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## Centre for Climate Economic & Policy

# Emissions pricing, 'complementary policies' and 'direct action' in the Australian electricity supply sector: 'lock-in' and investment

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**Abstract**

In Australia, carbon emissions pricing is politically contentious. The current Labor government has implemented such a scheme, but the Liberal National Party (LNP) opposition has pledged to repeal the scheme should it be elected. This article accepts the well-established position of emissions pricing as the core and least-cost approach to reducing greenhouse gas emissions. Its main focus is on examining and rebutting some recent LNP arguments to the contrary, notably in regard to the electricity sector under Australian conditions. In so doing, the article considers the problem of 'locked-in' carbon-intensive generating capacity, as highlighted by the IEA. As such, it focusses on use of price signals to reduce carbon intensity of electricity generation and also examines the role of passed-on price in encouraging end-use savings of electricity, including more energy-efficient end-use. Both of these mechanisms can be reinforced by well-designed 'complementary policies'. These two examples of the price mechanism's effectiveness demonstrate longer run impacts of prices and price expectations on investment decisions. This emphasis is appropriate given the context of catastrophic climate change as a long run phenomenon, albeit one also requiring urgent mitigating action in the shorter run.

**Keywords**

Emissions pricing; complementary policies; carbon ‘lock-in’; electricity sector; Australian climate policy options

**JEL Classification**

D62; D81; E27; H23; L71; L94; P46; Q41; Q42; Q54; Q58

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# Emissions pricing, 'complementary policies' and 'direct action' in the Australian electricity supply sector: 'lock-in', investment and other long-run policy issues

Barry Naughten[1]

## Abstract

In Australia, carbon emissions pricing is politically contentious. The current Labor government has implemented such a scheme, but the Liberal National Party (LNP) opposition has pledged to repeal the scheme should it be elected.

This article accepts the well-established position of emissions pricing as the core and least-cost approach to reducing greenhouse gas emissions. Its main focus is on examining and rebutting some recent LNP arguments to the contrary, notably in regard to the electricity sector under Australian conditions.

In so doing, the article considers the problem of 'locked-in' carbon-intensive generating capacity, as highlighted by the IEA. As such, it focusses on use of price signals to reduce carbon intensity of electricity generation and also examines the role of passed-on price in encouraging end-use savings of electricity, including more energy-efficient end-use.

Both of these mechanisms can be reinforced by well-designed 'complementary policies'.

These two examples of the price mechanism's effectiveness demonstrate longer run impacts of prices and price expectations on investment decisions. This emphasis is appropriate given the context of catastrophic climate change as a long run phenomenon, albeit one also requiring urgent mitigating action in the shorter run.

## Introduction

As to important objectives regarding the mitigation of climate change by reducing greenhouse gas emissions, the Liberal-National Party (LNP) Coalition's committed[2] policy approach in some important respects resembles that proposed and implemented by the Labor Government[3]. Notably, this is true insofar as both seek to meet the so-called 'unconditional' national emissions target by 2020, that is, 5 per cent below 2000 levels by that year, where the business as usual level would be 20 per cent higher than in 2000 (DIICCR&TE 2013).

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[2] Some backers of the Coalition continue to oppose mitigating climate change. An example is the Melbourne-based *Institute of Public Affairs* (Kelly 2013) which has proposed that a Coalition Government should

> repeal the carbon tax, *and don't replace it*. It will be one thing to remove the burden of the carbon tax from the Australian economy. But if it is just replaced by another costly scheme, most of the benefits will be undone. (emphasis added)

The IPA has consistently opposed policy action to mitigate climate change and has been especially harsh about the use of 'command and control' methods to do so. This is interesting given the LNP has rejected a market instrument as the core element of its abatement policy. The IPA has also sponsored visits by the prominent US 'climate sceptic', Patrick Michaels (Oreskes & Conway 2008). See also Moran (2011); Naughten (2011b).

[3] That is, as supported over the period 2010 to 2013 by the Greens and independents. For convenience, the entity of the minority Labor Government in concert with the Greens and a majority of House of Representative Independents over the period 2010-2013 will be referred to here as the Labor Government's policy

There are some subsidiary differences about objectives. For the Coalition, these reductions would all be from mechanisms operating within Australian territory rather than relying partly on reducing overseas emissions through the mechanism of internationally tradable emissions permits central to the Labor approach. Second, the LNP has also not yet committed to a 'conditional' target that would come into play later given some minimum level of international commitment. In this regard, the Labor Government position is 15 or 25 per cent below 2000 levels by 2020, and 80 per cent below 2000 levels by 2050[4].

Centrally relevant to the extent of international commitment are those of major countries such as the US, China and EU member-states acting collectively. For example, the Obama Administration, though hamstrung by Congressional opposition to emission pricing, has recently re-committed to the equivalent of a 21 per cent reduction relative to 2000 levels by 2020.

Increasingly 'ambitious' national emissions targets are all-important, but between the two major political parties there are some significant differences as to means, or policy instruments, toward these apparently not so dissimilar objectives. These differences as to means can be important because they impact on the ease with which targets can be met ─ hence legitimate concerns about both the *cost-effectiveness* and the *fairness* of alternative policy instruments, including compensatory measures.

Thus, for the incumbent Labor Government, a wide range of policies are proposed but its core approach is based on the pricing of greenhouse gas emissions[5], this approach being widely accepted within the international economics community as the most cost-effective approach to reducing emissions[6]. Australia introduced a price on carbon on 1 July 2012 (DIICCR&TE 2013). The Labor Government also presents a range of other policies, some at least of which can be viewed as 'complementary' to that core emissions pricing approach.

By contrast, the LNP in Opposition has rejected the Labor Government's core approach of pricing emissions. Its proposed alternative core approach is one that relies on its so-called 'direct action plan'[7].

The present paper does not purport to be a comprehensive comparison of these two policy approaches. Rather, its first purpose is to consider two arguments put forward by the Coalition intended to discredit the approach of emission pricing under Australian conditions. These arguments specifically relate to the electricity supply sector[8].

The Coalition's first such argument is that emission pricing will be ineffective in changing the carbon intensity of electricity generation because the evidence is that such pricing will not significantly change the 'merit order' of generation from existing power stations. Its second argument is that to the extent that higher costs due to emission pricing are passed on to the

[4] http://www.climatechange.gov.au/climate-change/greenhouse-gas-measurement-and-reporting/australias-emissions-projections/national

[5] The documentation of this core policy of pricing emission is not especially transparent. The appropriate reference would seem to be DIICCR&TE, 2013).

[6] On the Pigovian tax and the carbon tax in particular, see Mankiw (2009), Frank (2013); on tradable emissions permits see Tietenberg (2003).

[7] For details of the plan, see Hunt (2010). The policy, said to cost $3.2 billion, has been somewhat contentious within LNP ranks (Swan 2013).

[8] Notably, the Shadow Minister for climate change, the honourable Greg Hunt, for example, his speech at the ANU, 18 April 2013 as well as his associated written speech and written paper (Hunt 2013a,b,c).

consumer as higher-priced electricity, the consequent reduction in emissions will also be negligible because the evidence is supposedly that the price elasticity of demand for electricity is negligible.

In response, the present paper argues that both of these claims suffer from same limitation, that of failing to take into account the desired longer term consequences of emission pricing.

These longer term effects of pricing emissions are vital in addressing a problem, catastrophic climate change, that is itself long term in nature, that urgently requires a stable policy framework, and that achieves the required emissions at the least cost to the community. In particular, as underlined by the International Energy Agency (IEA 2011, 2012), there is an urgent need to ensure that high emitting generation technologies are not 'locked in', thus making the required emission reductions formidably difficult to achieve in the electricity sector and elsewhere.

This paper begins by examining the Coalition's claim that emissions pricing is ineffective in reducing emissions from the electricity sector under present conditions. It argues that the prime purpose of emissions pricing rather is to influence investment and retirement decisions over the longer term and hence is also about expectations about the future time-path of emissions. This is illustrated by comparing levelised costs of coal-fired versus gas-fired combined cycle gas turbines CCGTs). A range of related issues are then discussed. These include: the problem, identified by the IEA of allowing the 'locking in' of high emissions technologies; the issue of business confidence and investment uncertainty, including effects of the GFC; Australian circumstances regarding electricity sector emissions vis-à-vis those in the US and the EU; the timing of approaches to a zero emissions electricity sector and the role of intertemporal modelling.

As to 'direct action' policies, the 'in principle' difference between the stances taken by the two major parties may have been exaggerated by both sides for obvious political reasons. The LNP's Direct Action includes policies outside the electricity and broader energy sectors. These policies are not in contention in the present paper.

'Direct action' policies taken together comprise the core approach for the Coalition where emission pricing has from outset been the core approach for the Labor Government. As regards the electricity sector for example, latter's own program also includes policies other than the pricing of emissions. Semantically, these could be described as 'direct action'. However, where designed to be supportive of the core policy of emission pricing, the term 'complementary policies' is used to indicate this supportive role.

The paper enlarges on the conditions under which 'complementary policies' policies can be cost-effective in reducing emissions in the electricity sector. For example, in the Labor Government's approach such policies can be used to reinforce the emission price signals. It is argued here that such reinforcement (which can take a variety of forms) finds an important rationale given that, if the necessary national and international targets are to be met, private investors will need to take account of the long run price path for such emissions and not just their current levels which may be influenced by temporary or contingent factors. On the other hand within the Coalition's approach it might be envisaged that over time the use of sophisticated energy-economic models will render it increasingly possible to construct 'direct action' (or 'command and control') policies that mimic the effect of emission pricing and thereby facilitate an alternative set of approaches to cost-effective mitigation. Whether such 'direct action' policy approaches are supportive of predominantly price-based approaches or informed by such (publicly accountable) modelling, there is a reduced likelihood that such policies will be cost-ineffective 'silver bullets that miss the target'.

Finally, the corollary of the LNP's questionable argument that emissions pricing fails to influence generation mode is that emissions pricing amounts to no more than a tax on electricity. It further argues that such a tax passed on to the consumer is also ineffective in reducing emissions. But to the contrary, econometric studies indicate that the long run price elasticity of demand for electricity is significant. Further, such price-driven effects are likely to become more effective over time as a result of 'complementary policies' such as improved metering and other forms of improving the supply of information to consumers.

Both the failure to recognise longer run impacts on investment choices about generation modes and the long run impacts of price upon electricity demand are symptomatic of an unduly 'short-termist' perspective in abating emissions. The centrally important truth has a paradoxical element: the problem of catastrophic climate change is a long-term one requiring policies that take account of long-run mechanisms such as investment in both generation facilities and in end-use equipment. However, there is also a strong case for the urgency of mitigating action: the long run is a succession of short runs.

**Impact of carbon price on generation mode exemplified by unit costs of gas vs coal**

With respect to electricity generation, the Opposition's focus on immediate effects of emissions pricing rather than longer term considerations was reflected in a claim about 'merit order'. The claim was that emissions pricing under present Australian circumstances did not significantly affect operators' short run choices about the utilisation of existing generating capacity in order to meet instantaneous demand for electricity. However, problem of abating greenhouse gas emissions in order to mitigate climate change is a long term phenomenon. The key mechanisms are about encouraging future investment in low emissions technologies, and about the phasing out or retirement of older high Carbon emissions and often 'dirtier' (higher toxic and/or greenhouse emissions) power stations and technologies such as Latrobe Valley brown coal.

