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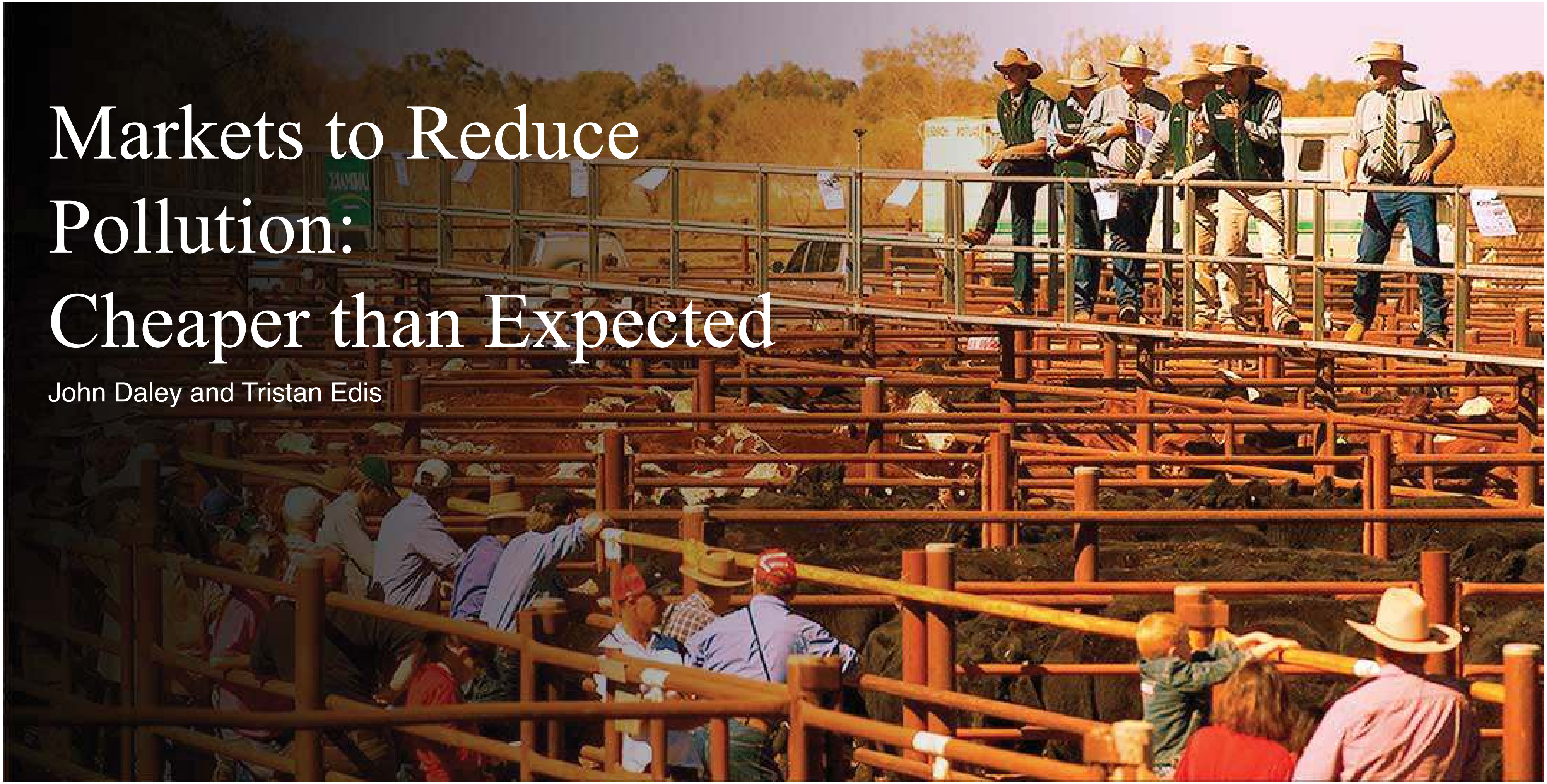

Markets to Reduce Pollution: Cheaper than Expected

John Daley and Tristan Edis

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Overview

Australia continues to debate the best response to concerns about carbon emissions. Should we put a price on carbon emissions, or should government pay for specific actions? If we do price carbon emissions, should this be a tax, a trading scheme, or some kind of hybrid? Whatever the response, few doubt that this would be historic, fundamental, reform.

While pricing carbon emissions is a fundamental economic reform, it is not a new one. Over the last few years, governments in Australia and overseas have priced pollution to reduce emissions. In such a scheme government usually sets a pollution or clean energy target and leaves market participants to decide the actions to achieve the target. Grattan Institute investigated the experience of six schemes – including the NSW Greenhouse Gas Abatement Scheme, the European Union carbon trading scheme, and the US sulphur emissions trading scheme.

In each case the outcomes diverged significantly from government and industry predictions. Environmental markets routinely led to lower emissions and achievement of targets at lower cost in practice than in forecasts. Forecasts tended to underestimate commercial innovation once money was at stake. In some cases the targets and regulations required relatively less change to business as usual than governments expected. Because it was relatively easy to achieve targets, the market price of emissions was lower than forecast. The price crash in European carbon markets was not just a “one-off” result of peculiarities in its initial design. The same pattern recurred in a variety of environmental markets.

This experience provides vital lessons for designing Australia’s response to reducing carbon emissions:

1. **Markets, enabled by pollution prices, deliver more emission reductions more cheaply** than government selecting specific actions or projects to reduce emissions. In the schemes reviewed, governments and experts that advise them, were usually wrong in their forecasts about which specific measures would reduce emissions and achieve targets at lowest cost. Rather than governments picking winners, markets unlock ingenuity across the community to converge on the cheapest reductions.

2. There should be a **floor price for pollution** – a little like the reserve price in a house auction – effectively reducing total pollution if it turns out to be cheap to reduce pollution. If governments think that reducing pollution will be expensive, they worry about the impact on the economy, and set relatively weak targets. If the economic cost of reducing emissions and achieving targets is less than expected – and this happened in all the schemes reviewed – then a floor price effectively tightens the pollution target.

