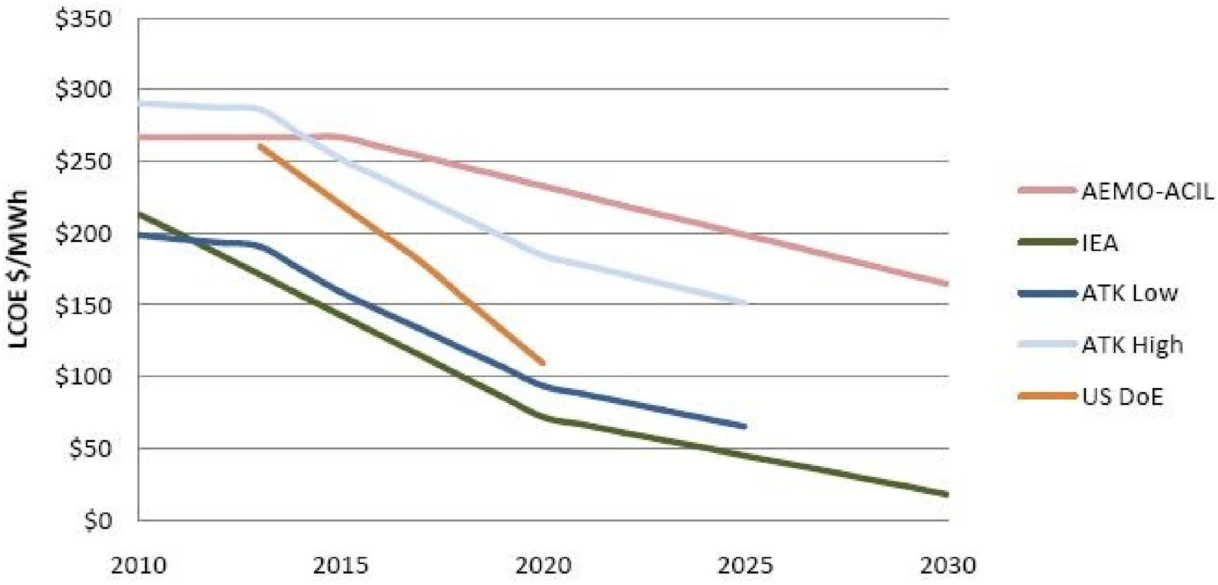

Figure 3: CST cost projections, at Direct Normal Irradiation of 2400 kWh/m2/yr.

Illustration 4: Cost projections for CST in AUD. Source http://www.garnautreview.org.au/update-2011/commissioned-work/renewable-energy-technology-cost-review.pdf

Of course, the LCOE of CST+ depends on the scale of the plant. The above chart assumes a scaling up over time, as well as a decline in costs from experience. In 2010, Sargent & Lundy gave the current LCOE from a 200MW CST+ as $130/MWh.

15 http://www.slate.com/articles/health_and_science/future_tense/2011/12/is_there_really_100_years_worth_of_natural_gas_beneath_the_united_states_.html