By contrast, 'merit order' decisions reflect short term considerations only. These include availability (including start up times) of existing installed plant and of its primary energy source (including wind and solar energy as well as fossil fuels) as well as operating costs, including fuel costs. Costs associated with investment in additional plant are not immediately relevant to this choice. However, along with emission characteristics, these investment costs do become centrally relevant to a long run task of reducing CO2 emissions over future years and decades at least cost, suitably discounted over time.

These investment costs are significantly diverse among technologies. For example, on a per kW installed basis, the capital cost associated with new brown or black coal-fired capacity is double to triple the investment cost per kW of new combined cycle gas turbine capacity (CCGT); say, \$2000/kW compared with \$800/kW.

In this longer term context, and at full capacity, the relevant economic comparison is between the full unit costs of electricity from additional CCGTs) and equivalent costs of electricity from coal-based capacity. To illustrate the comparison, these costs can be expressed in terms of unit levelised cost. In this case the capital cost is reflected in component of the unit charge that will meet that cost over the lifetime of the plant at the specified rate of return. The higher the rate of return required, for example to cover perceived risk, the higher this capital charge component.

An intermediate case would be where there is a large surplus of existing coal-fired capacity. In this case an investment decision might involve a comparison between the fuel cost inclusive of carbon price from the existing coal fired capacity versus the unit cost of a new gas-fired CCGT including both capital charge and fuel costs inclusive of the carbon price.

This investment test will be difficult to pass if there is significant underutilised existing coal-fired capacity. This represents the problem of ‘lock in’, discussed below. However, as also considered below, it is not only the current price of carbon that is relevant to such an investment decision but the future path of such decisions. The impact of this future price path on the investment choice is not so easily represented in a simple unit cost calculation.

Table 1 indicates representative levelised unit cost calculations. Purely for illustrative purposes[9] unit costs associated with gas (CCGT) are compared with those for coal-fired capacity. These are often considered rival technologies in providing base-load electricity.

The alternative assumptions include the capital charge component both included and excluded; at two different required rates of return on capital (5 per cent and 10 per cent) and with CO2 priced at zero and at $20/tonne). It can be argued that risks borne by private investors are such that the higher required rate of return is applicable (Dixit and Pindyck 1994; Naughten 2003).

The carbon intensity assumptions clearly favour CCGT over black coal (and even more so, brown coal) reflecting two distinct effects: the relatively lower carbon intensity of natural gas and the better energy efficiency of CCGTs relative to coal-fired power stations. This differential could be eroded if the gas is sourced in ways that involve fugitive emissions of the greenhouse gas, methane.

It can be seen that at this unit cost for CO2 and inclusive of the capital charge, CCGTs are clearly more cost-effective at a 10 per cent required rate of return and approximately the same at the 5 per cent rate. At a carbon price of $25/tonne and above the margin in favour of CCGTs and against new coal-fired plant will obviously expand. In reality, and given plant-life times of 30-40 years, the price of CO2 can be expected to rise considerably above these rates to the advantage of CCGTs in any comparison with new coal. By contrast, if only operating costs including fuel costs are considered as in choices about merit order or the supply of electricity from existing plant then at these assumed fuel prices CCGT does not have a cost advantage over coal, even with CO2 priced at $20/ tonne.

[9] Note that the unit costs indicator when used for various forms of renewable generation (such as wind power, solar thermal, photo-voltaics) is not well suited to the ‘stand alone’ assumptions made here. These renewable but often intermittent technologies need to be evaluated in the context of modelling particular total systems so that ‘capacity credits’, local climatic conditions etc. are properly taken into account. For a wider comparison, see AETA (2012). For earlier examples of such evaluations, see Naughten (2003) and Naughten and Noble (2001). For a discussion of the issue of ‘capacity credit’ associated with intermittent technologies, and the so-called ‘base-load fallacy, see Diesendorf (2010).

| Table 1. Levelised unit costs: Indicative comparison of gas-fired CCGT versus coal-fired | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fuel type | gas | coal | gas | coal | gas | coal | gas | coal |
| Carbon price ($/tonne CO2e) | 25.0 | 25.0 | 25.0 | 25.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Emissions intensity **a** | 0.40 | 1.00 | 0.40 | 1.00 | 0.40 | 1.00 | 0.40 | 1.00 |
| Return on capital (%/year) | 5 | 5 | 10 | 10 | 5 | 5 | 10 | 10 |
| Fuel price ($/GJ) | 6.0 | 1.0 | 6.0 | 1.0 | 6.0 | 1.0 | 6.0 | 1.0 |
| Overall efficiency (dim.) | 0.55 | 0.40 | 0.55 | 0.40 | 0.55 | 0.40 | 0.55 | 0.40 |
| Capital cost ($/kW) | 800 | 2000 | 800 | 2000 | 800 | 2000 | 800 | 2000 |
| Unit generating cost ($/MWh): | | | | | | | | |
| Fuel cost only | 39.3 | 9.0 | 39.3 | 9.0 | 39.3 | 9.0 | 39.3 | 9.0 |
| Capital charge | 5.1 | 12.7 | 10.1 | 25.4 | 5.1 | 12.7 | 10.1 | 25.4 |
| Total (excl. carbon price) | 44.3 | 21.7 | 49.4 | 34.4 | 44.3 | 21.7 | 49.4 | 34.4 |
| Carbon component of price | 10.0 | 25.0 | 10.0 | 25.0 | 20.0 | 50.0 | 20.0 | 50.0 |
| Total (incl. carbon price) | 54.3 | 46.7 | 59.4 | 59.4 | 64.3 | 71.7 | 69.4 | 84.4 |
| Total (incl. carbon price, excl. capital charge) | 49.3 | 34.0 | 49.3 | 34.0 | 59.3 | 59.0 | 59.3 | 59.0 |

Source: calculated for this paper. **a** tonne CO2e/MWh.

Operation and maintenance costs are excluded from this simplified analysis but are somewhat higher for the coal-fired plant (see Appendix 1). Capacity factor is 90 per cent.

See *Australian Energy Technology Assessment* Report, Bureau of Resources and Energy Economics (BREE), Canberra (for estimates of the existing and projected cost of primary fuels by States AETA, 2012: 23-24) and for levelised costs for a very wide range of electricity technologies under Australian conditions, including renewable technologies and carbon capture and storage options. Based on AETA findings, the Appendix 1 to this paper also indicates selected comparison between black coal, brown coal and CCGT technologies with and without the pricing of emissions at an indicated rate.

Summarising the above indicative results, Table 2 indicates the ratio of unit costs for the gas-fired CCGT to the unit costs from the coal-fired plant, both including the capital charge (relevant to the investment decision) and omitting the capital charge (relevant to the merit order decision in operation of plant already installed).

| Table 2. Ratio: unit cost gas-fired CCGT vs coal | | | | |
|---|---|---|---|---|
| Carbon price ($/tonne CO2e) | 25.0 | | 50.0 | |
| Return on capital (%/year) | 5 | 10 | 5 | 10 |
| Total (excl. carbon price) | 2.05 | 1.44 | 2.05 | 1.44 |
| Total (incl. carbon price) | 1.16 | 1.00 | 0.90 | 0.82 |
| Total (incl. carbon price, excl. capital charge) | 1.45 | 1.45 | 1.00 | 1.00 |

We see from this table that, on these particular assumptions, at carbon price of $25/tonne CO2 there is a break-even point for coal and gas on these particular assumptions when the capital charge is included and when the required rate of return on capital is 10 per cent. That is, the unit cost of CCGT is less than that for new coal for any carbon price in excess of $25 / tonne. When the price of carbon reaches $50/ tonne the ratio is 0.82 at the 10 per cent rate of return. Under these assumptions about fuel cost and at this price of carbon there is a break-even point even with respect to just the merit order choice.

The above calculations based on levelised costs for just these two types of power station can be supplemented by the extensive calculations of AETA (2012). A selection of these results, for variants of the same two basic technologies, is reproduced in Appendix 1.

**The urgent need for climate mitigation and the problem of 'lock in'**

As identified by the IEA, a major problem for effective emission reduction is indeed one of being 'locked in' to the existing set of electricity generating assets (IEA 2012: 25, 159, 184, 241, 261-6). Referring to the global situation the IEA comments (2012: 241) that

> Some 81% of the total CO2 emissions allowable over the *Outlook* period in the 450 Scenario is already locked-in with the existing energy infrastructure. The scope for reaching the 2°C goal is accordingly severely constrained. If global co-ordinated action to reduce CO2 emissions is not taken before 2017, the infrastructure existing at that time will account for all the remaining CO2 emissions allowable up to 2035 in the 450 Scenario.

This 'lock in' effect will occur unless mechanisms are put in place so that new and high capital cost coal-fired power stations are not installed in the first place. The future installation of such high carbon-intensive technologies must be deterred by the *prospect* of higher and rising emissions taxes in the future, sufficient to insure that given emission targets are met over time.

This is the first reason for policy urgency and against a deferral or wait-and-see approach. A second concern refers to arguments about more imminent 'tipping points' regarding certain climate mechanisms even though the full working out of those effects may be longer term[10].

The immediate effects of emission pricing on the level of emissions from an electricity generating system will depend on the pattern of its operation and of required capacity investment and retirement. At one extreme would be a system with an excess of generating capacity installed, much of it coal fired and with slow growth in expected demand. Such a system might require very high current emission prices in order to stimulate investment in new low emissions technology. Both the US[11] and Australian systems have some of these features due to excessive[12] investment on coal-fired electricity generating plant in the 1980s and given plant lifetimes in the vicinity of 30-40 years. In other words, significant 'lock in' has already occurred during this period. Whether CO2 pricing is the chosen policy instrument or not, this means that the immediate scope for reducing CO2 emissions by changing generation modes will be limited in the medium term, except to the extent that units generated increases over time as a result of factors like rapid population and GDP growth,

[10] One example is that of melting tundra in Arctic regions, resulting in ultimate release of massive amounts of the greenhouse gases methane and carbon dioxide previously held in a frozen state, but in respect of which the 'tipping point' or point of irreversibility may occur in the next few decades (Schaefer *et al*., 2011).

[11] The lumpiness and long-lead times associated with coal-fired capacity mean this technology is especially vulnerable to unrealised expectations. Much of this over-building of coal-fired capacity occurred in the 1980s, before concerns about emissions-induced climate change became a significant constraint in the minds of the public, governments and investors. Other reasons included: the 1970s hike in oil prices that precluded the future use of oil in electricity generation and induced fuel switching toward coal; the sharp cutback in nuclear plans due in large part to Three Mile Island (and later, Chernobyl); a prejudice against use of natural gas (viewed as a premium fuel) in electricity generation in a period that preceded development of highly efficient combined cycle gas turbines (CCGT). In Australia, such over-building was associated with an unfortunate 'resource boom' mentality that resulted in subsidised electricity to new aluminium smelters where owners claimed that otherwise they would invest elsewhere. That these grandiose plans were not fully realised again contributed to the state being left with the burden of excess capacity in coal-fired electricity generation.