Technology innovation is the key to reducing carbon emissions. Markets may not be perfect, but they are consistently effective at identifying lower cost opportunities, promoting innovation, and responding flexibly to changes. Markets are likely to deliver more innovation at lower cost than governments expect.

1. History of pricing schemes

Governments have priced pollution to reduce emissions through a series of schemes over the last few years, both in Australia and overseas.

These schemes include:

- Australian Mandatory Renewable Energy Target (MRET)
- NSW Greenhouse Gas Abatement Scheme (GGAS)
- Queensland Gas Target (QLD Gas)
- European Carbon Emissions Trading Scheme
- US North-Eastern States Carbon Emissions Trading Scheme
- US Sulphur Dioxide Trading Scheme

In each case the outcomes diverged significantly from predictions. Environmental markets routinely deliver substantially lower prices in practice than in forecasts. Experience shows that reducing pollution is almost invariably cheaper than expected.

1.1 Why forecasts are consistently too high

This is not surprising. Government forecasts almost inevitably underestimate commercial innovation when money is at stake.

Government forecasts tend to focus on opportunities for reducing emissions that are well understood, and about which forecasters are confident. A forecast based on a technology that does not yet exist, or is not yet in widespread use, tends to lack credibility. It is readily attacked by vested interests that stand to lose from environmental regulations. Assumptions can generally only be defended as "realistic" if they are comparable to what we can see and touch today.

However, history shows that once there is a financial incentive to reduce pollution and deploy cleaner sources of energy, businesses innovate rapidly to do this at lower cost than existing practice. Competitive cost advantage invariably depends on doing things in ways that are not already in widespread use by competitors.

Thus it is likely that government forecasts will assume a cost for reducing pollution higher than what evolves in practice – and consequently the market price will be substantially lower than forecast.

This theory is borne out by experience. As shown in the remainder of this Report, in a series of pollution and clean energy trading schemes, the market price turned out to be substantially less than forecast.

Consequently, price crashes are a recurring feature of pollution markets. Contrary to belief in some circles, the price crash in European carbon markets was not a "one-off" result of peculiarities in its initial design. The same pattern has recurred over and over again in a variety of environmental markets.

1.2 Australian Mandatory Renewable Energy Target: Phase 1 (2001-2006)

The Australian Mandatory Renewable Energy Target (MRET) provided Renewable Energy Certificates (RECs) to producers of renewable energy.

In its initial design, and through a subsequent redesign of the MRET scheme, the government significantly overestimated the price of RECs. In both phases of the scheme, companies succeeded in producing renewable energy at substantially lower cost than the original forecasts. Each time, REC prices crashed well below expectations. Each time, renewable energy was generated by means substantially different from initial expectations. In the first phase of MRET, it was expected that most renewable energy would be generated by burning sugar-cane waste. These forecasts were wrong, and instead wind and solar hot water generated most of the renewable energy. In the second phase of the scheme, it was expected that most RECs would be generated by wind. In fact, most certificates were generated by household solar PV panels and solar water heaters.

MRET aimed to provide renewable energy generation with a subsidy paid by electricity retailers and passed on to electricity consumers. RECs were issued to producers of renewable energy. Electricity retailers were required to buy these RECs in order to meet a government specified target and avoid a penalty. If there were relatively few producers of renewable energy, then REC prices would rise, encouraging new renewables producers to enter the market. As it turned out, there were many new producers of renewable energy, and REC prices fell.

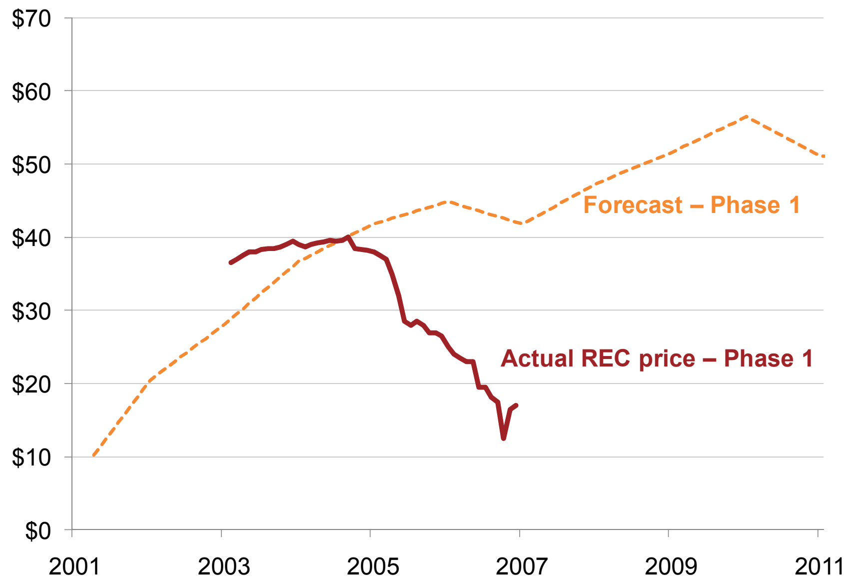
As part of the design of MRET, the government commissioned Redding Energy Management and McLennan Magasanik and Associates in 1999 to assess likely sources of renewable energy and expected renewable energy certificate prices.

They forecast prices would quickly rise to above $45/REC and ultimately stabilise above $50 out to 2020. Once the scheme commenced in 2001, actual prices were close to, or above, forecast for the first few years. There were only a few producers of certificates, and their market power kept prices high. There was an initial lag as industry built up capacity and developed new renewable projects. There was speculation that the renewable target would be raised, which would increase demand for RECs and their price. And there was a lack of market transparency that obscured the substantial certificates being produced by hydro generators.[1]

However, REC prices crashed in 2005 to around half of initial forecasts, as shown in Figure 1.

[1] Pre-existing hydro generators were eligible for RECs if they generated electricity above a baseline. Hydro generator baselines were not publicly disclosed until this was recommended by a government inquiry. RECs issued to hydro generators turned out to be a substantial proportion of REC demand.