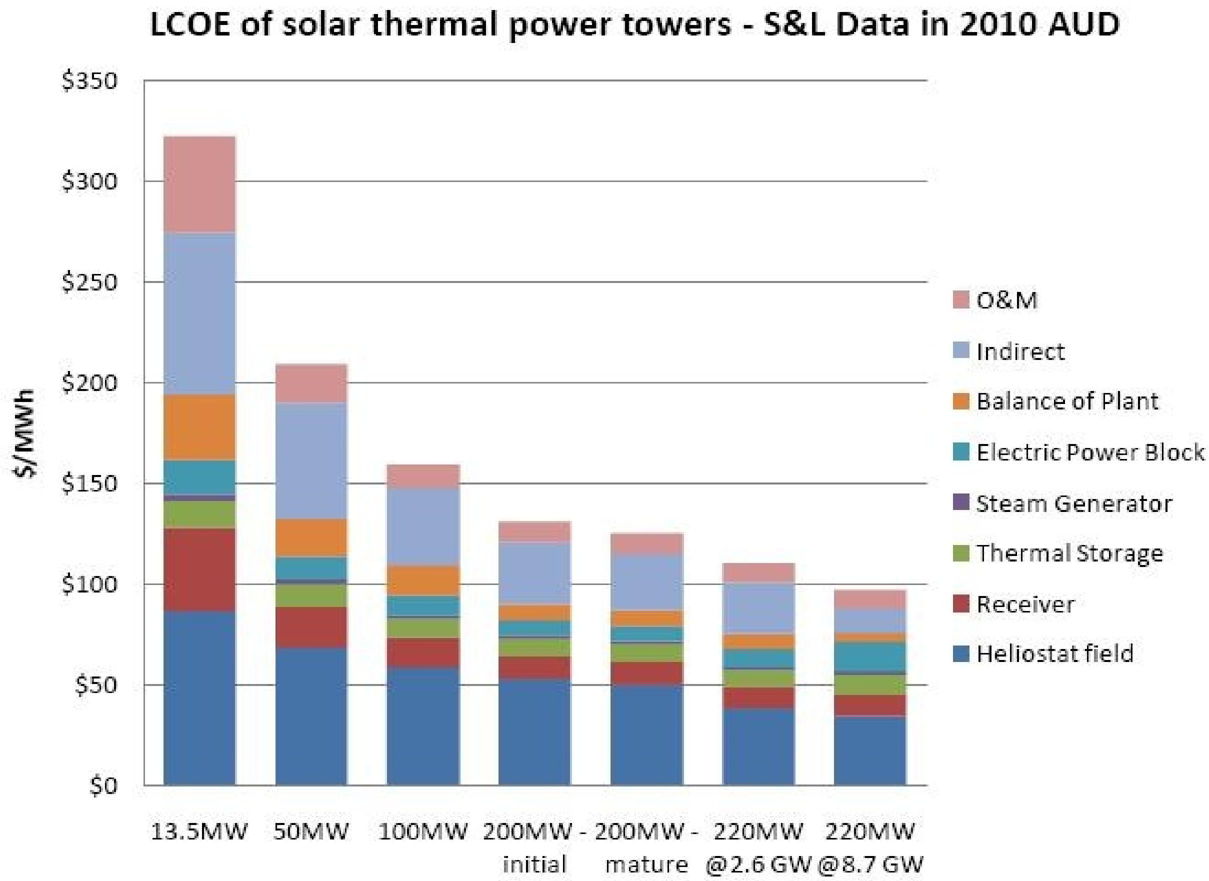

Figure 25: LCOE of CST central receiver calculated from Sargent & Lundy data (note - not inclusive of any REC price)

Illustration 5: Cost breakdowns for CST+. Source http://www.garnautreview.org.au/update-2011/commissioned-work/renewable-energy-technology-cost-review.pdf

5 'Baseload' and Intermittent Sources

Having determined the sources and costs of dispatchable power, attention can turn to sources that are intermittent, like wind and solar PV, or steady but inflexible, like coal and CCGT. If, for example, the dispatchables and intermittents could provide the entire demand it is conceivable that the average cost would be lower than that of some steady sources.

Figure 7.1 puts the 2030 LCOE of coal (supercritical PC) +CCS at $100-$170/MWh and that of wind at $70-$140. The IEA and GWEC already put the cost of wind at $60/MWh at the best sites.