[12] As indicated in a later section, despite the US system being well supplied with coal-fired capacity, its recent experience has been one of significant retirement of older, dirty coal-fired capacity, little or no new coal-fired capacity and of significantly falling CO2 emissions as a result of a rapidly growing share of electricity generated from new, gas-fired CCGTs fueled with very low-priced natural gas much of it from non-conventional sources. This has occurred despite the absence of any price on emissions.

absorbing existing generation capacity and so accelerating the need for investment in new capacity.

Does this mean that emission pricing is ineffective in transforming the electricity sector in cases where significant lock-in has already occurred? Several arguments strongly indicate otherwise.

First, while the *immediate* scope for cost-effective emission reductions from such an electricity sector may be limited, this will be the case *whatever* policy instruments are used. The existence of coal-fired capacity already locked in is not an argument against emission pricing and in favour of 'direct measures'. For example installation of (say) large amounts of solar thermal by 2020 would also be at high cost to the extent it meant failing to utilise existing capacity. This means 'high cost' relative to use of emission pricing to bring about economy-wide attainment of given targets. This may mean that immediate domestic emission reductions within an overall least-cost framework will be to a greater extent from sources other than changes in mode of electricity generation. This in no way invalidates the principle of emissions pricing as the core approach.

Second and most importantly, as noted above, it is not only the current price of CO2 that is relevant but its future price path in the expectations of investors. Over the next 10-15 years, the requirement for new electricity generating capacity will emerge and it is essential that CO2 be sufficiently priced to ensure the choice of low-emissions technologies in the sector as well as cost-effective retirement of older polluting capacity. 'Complementary' direct action policies such as banning both new and refurbished coal fired capacity are an essential part of a package of responses operating in part to reinforce future carbon price expectations.

Third, the particular system of emission pricing introduced by the Gillard Labor Government involves internationally tradable emissions permits. This means that the Australian system can cost-effectively promote immediate abatement of CO2 from electricity systems of other national economies where new investment would otherwise increase CO2 emissions, as in China and India. For a recent account of abatement action by both China and the US see Climate Commission (2013) and Garnaut (2013).

**Business confidence and investment uncertainty**

In the *investment* decisions as between electricity-generating technologies, the inter-related questions of business confidence and investors' expectations are centrally relevant. This is all the more so given the macro-economic context characterised both by continued global economic crisis (the GFC), and about uneven levels of compliance internationally with greenhouse emissions constraints. This is about the future pricing of greenhouse gas emissions as influenced by the politics and science of global climate change. If signals are absent or misread, the consequences can include 'wasted capital and stranded resources' (Carbon tracker 2013).

As previously noted, Dixit & Pindyck (1994) argue the relevance of risk premiums that are on the high side, reflecting options forgone by taking 'irreversible' investment decisions precipitately rather than deferral and wait-and-see approaches. This suggests required real rates of return of 10 per cent over one of 5 per cent. As already noted, such a preference would tend to favour technologies that are less capital-intensive such as CCGTs. However, considerations of risk also favour technologies that are more modular (scale economies at lower unit sizes) and with shorter planning and construction lead-times that again favour technologies such as CCGTs, wind and PVs. Because these technologies can be tailored to emerging growth in demand the problem of lock-in as occurred with coal-fired capacity in the 1980s is less evident. Further, the more modular technologies are more compatible with policies promoting end-use savings effort because investment in these less lumpy technologies with shorter lead-times can better track the course of consumer demand over the investment period.

An obvious major source of investment uncertainty arises from the lack of consensus and clarity concerning the climate mitigation policy and emissions pricing itself. Such uncertainty could reduce investors' willingness to finance and construct 'greener' technologies such as CCGTs, renewable electricity generation, and end-use efficient appliances. Uncertainty about Australia's carbon emissions price and implications for investment has been researched by Jotzo, Jordan and Fabian (2012) by means of surveying experts. In its main summary finding these survey results suggested (p. 403) that

> the community of experts that is close to or even directly involved in decisions about carbon-intensive investments and their alternatives does not have reliable information about the policy outlook and future market developments. This could have profound implications for the extent and nature of investments that will be made.

Importantly, this comprehensive and detailed report concluded (p. 405) that

> Uncertainty about future carbon policy has dogged Australia's investment community for years and it is set to continue amidst a deep political division in Australia between parties supporting carbon pricing and parties rejecting it. The continuing uncertainty is likely to have adverse impacts on investment decisions, particularly in Australia's electricity supply sector.

Arguments for interpreting emissions pricing as either carbon taxes or as cap-and-trade are outside the scope of this article. However an important consideration in this choice is also about business confidence and dealing with uncertainty. This problem is a central concern in the writings of Warwick McKibbin and Peter Wilcoxen (2002: 69-73). These authors point out that it is possible and necessary to devise 'hybrid' schemes that draw on both approaches, for example making use of floor prices and ceiling prices. This indeed is a feature of the Scheme introduced by the Labor Government[13]. As noted below, one approach to making the two approaches can be made compatible is through sound economic modelling so as to better understand emission price levels necessary to achieve given targets over time.

Another relevant uncertainty is about the future price of Australian natural gas fed into new power stations. For purposes of the above calculations, prices of \$6/GJ have been assumed for gas and \$2/GJ for coal. The current price of natural gas internationally is highly specific regionally, from as low as \$3/GJ in the US due to the boom in natural gas from shale to \$18/GJ in Europe, Japan and China where there are currently supply constraints and high demand pressures due in part to the trend away from nuclear post-Fukushima. However, this price imbalance is likely to be relieved over time by augmenting the supply of gas from other sources including future shale-based LNG from the US, piped natural gas from Central Asia and the Middle East, augmented Russian supplies, and indigenous shale sources, for example in Poland (Michta 2012) and in China (Jianliang Wang *et al* 2013).

Prolongation of the 2008 GFC, including its impacts on the Australian economy and long term budget planning, have had major impacts on climate policy. These include reducing both emissions and emission prices, but also in reducing general tax revenues and hence expanding budget deficits. The same circumstances reduce immediate budget revenues from

[13] Originally this involved a floor price of \$15/tonne with a ceiling price originally set at \$29/tonne [UPDATE]. but in the face of declining global economic growth this latter rate has been reduced to the (currently) low rate applicable in the EU cap-and trade system. By March 2012, and for similar reasons McKibbin had recommended an initial price reduced to less than \$10/tonne. …

a broad-based emission taxes but also tend to preclude 'direct action' policies based on subsidies.

The depth of the global crisis also brings into play 'Keynesian uncertainty' (Skidelsky 2011) and a strengthened case for policies designed (in part) to boost short run aggregate demand to relieve the effects of such a prolonged recession. There is no reason why such expansionary policies should exclude fiscally responsible 'green investment'[14] that enhances long-run productivity as well as being ecologically sound.

The problem of Keynesian uncertainty and its particular relevance in a macro-economic slump is beyond the scope of the present paper. However, one set of policy problems that arises regarding the pricing of emissions is that of compensation to losers (including emissions intensive forms and lower income electricity consumers) and the design and financing of structural adjustment policies (for example to employees in coal-electricity regions). There may be good political and economic arguments for coherent and cost-effective structural adjustment policies. However, Professor Ross Garnaut had commented that the previous CPRS[15] included 'an overly generous deal for business secured by a massive lobbying exercise by vested interests' (Alexander 2008). This suggests that hard decisions must be made about the merits of compensating firms for not taking seriously the prospects of emission pricing that have been on the public policy agenda now for approaching 25 years[16]. Such 'overly generous payments' could significantly erode a viable emissions mitigation policy. The more general notion of tax concessions and all kinds of favourable treatment to firms as a mode of bolstering business confidence when that is under threat is a fraught one for modern economies, as has been discussed in depth by Amit Bhaduri (2012).

## Australian *versus* the US experience, and expectations

Australian stationary energy emissions

Projections of Australian stationary energy emissions, with and without emission pricing are indicated in Figure 1. These estimates may be unduly pessimistic (Jotzo 2012).

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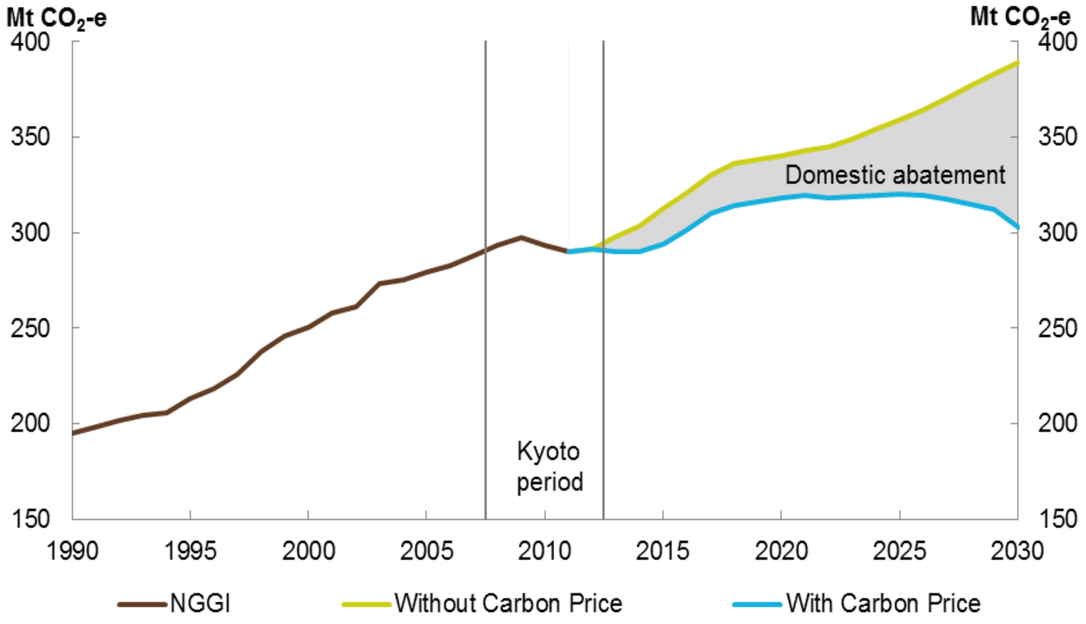
[14] A recent Australian example of 'green investment' largely motivated by the Keynesian principle of maintaining aggregate demand in a time of (global) recession was the no doubt the Rudd Labor Government's 'Home Insulation Program' of 2008-09. This case could also be regarded as exemplifying a means of reducing CO2 emissions through a form of either 'direct action' or 'complementary program'. Unfortunately, this no doubt basically sound program came to grief for a range of bureaucratic and political reasons discussed by Hawke (2010) and Lewis (2012) and Parker (2013).

[15] The Carbon Pollution Reduction Scheme (CPRS) had been the predecessor to the present Government's Carbon Pricing Policy (DIICCR&TE 2013).

[16] Indeed, during the period 1990-92, the Australian Government (along with other governments around the world was taking seriously and supporting economic modelling of the so-called 'Toronto target' for carbon emissions (for example, Jones, Peng and Naughten 1994). This emissions target was far more stringent as to both targets and timing that those now in contemplation, and aroused significant community interest.