Figure 1 – REC prices, Phase 1 ($/REC)

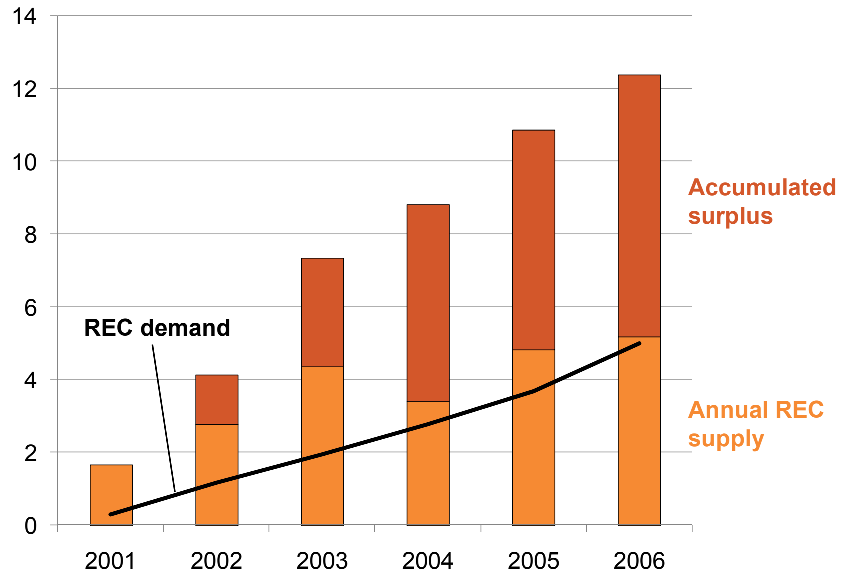


Note: Spot price data only available from 2003, once financial market conventions for trading had been developed.

Source: McLennan Magasanik & Associates (1999); Green Energy Markets (2010)

A surplus of RECs generated by solar hot water, wind and hydro generators built-up rapidly to double annual demand in 2005, as shown in Figure 2.

Figure 2 – REC supply and demand, Phase 1



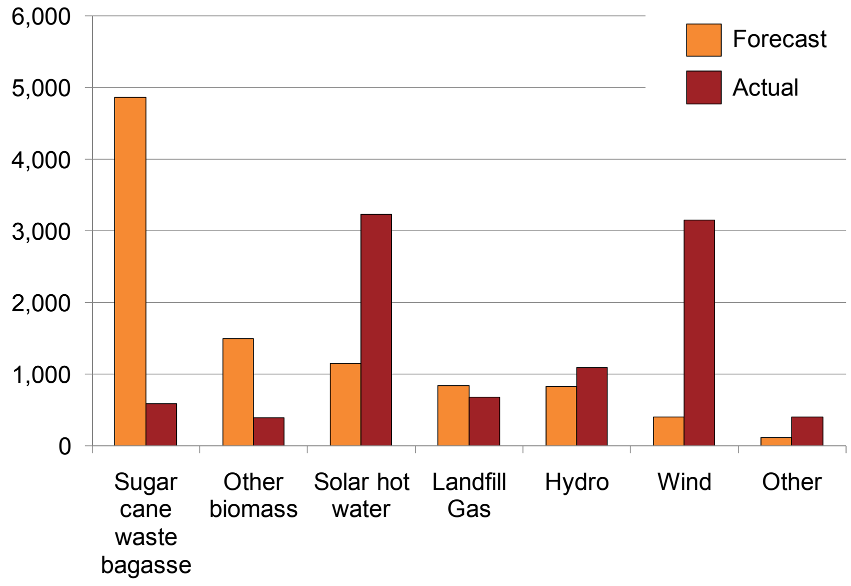
Source: Green Energy Markets (2009); www.rec-registry.gov.au

The government-commissioned forecasts were not even close in forecasting how RECs would be produced, missing major innovations. As shown in Figure 3, renewable energy was generated in practice by very different technology to the original forecasts.

The original forecasts expected that 50-70% of renewable energy would be generated by burning sugar cane residue (known as bagasse). The experts expected that wood waste would produce another 10% of the market. They expected that other sources of supply would be severely cost-constrained.[2]

However, there were major breakthroughs in wind turbine technology that substantially reduced its costs. Within the space of five years the wind industry identified a large number of sites with high quality wind resources capable of generating several thousand megawatts electricity (equivalent to the electricity consumption of 2 million households). Solar and heat-pump hot water systems also expanded rapidly due to market innovation and other government support. Sugar cane residue turned out to be immaterial.

Figure 3 – REC production ('000 certificates/year)



Note: Hydro is average for 2001-2008, with substantial annual variation. Forecast for 2010; Actual for 2008 prior to impacts of expanded targets.

Source: Redding Energy Management (1999); www.rec-registry.gov.au

[2] Redding Energy Management (1999)

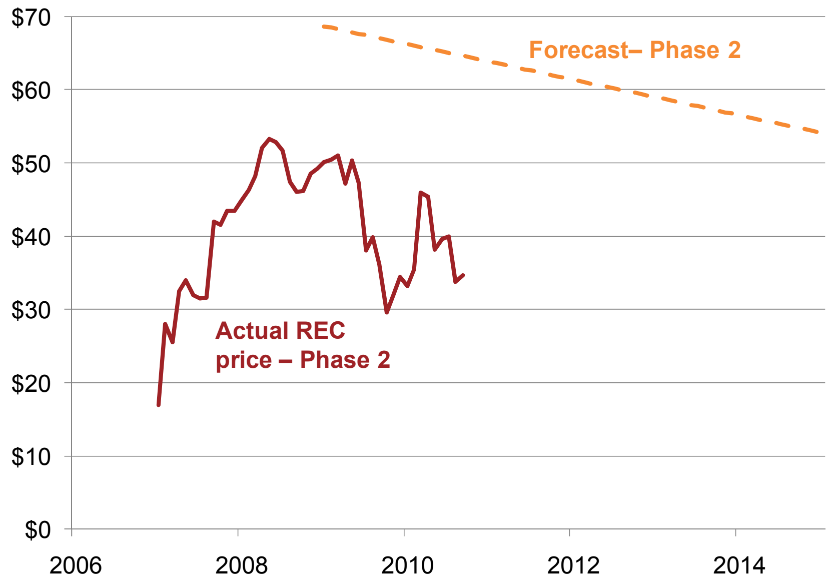
1.3 Australian mandatory renewable energy target: Phase 2 (2007-today)

In late 2006 and 2007, State and Federal Governments committed to expand demand for renewable energy certificates. It was expected that this would substantially increase the price of RECs. However, prices again crashed to be around half the forecasts. Based on the experience of the first few years of the scheme, it was expected that most RECs would be generated by wind. In fact most certificates were generated by household solar PV panels and solar water heaters.