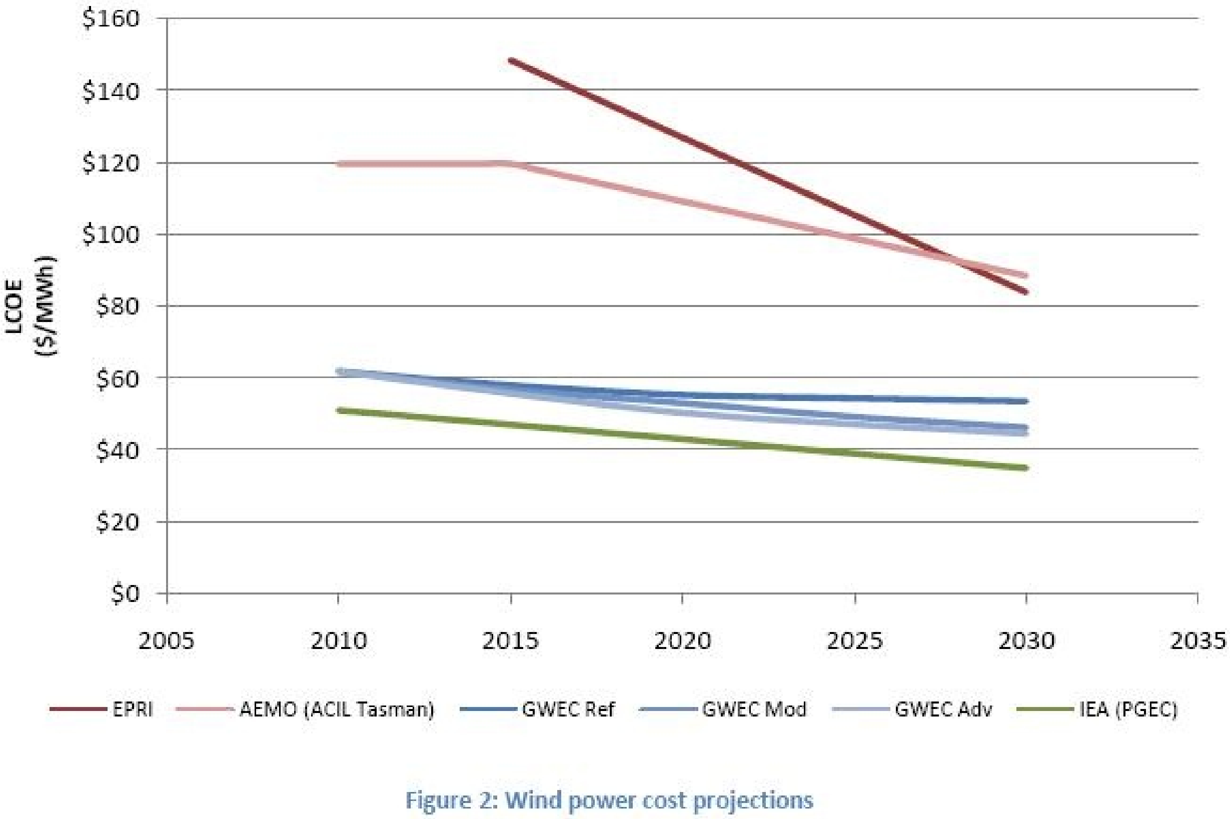

Illustration 6: Wind LCOE projections. Source http://www.garnautreview.org.au/update-2011/commissioned-work/renewable-energy-technology-cost-review.pdf

BZE has shown[16] that Australia has enough solar and wind resource that CST+ (60%) and wind (40%)[17] could power almost the whole grid. Taking the individual costs in 2030 as $120/MWh and $60/MWh respectively, the expected average cost/MWh would therefore be:

60% x $120 + 40% x $60 = $96

This puts it at the bottom end of the range for coal+CCS, and substantially undercuts CCGT+CCS. It follows that gas+CCS cannot compete with renewables.

Large scale Solar PV is cheaper than CST+, while still having a positive correlation with demand. That

16 http://media.beyondzeroemissions.org/ZCA2020_Stationary_Energy_Report_v1.pdf

17 Recent improvements in wind turbine technology have allowed the split to change to 50/50, bringing the average cost/MWh down to $90.

alone gives it a role in the mix, and it is expected to drop in price more than CST+ or wind. If it achieves $90/MWh then its statistical independence from wind should permit it to displace more CST+ than wind, bringing the average cost down a little more.