**Figure 1. Australian stationary energy emissions projection**




Source: Figure 13: DCC&EE 2012

…

<u>Emissions from the United States electricity sector</u>

Given Congressional opposition up to the present, it has not been possible for US Federal Administrations to implement the cap-and-trade carbon markets that had been foreshadowed by both Presidential candidates in the 2008 elections, although some states have schemes in place (Climate Commission 2013).

Despite this limited policy progress, the most recent U.S. *National Energy Outlook 2013* (US DOE EIA) reports a marked reduction in national CO2 emissions since 2005 and this level of emissions is not expected to be exceeded over the period projected as far ahead as 2040 (see figure 2).

This slackening in business as usual emissions growth is explained by a number of factors.

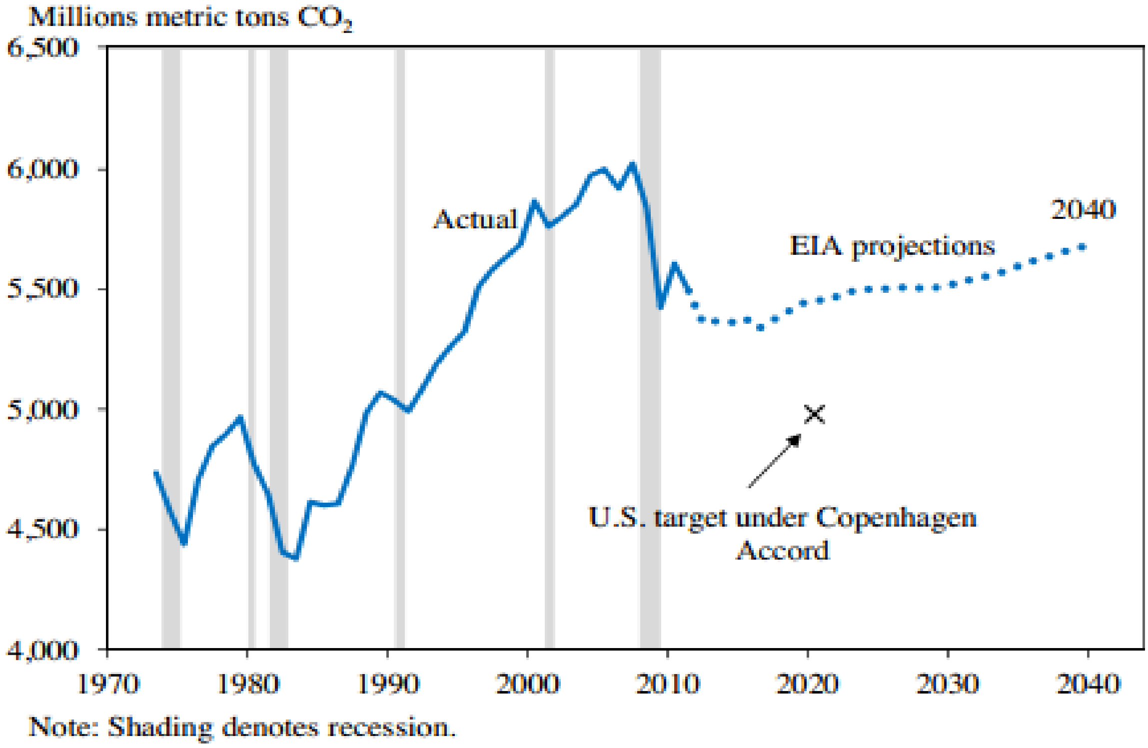
These include that the US Environment Protection Agency (EPA) has required the scrapping of older and more polluting coal-fired capacity; reduced rates of GDP growth since 2008, continued de-industrialisation. A crucial factor has been availability, for the time being at least, of relatively low priced natural gas much of which is from shale and used in new fuel efficient CCGTs. By international standards, current US gas prices are at very low levels (<$5/GJ). This is about a third of European and Japanese levels more closely linked to an incompletely developed international market in natural gas. This 'anomaly' about very cheap indigenous gas from shale is likely to be corrected early in the period to 2040 as US exports of LNG come into play.

Again, it is important to note that the differential favouring natural gas over coal is partly dependent on the assumption that fugitive methane has been sufficiently reduced or eliminated. This is of special concern regarding gas from non-conventional sources (Howarth, et al. 2011; Wigley 2011)

More recent data from the US (see Figure 3) indicates a recent resurgence power generation for coal-fired sources back to around 40 per cent. This suggests that reliance on temporarily low gas prices and presumed continued reduction in coal may not be enough to project emissions stabilisation, not to speak of the much sharper reductions actually required[17].

It is against this background that President Obama released his Climate Action Plan of June 25, 2013.

**Figure 2. US Energy-Related Carbon Dioxide Emissions, 1973-2040**




Source: EIA, 2012; CEA 2013: 195

Impact of Obama's 'Climate Action Plan' (June 2013)

In the latest response to this political constraint President Obama on June 25, 2013 presented a 'Climate Action Plan'. In the enforced absence of carbon emissions pricing, the policies include many regulatory and other initiatives (Plumer 2013). In regard to electricity generation and consumption policies include:

a. directing the Environmental Protection Agency (EPA) to complete (by 2015) carbon pollution standards for not only new power stations and but existing ones
b. setting a goal to double renewable electricity generation by 2020, thereby repeating the achievement since 2008.
c. increased funding for RD&D in electricity generation
d. new end-use efficiency programs

[17] In noting the problem of 'locked in' coal-fired power stations in the US and elsewhere, Michael Levi, a scholar attached to the US Council on Foreign Relations (2013) notes

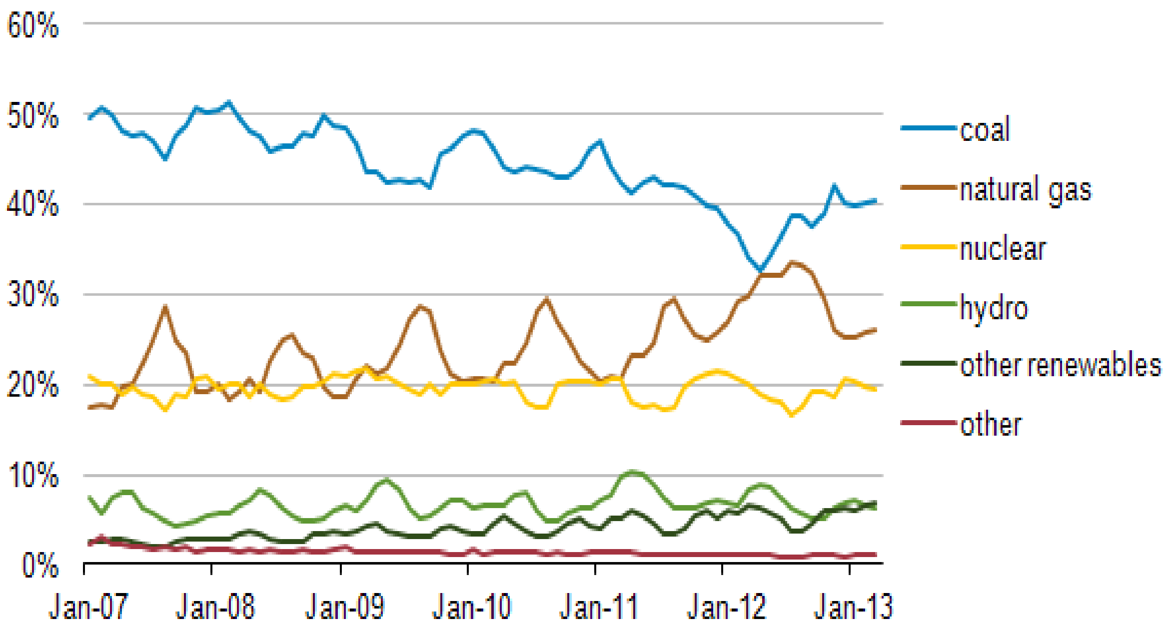
> In May 2012, fracking briefly spurred gas to pass coal as the top source of U.S. electricity. But as natural gas prices recovered, coal regained its top rank, a position most expect it to retain for decades to come. That won't cut it if we're going to seriously tackle climate change. To be certain, cheap gas makes it less expensive to cut our emissions, by shifting away from traditional coal. But we'll still need governments to step in and tip the balance, whether through new regulations or a price on carbon that gives gas an advantage over coal.

With a focus on older, existing and ‘dirty’ coal-fired capacity action under policy (a) could be viewed as addressing the problem of ‘locked in’ coal-fired capacity.

Are these measures to be viewed as forms of ‘direct action’ (as claimed by Hon. Greg Hunt 2013) or are they ‘complementary measures’? More accurately they can be viewed as ‘second best’ policies given that the optimum policy of US Federal emission pricing is ruled out for now on political grounds. As discussed above, in the hypothetical presence of emission pricing such measures as (a) could also have a role as ‘complementary policies’ having a reinforcing effect, especially having regard to a future rising path of emission prices.

According to the ‘Climate Action Plan’, these and other policy instruments are designed to achieve a US national commitment to a 17 per cent reduction of annual greenhouse gas emissions by 2020, relative to 2005 levels, corresponding to the US’s commitment under the Copenhagen Accord (see Figure 2) . This reduction is equivalent to 21 per cent relative to 2000 levels (Obama 2013). This compares with an Australian 2020 target of 5 per cent reduction relative to 2000 (unconditional target for both ALP and NCP) and up to 25 per cent reduction (in ALP policy conditional on sufficient international action). The achievement of such a target by the US (with or without emission-pricing) would go far to encouraging Australia to strive for a comparable target by 2020-25.

**Figure 3 US monthly electric power generation, Jan 2007 to March 2013** (per cent share)
Resurgence of coal-fired electricity




Source: EIA 2013, U.S. Energy Information Administration, Electric Power Monthly.
Note: Other includes petroleum, purchased steam, non-biogenic municipal solid wastes, batteries, and other sources of electric generation.

## Electricity sector emissions in the European Union

In the EU’s tradable emissions scheme, the carbon price has fallen to very low rates, less than \$5/ tonne CO2. This is in part because emission levels have sunk as a result of the severe economic downturn, but EU-wide emission targets have not become more ambitious over the same period. Existing emission trading arrangements would seem to have precluded a policy opportunity to increase this level of ‘ambition’ The low price on emissions has prolonged the life of existing coal-fired capacity and even allowed new construction given the self-imposed limits on new nuclear capacity. The EU move back to coal-fired capacity is encouraged also by import of low cost coal from the US made available by the trend to gas-fired capacity noted above. Phasing out of nuclear power post-Fukushima is also a factor. However, a trend to gas-fired capacity in the EU could be encouraged by more competitive natural gas market as gas supply is augmented from a variety of sources including shale (for example, in Poland) and imported from the US as LNG, again based on shale, as well as conventional gas from new sources such as Central Asia and even Iraq and Iran. But all these sources assume environmental and safety concerns are addressed (IEA 2011).

On the basis of this EU experience, Helm (2012a,b) has argued that 'instead of the low, volatile and short-term price produced by the European Union's Emissions Trading Scheme, we need a long-term stable and rising price — a carbon tax'.

Another uncertainty facing investors and electricity suppliers is about the future growth in the consumption of electricity. Reminiscent of the 1980s electricity demand is falling short of earlier long run projections (Palmer 2013)[18]. This reduction in electricity demand in recent years compared with forecasts has also resulted in emission levels well below those projected (Edis 2013b).