After prices crashing in 2004-2005, the REC market was revived in 2006-2007 when State Governments announced their own renewable energy targets. This resulted in prices rebounding above $30. The REC price increased further in the lead-up to the 2007 Federal Election when both sides of politics committed to substantial increases in the target. After its election in 2007, the Labor Government increased the renewable energy target from 9500 GWh to 45,000 GWh, although most of the expansion was targeted for 2015-2020.

Accordingly, REC prices jumped to around $50 by April 2008, although this was still less than the $70 forecast in January 2009 in a report for the Department of Climate Change, as shown in Figure 4. However, by October 2009, prices had again fallen to around $30, less than half of the forecast under the new rules.

Figure 4 – REC prices, Phase 2 ($/REC)



Sources: McLennan Magasanik & Associates (2009); Green Energy Trading (2010)

Under Phase 2, the forecasts expected that most RECs would be generated by wind farms,[3] which on current costs would drive REC prices to around $55.[4] This was consistent with the expectations of major Australian electricity generation companies that told investors that the scheme would result in a boom of wind

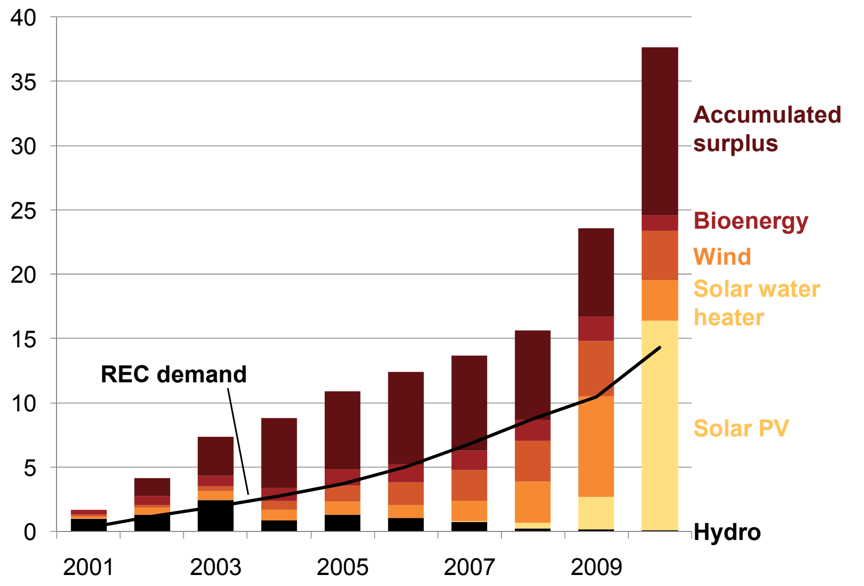
[3] ROAM Consulting (2008); Carbon Market Economics (2009); ACIL Tasman (2008); McLennan Magasanik & Associates (2009); Emerging Energy Research (2009)
[4] AGL (2008)

power.[5] Some commentators even criticised the scheme as a "picking winners scheme" for wind.[6] In practice, however, there was a boom in solar water heaters and solar PV.

The water heating industry benefitted from new entrants, development of heat pump products, increased consumer concern for the environment and a generous rebate. The water heating industry created double the RECs in 2009 over 2008.

Solar PV had generated very few RECs and expert forecasts expected this to continue, even though generous government subsidies were in place when many of the forecasts were made.[7] Government effectively *reduced* the financial support for solar PV by several thousand dollars in May 2009 when it replaced a direct subsidy with a bonus under the MRET scheme of five times as many RECs as actual expected electricity generation.[8] Nevertheless, sales of solar PV jumped when the price of solar PV systems halved in 12 months.[9] The surge in solar PV installation had an amplified effect on the overall REC system because of the multiplier. From almost nothing in 2007, solar PV generated more than 50% of RECs in 2010 (as at November 22), as shown in Figure 5.

Figure 5 – REC demand and sources of supply, 2001-2010 (millions of RECs)



Note: RECs data for 2010 is incomplete (registry accessed November 22) and probably substantially understates RECs from wind, solar water heaters and solar PV: AGL (2010) estimates that solar PV and solar water heaters will create 30m RECs for 2010

Sources: www.rec-registry.gov.au; Green Energy Markets (2009)

This was well beyond experts expectations, including representatives of the solar PV industry itself[10] and the study

[5] AGL (2009); Origin Energy (2009); Infigen Energy (2009)
[6] Wood (2009)
[7] ROAM Consulting (2008); Carbon Market Economics (2009); ACIL Tasman (2008); McLennan Magasanik & Associates (2009)
[8] The earlier government subsidy provided $8700 for a 1 kW system irrespective of location. The REC Solar Bonus multiplier equated to a subsidy of approximately $3500/kW in Melbourne and $4100/kW in Sydney, Brisbane, Adelaide and Perth.
[9] AECOM (2010)

[10] Solar Shop Australia (2009)

conducted for the Department of Climate Change in January 2009 (which incorporated the Solar REC multiplier).[11]

As a result, the 500 MW to 1000 MW of annual wind power installations that were forecast did not eventuate.[12] Instead, only 263 MW were committed in 2008[13] and 345 MW in 2009.[14]

Consequently in 2010, the government separated small scale solar systems from the wider scheme to stimulate the wind industry more. In December 2010, in light of the large volumes of RECs flowing from solar PV, the government tightened the Solar REC Multiplier, reducing it from five times electricity generation to four times.[15]

[11] McLennan Magasanik & Associates (2009)
[12] ROAM Consulting (2008); Carbon Market Economics (2009); ACIL Tasman (2008); Emerging Energy Research (2009)
[13] Green Energy Markets (2008)
[14] ABARE (2009) and AEMO (2010)
[15] Combet (2010)

1.4 NSW Greenhouse Gas Abatement Scheme

The NSW Greenhouse Gas Abatement Scheme (GGAS) required electricity retailers to purchase abatement certificates in order to meet a state-wide per-capita emissions target. Despite forecasts that prices would stay near the regulated ceiling, after three years of scheme operation, prices crashed. Forecasts did not foresee the volume of take-up of household energy saving products (such as light globes and water-efficient showerheads).