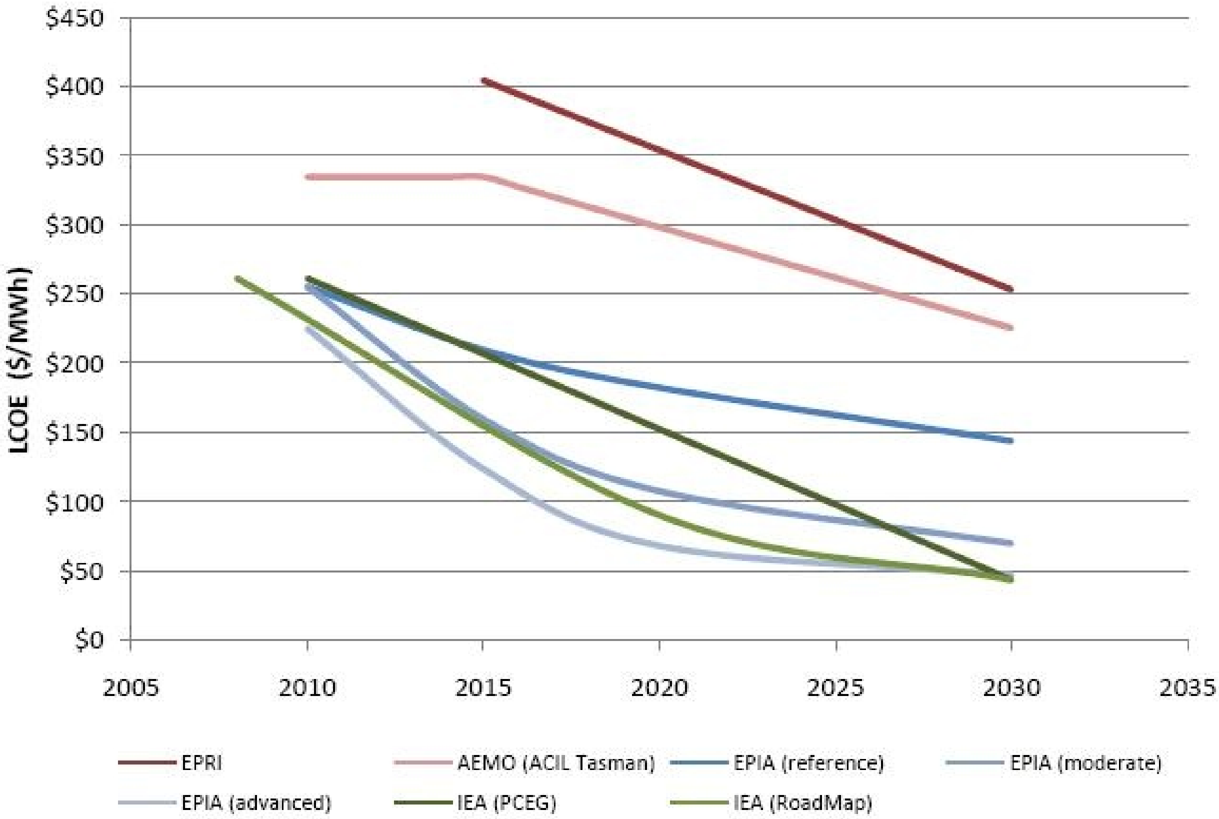

Figure 1: Solar photovoltaic cost projections (Direct Normal Irradiation = 2445 kWh/m2/yr)

Illustration 7: LCOE projections for Solar PV. Source http://www.garnautreview.org.au/update-2011/commissioned-work/renewable-energy-technology-cost-review.pdf

6 Glossary

1 Petawatt (PW) = 1000 Terawatts (TW) = 10^6 Gigawatts (GW) = 10^9 Megawatts (MW) = 10^{12} Kilowatts (kW) = 10^{15} Watts

Term	Description
ACIL Tasman	An economics consultancy
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
BZE	Beyond Zero Emissions, a Melbourne-based not-for-profit
CCGT	Combined Cycle Gas Turbine, a baseload power technology
CCS	Carbon Capture and Storage
CST	Concentrated Solar Thermal
CST+	Concentrated Solar Thermal with molten salt storage (aka CSP+), a dispatchable power technology
EPIA	European Photovoltaic Industry Association
EPRI	Electric Power Research Institute (US)
EV	Electric Vehicle
Gen-tailer	A commercial enterprise that both generates and retails electricity
GWEC	Global Wind Energy Council
IEA	International Energy Agency
IPART	Independent Pricing And Regulatory Tribunal
LCOE	Levelised Cost of Electricity
MRET	Mandated Renewable Energy Target
NOAA	National Oceanic and Atmospheric Administration (US)
OCGT	Open Cycle Gas Turbine, a dispatchable power technology
PV	Photovoltaic
REC	Renewable Energy Certificate
RET	Renewable Energy Target