**'Complementary' policies and 'direct action'**

In rejecting emissions pricing as its core approach, the Opposition's climate change policy substitutes instead makes its core approach what it refers to as 'direct action' (Edis 2013a). The Government's position also includes a range of regulatory and also other approaches, market-based and otherwise, but its important claim is that these approaches are designed to 'complement'[19] its own core approach of emission pricing.

Although the Coalition's policy centres around 'direct actions' (at least rhetorically) it also has only a limited and budget-capped role for the price mechanism in a so-called 'reverse auction' scheme, consideration of which is outside the scope of the present article. Warwick

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[18] As previously noted, this regard, there is considerable advantage in technologies that are less dependent on economies of scale, are modular and have shorter investment lead-time. These are all areas of advantage for CCGTs as distinct from new coal-fired capacity which is capital-intensive, has long planning and construction lead-times and comes in large units to achieve scale economies.

[19] 'Complementary policies' have been discussed recently in special issue of *Economics and Labour Relations Review* (2012) in papers by Denniss, Grudnoff and Macintosh; Perry & Twomey; Twomey; Spash & Lo. See also Carlson (2011).

Among left-leaning or green-leaning analysts there is a wide range of views about the efficacy of emission pricing (with compensation) relative to direct action. For example, Hahnel's analysis (2012) favours emission pricing, while several articles in the *Journal of Australian Political Economy* of January 2011 tend to favour direct action. 'In principle' features of either approach need to be distinguished from the merits and deficiencies of either approach as applied in particular instances.

Both approaches can be well or badly implemented, and both are subject to distortions arising from the power of vested interests. In regard to direct action, the text focusses on cases of 'client capture among 'silver bullets that miss the target'. However, where compensation is paid to losers in a scheme of emission pricing the danger is that vested interests can receive excessive compensation often failing to take account of reasonable expectation of imminent emissions pricing over at least the last two decades often held at bay by political pressure from these same vested interests. The predecessor of the Government's current scheme of emission pricing was the Carbon Pollution Reduction Scheme (CPRS). Of this scheme, the Government's own key advisor Professor Ross Garnaut commented that the CPRS was 'an overly generous deal for business secured by a massive lobbying exercise by vested interests' (Alexander 2008).

McKibbin (2012) is one who has put the view that with ‘direct action’ policies as the core response there is little prospect of ‘scaling up’ such programs to the extent necessary.

Aside from the question of what constitutes the core response, what are the arguments for (and against) ‘complementary policies’ and ‘direct action’ policies?

A clear cut example of a complementary policy is one that reinforces the expected increasing price path for carbon emissions with bans on new ‘dirty’ coal fired power station. The relevant time intervals include the planning and construction period (varying from 2-10 years depending on technology) and later the life time of the project itself. Based on inter-temporal economic modelling of the costs and consequence of meeting emission targets as these change over time, Governments can indicate the changing shape of this price path and thereby assist in the private and public investment planning process. Given these rigorously based expectations about the future price of emissions, Governments may also reduce the uncertainty faced by investors by introducing regulations such as the banning of new coal-fired power stations and the earlier scrapping of older and more polluting coal capacity.

Such a ban has been put in place by the Labor Government[20]. To be meaningful any such ban would have to encompass any coal-fired power stations on the drawing board and hence not ‘locked in’. Unfortunately, the press comment on this statement indicates this is *not* the case. Similarly, any meaningful definition of ‘dirty’ would need to encompass all new and planned coal-fired power stations except to the extent that these incorporate carbon capture and storage (CCS). This is a technology as yet far from cost-effectiveness but conceivable given a sufficiently high price on carbon. CCS plays a major role in important major scenarios such as those of Stern (2008) and the IEA.

Other examples of complementary policies include support for end-use energy savings. In this case, regulatory policies can correct various forms of recognised market failure that inhibit efficient energy use. To this extent they are remain based on sound ‘social market’ principles. A second such case is about the role of governments in the promotion of R&D in renewable technologies given the inability of innovators to appropriate all benefits. ‘Green energy voucher’ schemes are market-based approaches that take advantage of prospects for ‘learning by doing’. The IEA has warned that the future ready availability of low cost gas should not be allowed to undermine advancement of renewables through such policy regimes.

To promote cost-effectiveness, such complementary policies should be fully open to public scrutiny, rigorously tested against cost-effectiveness criteria etc. As in the case of other forms of direct action there is always a danger that ‘special interests’ and ‘rent-seekers’ can capture the regulatory process and we may be left with policies that resemble ‘silver bullets that miss the target’ (Ackerman 2009: 116-9). One such example is the corn-based fuel ethanol industry in the US, which is supported by a plethora of subsidies, tax-breaks and favourable regulations. As well as its doubtful claims about environmental and other benefits, subsidising ethanol has ‘intolerable effects on food prices and supplies’ (Ackerman 2009: 117)

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[20] A contemporary press report (SMH 2010) read as follows:

> All new coal-fired power stations will have to meet greener standards before they can be built, Prime Minister Julia Gillard has announced.
> Tougher emissions standards will be implemented to ensure energy generation is "cleaner and greener".
> ‘This means that we would never allow a highly inefficient and dirty power station to be built again in Australia," Ms Gillard said in a speech at the University of Queensland in Brisbane today.
> There are 15 coal-fired power stations already on the drawing board around Australia and the new rules will *not* apply retrospectively to these (note emphasis added)

Another category for which forms of regulatory action and direct action, in conjunction with pricing and taxing policies is in regard to greenhouse gases other than CO2. One such example has been refrigerants that are also potent greenhouse gases, including CFCs (now banned), HCFCs and HFCs[21].

**'Zero emissions' policies ─ but when? A case for system-wide intertemporal modelling**

According to the analyses and prescriptions of commentators such as Lord Stern, the attainment of global targets such as 450 ppm of CO2e by a date such as 2050 will require cuts in emissions of the advanced OECD economies that are far more stringent than can reasonably expected of poorer industrialising countries. These OECD cuts might need to be of the order of 90 per cent or more of current levels.

In this context it is indeed appropriate to analyse zero emissions policies for Australia and specifically for its electricity sector. Specifically engineering studies have been undertaken to show the feasibility of 'all renewable' approaches to generating electricity, for example the recent simulation study of Elliston, Diesendorf and MacGill 2012. Another comprehensive '100 Per cent Renewables' study has been the subject of a report by AEMO (2013) selected results from which are reproduced in Appendix 2.

However, it is important conceptually to make clear the distinction between engineering feasibility and economic cost-effectiveness studies. The latter imply the former but not *vice versa*. It is also desirable to undertake studies of the cost-effectiveness of 'all renewable' electricity systems as an extreme case as well as a wide variety of other scenarios that reflect promotion of renewables by means of various mixes of emissions pricing and other approaches.

Some promoters of an 'all renewables' solution in the electricity sector within a much shorter time period, such as 2025, may feel justified in doing so because they regard even a 2 degrees Celsius (450 ppm) global target as presenting too much of a climate risk and seek to meet an even more ambitious target such as 350 ppm[22]. Presumably, they also believe that such action by Australia will tangibly result in parallel extreme action by other countries.

However, the foregoing arguments about 'lock in' imply that the consequent instantaneous scrapping of existing capacity will involve potentially very high costs. The implication is

[21] CFCs (chloro-fluorocarbons), HCFCs (hydro-chloro-fluorocarbons) and HFCs (hydro-fluorocarbons) are man-made chemicals that are also extremely potent greenhouse gases.

Following the Montreal Protocol, CFCs have been banned from use because of damage caused to the Ozone layer in which HCFCS are also implicated. HCFCs and HFCs might also be cost-effectively banned to the extent that alternative, benign chemicals are to hand for refrigerant and other purposes. Currently in Australia, there is a prohibitive import duty on HCFCs. These are not being used in new equipment and total consumption is falling rapidly.

Although HFCs do not damage the Ozone Layer, as noted they are potent greenhouse gases even at low concentrations. Exacerbating this problem, HFCs have been major replacement refrigerants. However, but their price now has a carbon component in Australia. This will encourage a continued increase in replacement refrigerants that are benign in climate change terms. Thus, HCs (hydrocarbons) and ammonia are gaining market share as refrigerants. The EU also taxes HFC as reinforcement to regulating their phasing down. This mechanism will become increasingly important as the share of other greenhouse gases such as CO2 recedes over coming decades (personal communication, Dr Ian Maclaine-cross).

[22] This target is being promoted by individuals such as the climate scientist James E Hansen and by Bill McKibben, and the 350.com movement. Hansen supports a (high) carbon tax but not a tradable emissions scheme. He also supports a strong role for nuclear energy. Advocacy of hazardous mitigation measures including some forms of climate engineering (Hamilton 2013) is a consequence of such very ambitious targets.

that even very stringent targets with respect to nationwide emissions on this sort of time scale will not involve all renewable electricity systems on such short time-scales if cost-effectiveness principle are observed. Such concerns about misplaced over-ambition about the role of renewables are by no means to denigrate either ambition about nation-wide targets or the notion of full- or part-scale demonstration plants with respect to such technologies as solar thermal power stations integrated into existing systems.

An ecologically 'responsible' policy and political position is one that recognises some level of political pragmatism based on cost-effectiveness principles. These principles hold true whether the global target is the 450 ppm target (or two degrees Celsius) espoused for example by the International Energy Agency (IEA 2012) or some other target, either more or less ambitious. The IEA fears even the 450 ppm target may soon be out of reach politically.

Whatever mitigation goal is pursued, emissions pricing thus remains the core means to such an end because it minimises what could be a significant cost, especially if the more ambitious targets are pursued. Indeed, seeking a more ambitious target *strengthens* the case for emission pricing. By contrast, a 'direct action' policy such as seeking to scrap all existing capacity and replace it with renewable forms of electricity generation in a very short time-scale (say of a decade or two) would likely involve unnecessarily large costs and be counter-productive politically.

<u>System-wide and economy-wide modelling</u>

The bench-mark modelling of carbon emissions pricing in Australia has been undertaken by the Commonwealth Treasury in collaboration with other Government Agencies and specialist consultants. As documented in its major report (AGT, 2011) representations of the electricity sector (SKM MMA 2011), including existing generating assets are embedded in an economy-wide model and also within ETSAP, a general equilibrium model of the global economy (AGT 2011: 127; Pant 2007). The interconnections among the sub-models are indicated at AGT 2011: 11, 134).

Measuring the costs of higher levels of renewables is well beyond both the simple approach of comparing levelised unit costs and the scope of this paper.

Intertemporal system-wide modelling[23] can be used to assess costs and consequences of achieving given national targets, whether by pricing emissions or by other methods. Ideally, these models allow specification of all major relevant energy flows, technologies and assets. Such modelling includes both existing assets and their vintages and remaining lifetimes and

[23] One of the most widely used system-wide models is that of MARKAL (Seebregts, Goldstein and Smekens n.d.). This model has been used to address least cost attainment of emissions targets within many nation-specific versions of its data base, including Australia (Jones et al; Naughten 2003). In its original version, this inter-temporal optimising model was developed under IEA auspices 30 years ago. It is currently used by the IEA with a global database and as such has been used as the basis for climate change analysis for the G20. As Greg Hunt rightly underlined (Hunt 2013), it is relevant that Australia is expected to be the chair of G20 in 2014, representing an opportunity for Australia to show leadership on addressing climate change mitigation.