The NSW Greenhouse Gas Abatement Scheme (GGAS) provided NSW Greenhouse Abatement Certificates (NGACs) to those who reduced emissions through measures such as lower emissions electricity generation, energy efficiency, or carbon sequestration from planting trees. Electricity retailers were required to buy NGACs proportionate to the electricity they sold. A ceiling price for NGACs was created as electricity retailers could pay a penalty in lieu of an NGAC equating to $13-$15 (incorporating tax impacts due to non-tax deductibility).

A number of industry experts were asked to forecast NGAC prices as the scheme commenced and in its first few years. Forecasters expected that there would not be sufficient abatement opportunities, and prices would stay at the regulated ceiling. As the scheme commenced in 2003, EnergyAustralia, one of the largest purchasers of certificates in the scheme, submitted to the NSW government electricity regulator that:

> *"The costs are estimated to be near or at the level of the penalty set by the scheme . This reflects limited identified abatement opportunities. There does not appear to be sufficient potential abatement to meet the scheme targets. An*

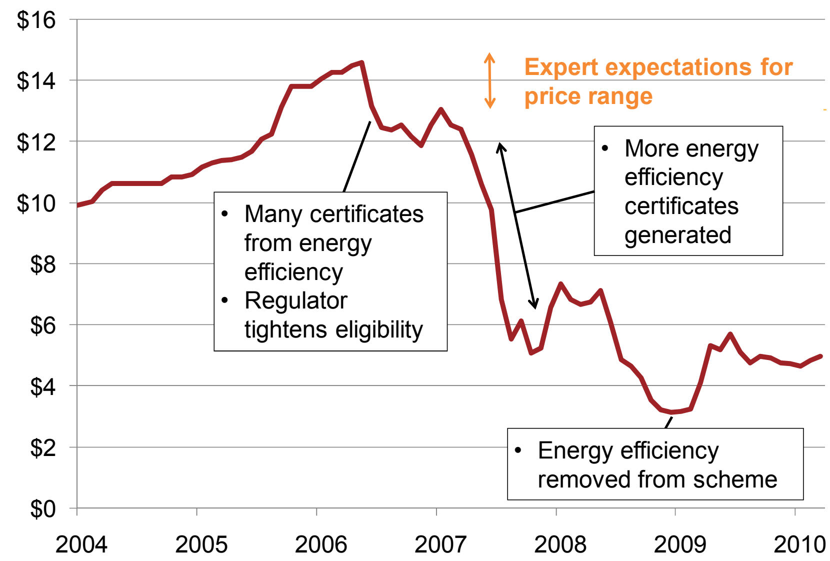
external report for EnergyAustralia indicates that the abatement target for the State will be 26.9 million tonnes of carbon dioxide in 2012 but that only 17 million tonnes can be identified at this stage."[16]

In 2005, after the scheme had operated for 2 years, ACIL Tasman, an energy and economic forecaster, in a report for the National Electricity Market Management Company, stated that it expected NGAC prices to remain around the regulated ceiling, equating to a price of around $13-14/NGAC.[17]

In June 2006, the Institute of Economic and Industry Research prepared another report for the National Electricity Market Management Company, and forecast that NGAC prices "are likely to rise towards $15.70/t CO2".[18]

However, after three years of prices close to forecast, in 2006 NGAC prices crashed to be less than half of the forecast, as shown in Figure 6.

Figure 6 – NSW GGAS abatement certificate prices ($/NGAC)

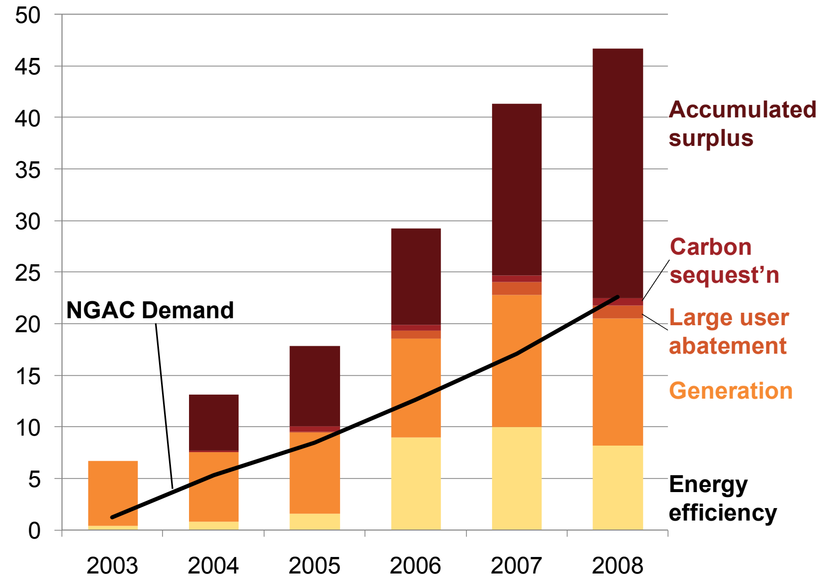


Note: prices based on a 4 week rolling average of last spot market price
Source: IPART (2010) p76, citing www.nges.com.au

This price collapse was driven as energy efficiency activities, particularly compact fluorescent light bulbs and water-efficient showerheads (which save energy by reducing water heating requirements), created a large number of NGACs for the first time in 2006, as illustrated in Figure 7. Prices have subsequently remained low, despite additional regulatory conditions aimed at restricting the number of NGACs that could be created from energy efficient light bulbs.

[16] EnergyAustralia (2003)
[17] ACIL Tasman (2005)
[18] National Institute of Economic and Industry Research (2006)

Figure 7 – NSW GGAS demand and sources of supply, 2003-2008 (millions of NGACs)



Source: IPART (2010)

1.5 Queensland Gas Target

The Queensland Gas target aimed to encourage a switch from coal-fired electricity generation to gas-fired generation, thereby reducing carbon emissions and encouraging new sources of gas supply. The Queensland Government and energy forecasters envisaged that the new gas-fired electricity generators would need to pipe gas from Papua New Guinea (PNG) to Queensland to achieve the target. Initially, the price of Gas Certificates traded near their price cap. However, prices ultimately dropped to 20% of their prior level as large, unforeseen reserves of coal seam methane were developed. These reserves have turned out to be so large that far from being an importer of gas to meet a relatively small demand from electricity generators, Queensland is likely to become a major exporter of gas to international markets.

Under the Queensland Gas Target announced in 2000, the Queensland Government required a minimum of 13% of electricity to be produced by gas-fired generators. Gas Certificates were issued to producers of gas-fired electricity. Electricity retailers were required to buy Gas Certificates equating to 13% of electricity supply.

The original Queensland Government policy from 2000 envisaged that the new gas supply would be piped from PNG. The policy document explicitly emphasised the Government's intention to help facilitate the PNG Gas Pipeline Project. While it also acknowledged the availability of domestic coal-seam methane, it was not the main focus of the initiative.[19]

[19] Queensland Government (2000)

Commercial forecasters shared this view. In 2003, ACIL Tasman observed that:

> *"Coal seam methane has experienced significant growth in Queensland and is being used in major electricity generation projects. However, it would be dangerous to extrapolate this success and conclude that CSM would be a large viable source of gas to support substantial base load electricity generation."* [20]

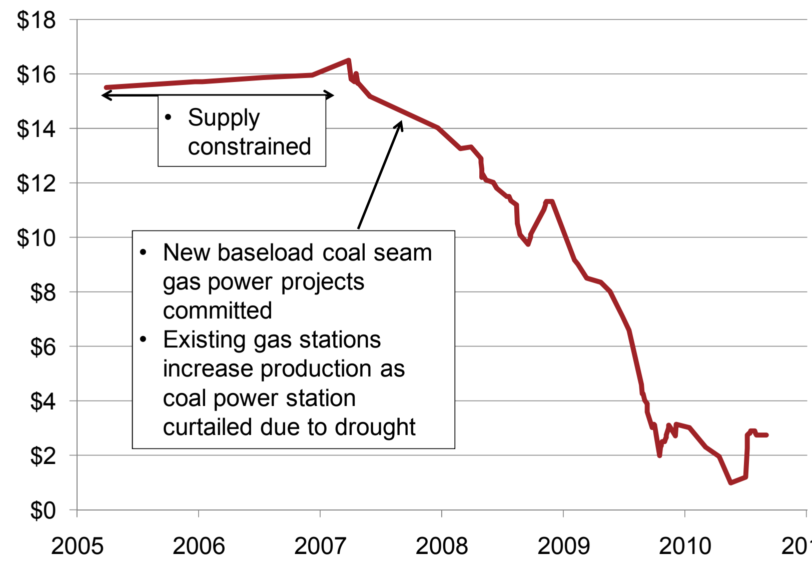
Similarly in 2004, the Commonwealth Government's resource forecaster ABARE observed that:

> *"In addition to natural gas, there are prospects for the commercial utilisation of Australia's deposits of coal seam methane However, there is significant uncertainty about the extent of coal seam methane reserves in Australia and hence the true potential for future production. The primary resource base is large but the majority of this is currently not commercial."* [21]

Given a shortage of gas generation, Gas Certificates traded near their price cap of $15.70 for the first two years of the scheme. However, in 2007, prices entered terminal decline, and now sit around $3, as shown in Figure 8. This is despite the Queensland Government committing to increase the target in June that year.

[20] ACIL Tasman (2003)
[21] ABARE (2004)

Figure 8 – Queensland Gas Electricity Certificate price ($/GEC)



Source: Tradition Financial Services (2010) and Grattan Institute analysis

Prices have been driven down to such levels because, far from having insufficient amounts of gas, Queensland has more than it can consume. In just a five year period subsequent to the Queensland Government's institution of the gas target, coal seam gas reserves increased 10-fold as interest was sparked in exploring and developing this resource.[22] Just two years after dismissing as "dangerous" the notion that coal seam gas was a viable source of gas for substantial base load electricity, ACIL

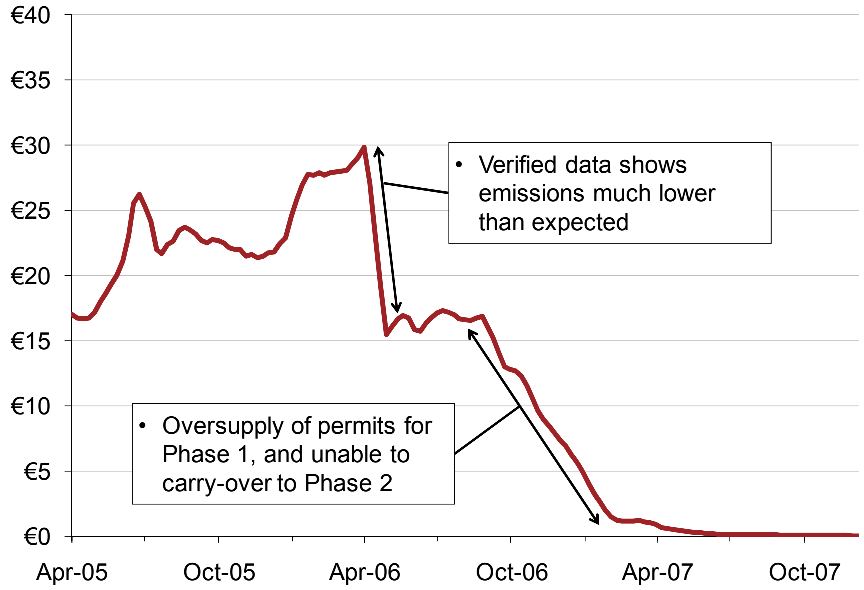
[22] Origin Energy (2005)

Tasman noted that coal seam gas could provide "sufficient volumes of gas" for extensive gas-fired electricity generation in Queensland.[23] There are now a number of gas liquefaction plants in development in order to export the gas overseas in such large volumes that domestic gas fired electricity generation will be a relatively minor source of demand. And plans for constructing a gas pipeline from PNG have been shelved.