It is important to note that models such as MARKAL assume away the problems of business confidence and future uncertainty that have been emphasised above. The underlying assumption of such models is thus one of 'perfect foresight'. This limits their use in forecasting but not in policy analysis. For example, the rational decision-maker modelled is assumed to be aware of long run prices, cost and technological assumption over the relevant period of 30-40 years. This includes knowledge of the future path of emissions pricing necessary for consistency with national emissions price paths over the same period. This feature does not detract from the usefulness of such models in the provision of benchmarks and understanding of system interactions through markets and market instruments.

can allow assessment of the cost of accelerated scrapping of such existing capacity. Such models can be used for many purposes including indicating the consequences of applying particular system wide emissions targets including the implied price path for CO2 as well as investment decisions and timing) or alternatively, give the price path the implied total emissions.

One application of such modelling is to test alternative policies, such as arbitrary ‘all renewables’ approaches, *versus* approaches that allow just the pricing of emissions to determine costs and configurational changes necessary to meeting the chosen emissions targets at least cost. That is it becomes possible to quantify the cost of certain direct action policy as compared with policies based on the pricing of emissions. This is an important policy mechanism by which to ensure against rent-seeking by proponents of particular technologies. By quantifying the extent to which these options may be ‘silver bullets that miss the target’ the models can and should form part of policy of transparency and accountability.

These modelling results can also in principle be utilised in designing and implementing ‘command and control’ policies, more generally, if for some reason emission pricing is rejected or is not feasible, for example because of high transaction costs[24]. However high transaction costs is not a problem in the energy sector, where (as noted for example by McKibbin 2012) taxes or prices can typically be applied cost-effectively to just a few major emitters.

It would be ironic, to say the least, if a future LNP Government, as the main celebrants of the ‘free market’ in Australian politics, were to resort to such ‘command and control’ policies as a result of having closed off the ‘market instrument’ option of emission pricing

Such energy system-wide models can also be used in concert with economy-wide models both national and international, the function of which is to explore both inter-industry effects outside the energy sector and relevant macro-economic effects.

**Short-run and long-run impacts of carbon price on the demand for electricity**

Does the application of carbon pricing to the electricity sector amount to no more than an electricity tax in disguise? Further, to the extent this is so, is such a tax ineffective at reducing CO2 emissions? On at least three grounds, such assertions, made by Coalition (Hunt 2013) are dubious:

1. The most relevant effect of the carbon tax on and through the electricity sector (in Australia and elsewhere) was not so much in raising the after-tax price of electricity. Rather it is in influencing the way that electricity is generated over the long run, especially by influencing investment choices. This argument has been discussed above
2. Certainly the pricing of emissions will tend to increase the price of electricity. It does so in two ways, through passing on the effect of the tax itself (a transfer payment) and through encouraging generation technologies with a higher ‘resource cost’, albeit with lower or zero emissions..
3. Although the short run price elasticity of demand for consumption of electricity is often considered low, that for the longer run is a multiple of the short run effect. Further this price-induced reduction in consumption may well increase in the future, especially in

[24] Prohibitively high transactions costs with regard to emissions pricing might be true of other emitting sectors such as branches of agriculture or forestry, or sinks.

conjunction with more effective metering and other administrative approaches to reducing wasteful electricity use complementary to the price mechanism.

As regards the increased electricity price due to higher resource costs this will be equally present under a 'direct action' approach, for example to promote switches in the mode of electricity generation away from coal to less emissions-intensive modes. Indeed, to the extent 'direct action' fails to utilise an efficient price mechanism in inducing this shift of generation modes this 'resource cost' component to the increase in electricity prices will be higher than in a method relying more on emissions pricing.

Further, under the Government's preferred option of emissions pricing, revenue collected from the carbon tax can be used to reduce more distorting taxes elsewhere in the budget. This can even lead to production efficiencies gains given that an emissions tax is an efficient tax (rather than a 'distorting' one), both because it is a broad-based tax (with a low rate relative to its base revenue) and because, as a 'Pigovian tax' (Mankiw 2009), it is designed to minimise social costs[25].

The second question is about the extent of such cost-driven price increases for electricity. It has been controversial for some years now that well before institution of emission-pricing a range of other, extraneous factors have been pushing up electricity prices. These have included the cost of investment on transmission and distribution as a result of the untimely obsolescence of some these assets and also in some instances alleged 'gold plating' of some such infrastructure, these have resulted in very significant price increases over the last 2-3 years. Confusion about these extraneous causal factors is potentially a boon for those wanting to discredit an emissions charge. In any such comparison, the choice of time-period can be made in distorted fashion so as to tell the preferred story. For example, price projections made only the most recent period could highlight the future carbon tax but minimise the apparent impact of the other recent causal factors by building such impacts into the baseline.

The only objective comparison would be one that displayed the relevant effects on electricity price over an extended historical and prospective period, preferably in graphical form.

Fortunately, recent and prospective electricity price increases and their causal factors have been documented and modelled in a major report by the Australian Energy Market Commission[26] (AEMC 2012). This enables us to inspect the price trends and causal factors over a longer relevant period.

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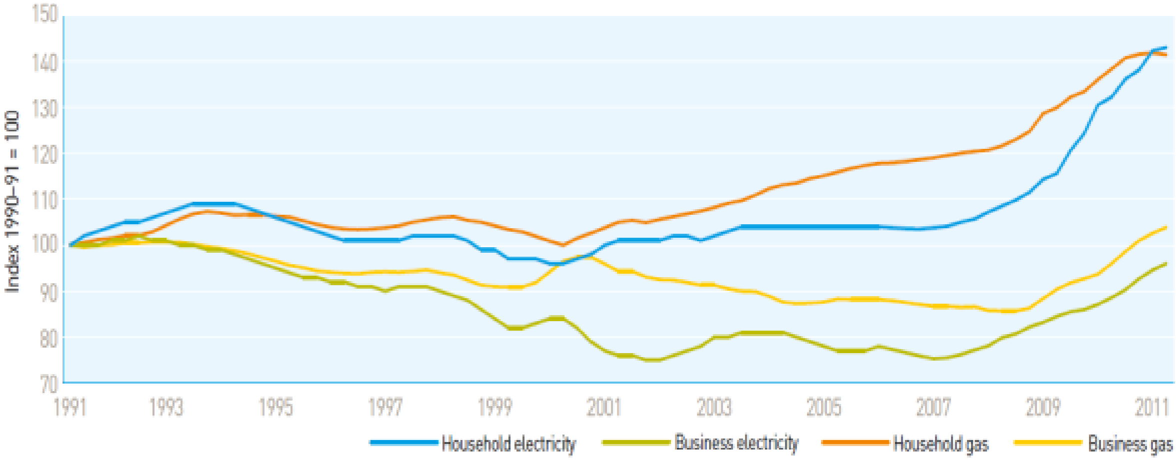
[25] As a corollary of his argument for a 'Pigovian tax', Mankiw is a strong supporter of a carbon tax to mitigate catastrophic climate change. While he supports the carbon tax, along with Helm and others he is less enamoured of cap-and-trade or tradable emissions schemes. This is on several grounds, as follows.

> Cap-and-trade systems are also relatively inefficient for three reasons. First, if pollution rights are allocated based on historical emissions, the prospect of a cap-and- trade system encourages utilities to pollute more before the system is put into effect in order to ''earn'' pollution rights. Second, unless pollution rights are fully auctioned, they waste the opportunity to use the Pigovian tax revenue to reduce distortionary taxes on labor and capital. Third, if the demand for carbon emissions fluctuates from year to year because of, for example, the business cycle, the price of a pollution permit and thus the marginal cost of abatement would fluctuate over time. Because global warming depends only on the sum of carbon emissions over time, the cost-minimizing path is to smooth the price of emissions and to allow the quantity to fluctuate. That efficient dynamic path is more easily achieved with a Pigovian tax on carbon emissions.
>
> Of course, cap-and-trade systems are better than heavy-handed regulatory systems. But they are not as desirable, in my view, as Pigovian taxes coupled with reductions in other taxes

[26] The Council of Australian Governments (COAG), through its then Ministerial Council on Energy (MCE), established the Australian Energy Market Commission (AEMC) in July 2005. In June 2011, COAG established the Standing Council on Energy and Resources (SCER) to replace the MCE. The AEMC has two principal

**Figure 4. Trends in retail electricity and gas prices, Australia, 1991-2011**




Source: DRET, 2012

Figure 4 drawn from DCC&EE (2012) indicates that electricity prices have tended to increase since around 2000 but especially since around 2007 with the sharpest increase occuring for household electricity consumption where the price has almost doubled since that year compared with the early 1990s.

Figure 5 from the same source indicates that these price trends reflect the increase in transmission and distribution investment, especially the latter, over the relevant historical period.

**Figure 5. Total electricity network investment**


Source: DRET, 2012 and Aurora Energy, 2011

The second question is about price-elasticities of demand for electricity: the extent to which these price increases will induce reductions in electricity consumption and hence in emissions. In fact, the evidence is that there has been a significant slackening in the annual

functions: … make and amend the national electricity, gas and energy retail rules, and … conduct independent reviews of the energy markets for the SCER.

demand for electricity well before the introduction of emissions pricing. This is consistent with the other factors causing an increase in price, though other influences have also been at play.

As in the case of the effect of carbon price on the choice of generation mode, it is the long run effect, in this case on electricity consumption, that are important.

Similarly, long run price elasticities of demand, whatever the commodity, exceed the short run effect. In the case of electricity[27], this is because these long run effects include price-induced *investment* in less energy-intensive appliances, equipment, buildings and dwellings, and not just different ways of using currently available assets. Accordingly, a recent study of the residential demand for electricity in Australia (Narayan and Smyth 2005) stressed the distinction between the estimates of long run price elasticity of demand and the short run parameter. These authors found that although the short run price elasticity of elasticity of demand was -0.26, the corresponding long run parameter was a far from insignificant -0.54. This means that a price increase of 10 % can over time be expected to cause a reduction of 5.4 % in demand for electricity in Australia, a not inconsiderable effect. Using advanced statistical techniques these authors also found that the parameters for residential electricity demand for Australian had been stable over time.

However, this finding of course does not preclude greater sensitivity to price going forward. One reason this sensitivity could increase is that in regard to short run price responses consumers may find it difficult to quickly react to price increases if they are not given this information in the timely fashion that is technically possible with proper time-related metering. Such time-dependent metering is proceeding apace (see AEMC 2012: 68-111).

Third, the effect of complementary programs (or direct action' programs) to reduce electricity consumption is complementary to emission-pricing: awareness of higher electricity prices will clearly focus attention on mechanisms and public policy programs to reduce household use of electricity.

In asserting that the demand for electricity was price-inelastic, Mr Hunt had referred to a U.S. paper by Azevedo, Lave and Morgan (2011). It is notable that this paper had concluded that

> public policies aimed at fostering a transition to a more sustainable energy system in order to address the climate change challenge will require more than an increase in electricity retail price if they are to induce needed conservation efforts and the adoption of more efficient technologies by households.