1.6 European Union Emissions Trading Scheme

The European Union's carbon emissions scheme was set up in 2005. The scheme imposed a cap on carbon emissions, and required carbon emitters to buy permits proportionate to their emissions. Prices initially traded close to expectations, but crashed after a year, as shown in Figure 9, when it became apparent that European Governments had set insufficiently stringent emissions caps.

Figure 9 – Phase 1 European Union permit prices (€/tCO2 – 2007 delivery)



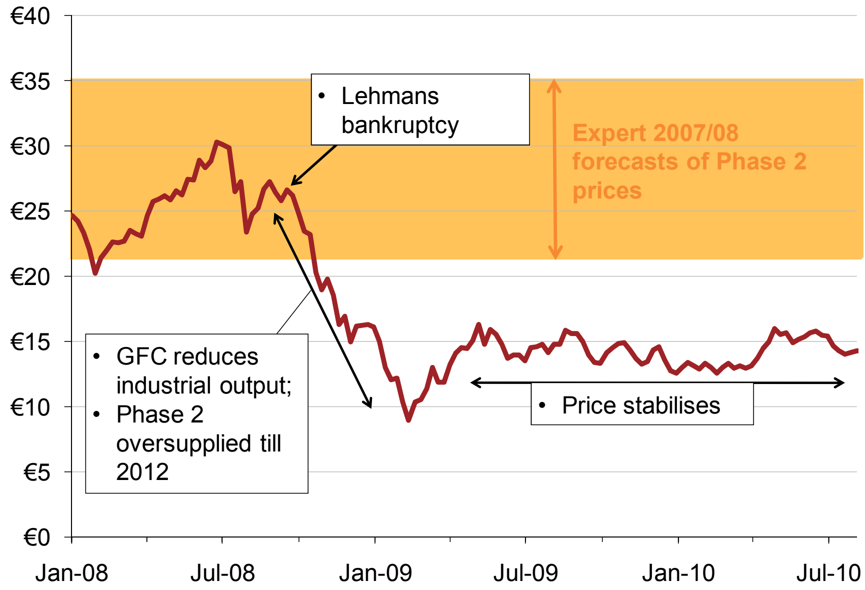
Source: European Climate Exchange data accessed (2010); Capoor and Ambrosi (2007)

[23] ACIL Tasman (2005)

In the European scheme, prices crashed to near zero in April 2007 due to a major oversupply of emission permits and because it was not possible to "bank" a permit and use it in a subsequent compliance period (2008-2012 known as "Phase 2").[24] While this design flaw has been corrected, a similar unforeseen price collapse occurred in Phase 2 of the scheme due to the downturn induced by the global financial crisis, as illustrated in Figure 10. In 2007 and early 2008, experts expected carbon prices to fall within around €21 to €35 over Phase 2. Yet they have fallen within a range about half that expected, at between €14-€16.

While this drop in prices, in line with a downturn, is not necessarily a bad thing, the substantial banking of excess permits occurring now will have long-term implications on the effectiveness of the scheme out to 2020. The European Commission now estimates that through to 2020, emissions are likely to be substantially lower than estimates issued just two years ago. Consequently, there will be a major overhang of surplus permits, equal to more than an entire year of emissions through to 2020, as shown in Figure 11. The European Commission has halved its forecast of the average carbon price over the next decade, down from the €32 it estimated in 2008, to €16 in its 2010 assessment.[25]

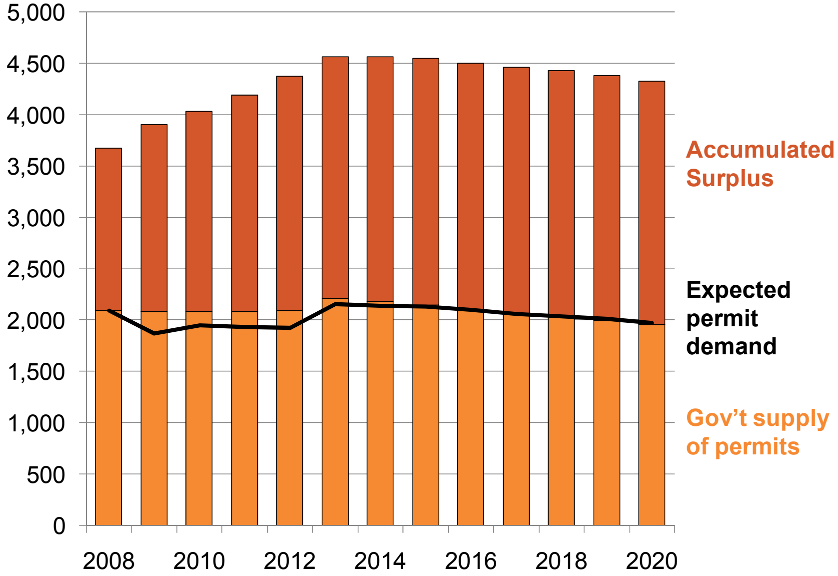
Figure 10 – Phase 2 European Union permit prices (€/tCO_2 - 2010 delivery)



Source: Price data – European Climate Exchange; Expert forecasts - Point Carbon (2008; Deutsche Bank (2007); UBS and Societe Generale cited by Vattenfall (2007)

[24] Capoor and Ambrosi (2007)
[25] European Commission (2010a)

Figure 11 – European Union emissions permit demand and supply (millions of permits – tCO_2)



Source: European Commission (2010b)

1.7 US North-Eastern States Greenhouse Gas Initiative

The North-Eastern States Regional Greenhouse Gas Initiative (RGGI) is a more recent carbon emissions cap and trade scheme, implemented in 2008.