This is an uncontroversial conclusion and is in accord with the notion, emphasised here, that the main mechanism by which a carbon tax can be expected to reduce CO2 emissions is by inducing a switch in generation modes. The paper's findings on the price elasticity of demand for electricity rest on US and EU data. As regards these findings, the authors report only the short run parameter and not the long run elasticities underlined here. In this regard their findings are very similar to Narayan and Smyth (-0.21 to -0.25, compared with -0.26).

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[27] Similarly, it is often fallaciously argued that for the same reason increasing the tax rate on oil-based transport fuel (gasoline and diesel) will not significantly reduce the demand for these fuel commodities. But again the long run price elasticities are a multiple of the short run rates. This is why Mankiw (2006) argues for an increase in this tax from its low US rate, given that the multiple associated social costs well exceed the present tax rates (Parry *et al.* 2005, 2007). The high rates of per capita use of gasoline in the US relative to other OECD surely reflect these long run and very long run price effects on demand. Here the relevant investment decisions include not only the private decisions of motorists and purchasers of more fuel efficient vehicles but the public policy decisions about road transport infrastructure and its competitive forms of infrastructure, the compactness of urban development etc.

Finally, there is the controversial issue of the 'rebound effect' and the closely related 'Jevons effect'. This effect is sometimes dubiously invoked to discredit the energy-saving impact of regulatory policies to enhance the energy efficiency of appliances, for example those that use electricity. The 'rebound effect' is not in any way an anomaly but refers to the normal operation of markets and to a situation in which an (exogenous or endogenous) improvement in the energy efficiency of an appliance reduces the unit cost of that energy service and hence prompts increased use of this equipment, thereby improving productivity and welfare but tending to offset the potential input energy savings[28]. This is only a concern if the offset approaches the point where energy savings are foregone. A slight offset is not a concern. Moreover, there are important circumstances likely to ensure that an offset is kept within reasonable bounds, notably when there is negligible reduction in the unit cost of the relevant energy service. This can occur for at least two reasons. First, the more energy efficient equipment may in general be available at a cost premium relevant to the standard efficiency equipment. Second, in the case where the improvement in energy efficiency is induced (or partially so) by a higher tax rate on the energy input, the tax-inclusive unit operating cost to the user will not necessarily fall. In either case, the rebound effect is not likely to significantly negate the energy savings potential due to improved energy efficiency.

## Conclusion

It has been argued here that dismissing emissions pricing as the core approach to reducing greenhouse gas emissions has been flawed by an undue focus on just the short term effects of such a policy. Rather, it is the longer term effects that are both decisive and cost-effective in the longer run task of reaching the necessary emissions targets by key dates such as 2020 and 2050. These longer term effects include sharply reducing the carbon intensity of electricity generation and the *per capita* consumption of electricity itself in present uses.

The implications of such a 'short-termist' perspective would be unfortunate indeed should they result in destruction of the policy framework of emissions pricing along with those 'complementary policies' that are a logical and functional part of this framework[29].

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[28] Economy-wide income effects as well as pure price effects may also be involved. This is often the case referred to as the so-called 'Jevons paradox' (Barrett 2011).William Stanley Jevons' example was about vast improvements in the efficiency of coal used  to raise steam, for example in electricity generation. These technical innovations reduced the unit cost of electricity and hence greatly promoted its consumption growth over time though both a price effect and an income effect, noting that many uses of electricity are income elastic as well as price elastic. Several points can be made. First, many other factors caused income increases and hence increases in electricity sales. Second, electricity consumption in the advanced economies has arguably approached a saturation point relative to human needs. Third, scope for cost-effective energy efficiency improvements in coal-generated electricity has certainly approached a saturation point with little improvement in the last 40 years. Fourth, we are getting used to the notion that not only is coal a scarce resource but of greater concern is the problem of human-induced climate change to the point where there are calls to leave fossil fuels in the ground (Carbon tracker 2013). These calls are implemented by policy techniques the slow the growth in coal and electricity consumption, as described above.

[29] This 'structural' point is well made by Naomi Oreskes (2011: 228):

> … we can see one crucial potential benefit of a revenue-neutral carbon tax: Once implemented, it will become part of life like any sales tax, VAT, or other tax imposed at the point of purchase. It does not require any special appeal to patriotism, exigency, camaraderie or any other virtue. It does not require altruism. No one pretends that tax, any more than death, is a good thing, but most of us (with some exceptions), accept that taxes are necessary for civil society to function. We accept that taxes are normal. We need not invoke metaphors of warfare or questionable claims of emergency and crisis. We just have to acknowledge, as we do with the other forms of taxation with which most of us routinely comply, that it is *necessary*.

Any such destruction is would have long term adverse consequences for the project of reducing Australia's own greenhouse gas emissions and for our ability to cooperate with the rest of the world in reducing global emissions in order to avert catastrophic climate change.

This would be doubly unfortunate given that Australia is expected to be the chair of the G20 group[30] in 2014, representing a lost opportunity for Australia to show leadership in addressing climate change mitigation at perhaps the most relevant international institution, one that includes both OECD and major industrialising countries such as the BRICS[31].

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[30] This international group includes both major energy consuming states (OECD states plus China and India) and also the major producers and exporters (Russia, Saudi Arabia, the US, Australia, Brazil, Canada). However, it does not include the state with the largest holdings of conventional oil and gas combined (Iran) nor post-Saddam Iraq. The absence of Iran from this forum (due to its 'rogue' status in the eyes of the US) is in some relevant respects especially unfortunate. First, Iran is potentially a major supplier of natural gas to China and India where it has the potential to displace coal fired electricity and given supply constraints on China's gas resource (Jianliang Wang *et al.* 2013). Second, like other Middle East oil producers, Iran could usefully be made accountable for its prodigal oil and gas consumption policies. Armed with specially commissioned analysis by the IEA (2010), the G20 had in 2010 been the international body that had forcefully raised this major issue of subsidised waste of fossil fuel energy and its concomitant in terms of higher greenhouse emissions.

[31] Brazil, Russia, India, China, South Africa

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## Appendix 1. Comparison of unit generating costs with and without carbon price

Selected data and findings fossil fuel generation from *Australian Energy Technology Assessment* Report, Bureau of Resources and Energy Economics (BREE), Canberra (AETA 2012).

### 1. Comparison of data on operation and maintenance costs fossil fuel generation

Comparison of data on operation and maintenance costs, electricity generation from black coal, brown coal and gas-fired CCGTs

Table A1.1 operation and maintenance costs

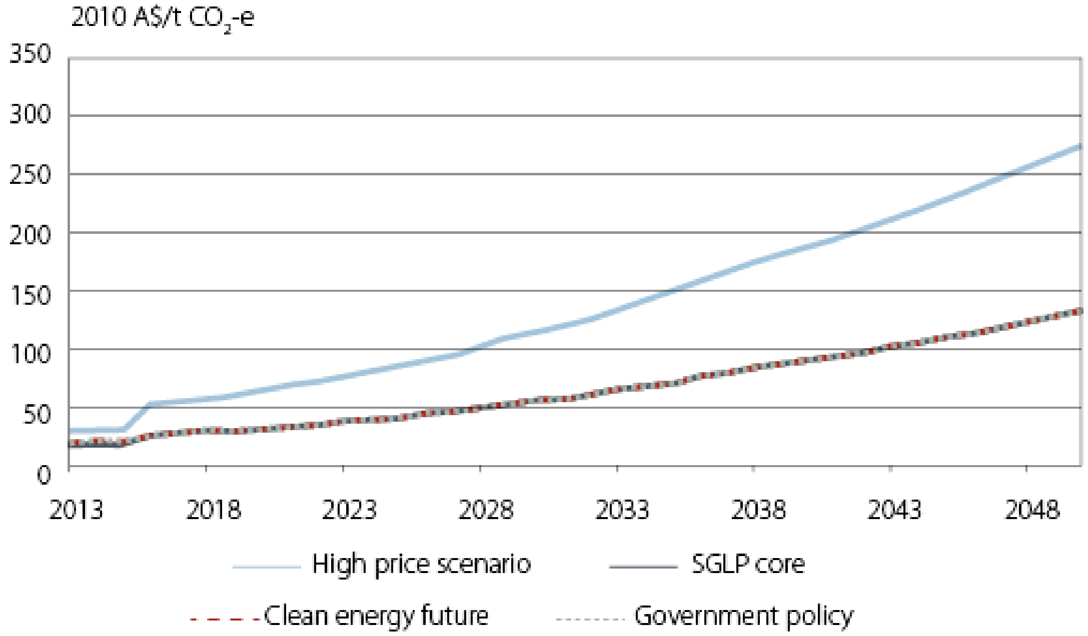
| | Fixed O&M ($/MW/year) | Variable O&M ($/MWh sent out) |
|---|---|---|
| Brown coal supercritical | 60,000 | 8 |
| Black coal supercritical | 50,000 | 7 |
| Combined cycle gas turbine | 10,000 | 4 |

Source: AETA (2012: …) Technologies are, respectively: Pulverised coal supercritical plant based on brown coal, LCOE, Victoria; Pulverised coal supercritical plant based on bituminous coal, LCOE, NSW; Combined cycle plant burning natural gas, LCOE, NSW

### 2. Carbon price assumptions

The figure 2.2.1 from the AETA Report indicates the assumed carbon price paths under consideration in the estimations of unit levelised cost.

Figure A1.1: Carbon prices, 2013 to 2050




Source: AETA 2012: 19. Figure 2.2.1. Treasury estimates from MMRF model, 2011. SGLP: Strong Growth, Low Pollution refers to Treasury modelling of a carbon price in the Australian economy.

## 3. Unit costs with and without carbon price

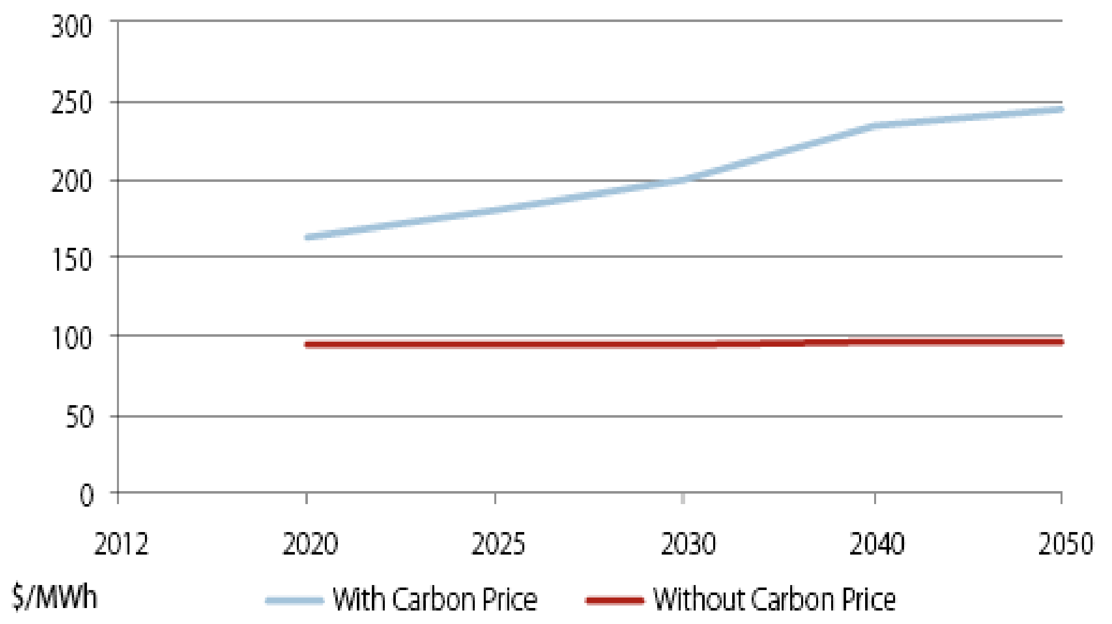
Unit costs with and without carbon price: brown and black coal-fired *versus* gas-fired CCGT *versus* brown coal retrofitted for carbon capture and storage (AETA 20120.

Table A1. 2 Unit costs with and without carbon price: coal-fired versus gas-fired CCGT

| ($/MWh) | 2012 | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| Without carbon price: | | | | |
| Brown coal supercritical | | 95 | 95 | 95 |
| Black coal supercritical | | 80 | 80 | 80 |
| Combined cycle gas turbine | 90 | 100 | 100 | 95 |
| Brown coal supercritical with retrofit CCS | | | 135 | 135 |
| With carbon price: | | | | |
| Brown coal supercritical | | 155 | 200 | 250 |
| Black coal supercritical | | 135 | 165 | 200 |
| Combined cycle gas turbine | 100 | 120 | 135 | 145 |
| Brown coal supercritical with retrofit CCS | | | 152 | 160 |

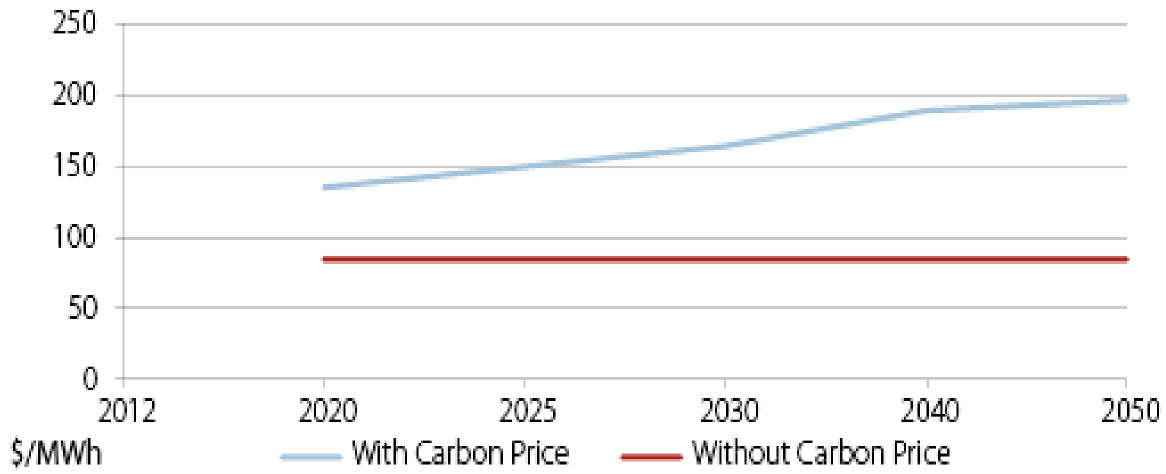
Source: AETA (2012: …)

Figure 4.6: Pulverised coal supercritical plant based on brown coal, LCOE, Victoria



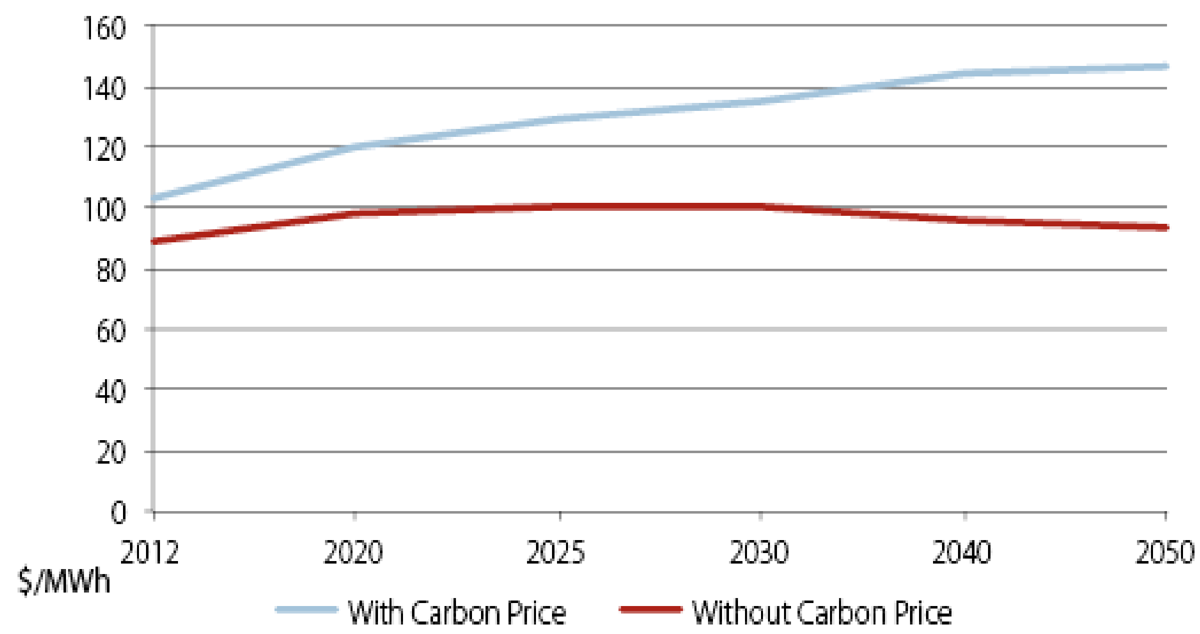

…

Figure 4.9: Pulverised coal supercritical plant based on bituminous coal, LCOE, NSW



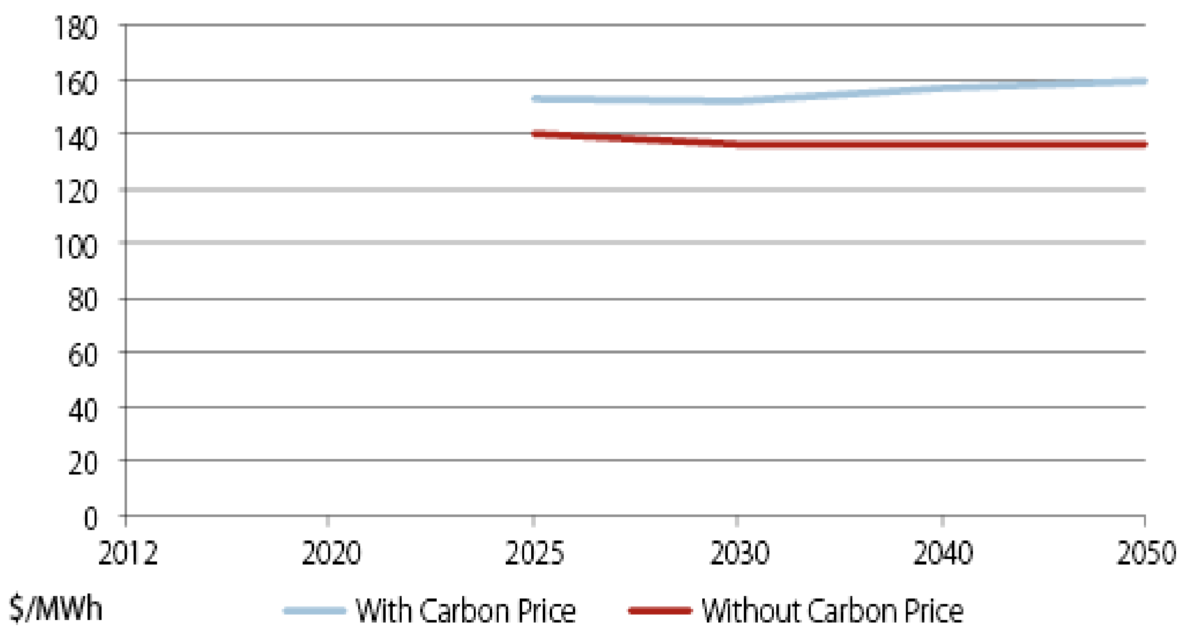

…

Figure 4.16: Combined cycle plant burning natural gas, LCOE, NSW




…

Figure 4.8: Pulverised coal subcritical plant based on brown coal with retrofit post-combustion CCS, LCOE, Victoria




…

**Appendix 2 100 Per cent Renewables Study: Draft modelling outcomes**[32]

Below are selected preliminary results from a study by the Australian Energy Market Operator on the costs and feasibility of attaining 100 Per cent Renewables electricity system in Australia under each of four scenarios. The study was released 24 April 2013.

Scenario 1: Rapid transformation and moderate growth—this scenario assumes strong progress on lowering technology costs, improving demand side participation (DSP), and a conservative average demand growth outlook in the lead up to the year being modelled.

Scenario 2: Moderate transformation and high growth—this scenario assumes current trends in lowering technology costs, moderate DSP, and robust economic growth in the lead up to the year being modelled.

Each scenario was modelled under two timeframes: 2030 and 2050.

This resulted in a total of four cases being modelled: Scenario 1 (2030), Scenario 1 (2050), Scenario 2 (2030), and Scenario 2 (2050).

AEMO was required to prepare a report containing the following:

- Scenarios for a 100 per cent renewable electricity supply at 2030 and 2050.
- Generation plant and major transmission networks required to support each scenario.
- The estimated capital cost requirements for each scenario based in 2012 dollars.

Among the full range of results below are just two: the estimated capacity requirements and the estimated impact on unit costs compared with current wholesale costs.

Table A2.1 (AEMO Table 9): Capacity requirements

| Type | Scenario 1 2030 | Scenario 1 2050 | Scenario 2 2030 | Scenario 2 2050 |
|---|---|---|---|---|
| Total capacity (MW) | 82,550 | 103,572 | 97,985 | 127,982 |
| Maximum demand (10% POE) | 40,791 | 45,046 | 45,822 | 55,576 |
| Capacity relative to maximum demand | 202% | 230% | 214% | 230% |

Table A2.2 (AEMO Table 13): Hypothetical unit costs

| | Scenario 1 2030 ($/MWh) | Scenario 1 2050 ($/MWh) | Scenario 2 2030 ($/MWh) | Scenario 2 2050 ($/MWh) |
|---|---|---|---|---|
| Total wholesale | 111 | 112 | 128 | 133 |
| Current wholesale (2012 estimate) | 55 | 55 | 55 | 55 |
| Additional wholesale | 56 | 57 | 73 | 78 |
| Additional transmission | 10 | 10 | 6 | 6 |

[32] AEMO, 2013, 100 Per cent Renewables Study: Draft modelling outcomes, Version: draft for stakeholder briefing Australian Energy Market Operator, 24 April.

As well as validating these and other characteristics and costs, it would be of interest to have the AEMO and/or other modellers compare against scenarios that simply set emission targets over the same period, allowing the model to determine costs as well as the rapidity and extent to which renewables form part of such a least cost solution.