It seeks to reduce carbon emissions from electricity generation in the US states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont

In light of experience of previous schemes, the RGGI set a floor price for permits, although it was expected that actual prices would be substantially higher. In practice, prices for permits have traded just a few cents above the floor price at around $2/$tCO_2$.[26] Government forecasts commissioned in 2007 expected a carbon price of twice this amount.[27]

According to the The Wall Street Journal, it appears that RGGI has encountered similar forecasting problems as other trading schemes, leading to lower prices than forecast:

> *"First, state authorities appear to have made a similar mistake as European authorities did when they started their own cap-and-trade program. That is, they over-estimated the amount of permits that power companies would need to cover their emissions requirements. The result is a surplus of pollution permits, which pushes their price down. Second, the recession whacked demand for electricity, which means that power plants emitted even less than they thought they would. Third,*

[26] Chicago Climate Futures Exchange (2010)
[27] Ahmad *et al.* (2007)

cheap natural gas [caused by major innovations in extraction of unconventional gas from shale] over the last year has made it easier for power companies to switch to the cleaner-burning fuel, which again means fewer emissions of greenhouse-gases." [28]

1.8 US SO_2 and NO_x trading schemes

Trading schemes to control pollution were pioneered in the United States in the 1990s to control emissions from coal-fired power stations of sulphur dioxide (SO_2) and various nitrogen oxides (NO_x). Actual prices were about half of forecasts through the first five years of the scheme. Actual prices were less than a quarter of the prices expected for the subsequent five years of the scheme. Technology innovation in practice diverged from expectations. Instead of installing "scrubbers" to remove emissions from waste flows, generators changed the fuel mix. Ultimately scrubbers were installed, and they turned out to be much more efficient than expected. If policy makers had known how cheap it would ultimately be to reduce SO_2 and NO_x emissions, they might well have set more stringent caps.

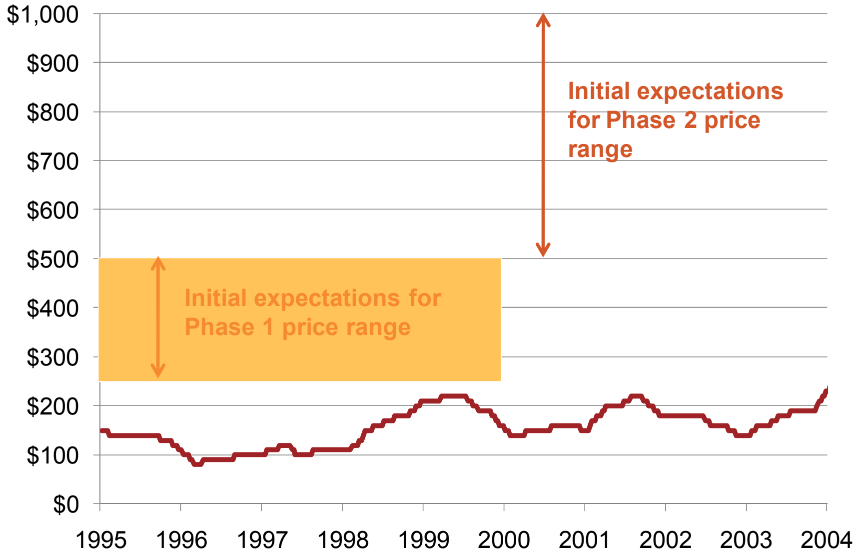
Under US legislation enacted in 1990, SO_2 and NO_x emissions were capped across a number of states. The maximum level of emissions reduced each year. Emitters – principally coal-fired power generators – were required to buy certificates proportionate to their emissions. If actual emissions were close to the cap, then the generators would bid up the price of certificates, so that it became increasingly worthwhile to reduce emissions and the need to buy certificates.

From when the scheme began to operate in 1995, prices were substantially lower than the original forecasts, as shown in Figure 12. A second phase of the scheme, with a significantly lower cap, operated from 2000-2005. Although it was expected that this

[28] Johnson (2009)

lower cap would substantially increase the price for emissions, this did not eventuate.[29]

Figure 12 – SO_2 allowance price (tonne SO_2)



Note: Price expectations are from US EPA (2009), and were expectations in 1995, just prior to the start of the program

Source: Monthly price data originally collected by Cantor Fitzgerald and presented graphically by US EPA (2009)

While prices did spike from May 2004 and over 2005 above initial forecasts, this was driven by a government proposal to tighten the cap considerably from Phase 2 levels and gas shortages driven by hurricanes Katrina and Rita. Prices have subsequently plummeted and in 2009 allowances were trading as low as $65.[30]

In the planning phase of the scheme it was expected that coal-fired power stations would comply principally through installing scrubbers. However, only half of the anticipated scrubbers were installed. Instead, electricity generators delivered 55-60% of the emission reductions by using more low sulphur coal.[31] Instead of a 5%:95% blend of low sulphur coal originally thought feasible, they achieved a 40%:60% mix. The cost of transporting low-sulphur coal fell by 50% as the rail industry invested and responded to the commercial opportunities of sulphur regulation as well as rail deregulation that occurred at the same time.[32] And then scrubbers turned out to deliver emission reductions at lower cost than expected: scrubbers cost 40% less to install than the original estimates; and they removed 95% of the sulphur rather than the expected 85%.[33]

Similarly, prices for NO_x emissions from 1999 fell well below expectations. Technology innovations meant that retrofitting pollution control equipment was much cheaper, and power station owners found ways to alter operating conditions to reduce creation of NO_x. This led to such a large surplus of NO_x allowances that regulations were triggered to restrict the use of excess permits in subsequent compliance periods.[34]

[29] Burtraw and Szambelan (2009)

[30] Burtraw and Szambelan (2009)
[31] Burtraw and Szambelan (2009); Harrington, Morgenstem and Nelson (2010)
[32] Burtraw and Szambelan (2009)
[33] Harrington, Morgenstern, and Nelson (2010)
[34] Burtraw and Szambelan (2009); Fraas and Richardson (2010)

2. Policy consequences

The pattern repeated across each of these schemes is that forecast prices for pollution permits and clean energy certificates are much higher than actuals. Forecasts consistently assume a continuation of "known" technologies, and market forces routinely deliver surprising innovations within a few years, resulting in achievement of targets at substantially lower cost than expected. In some cases the targets and regulations required relatively less change to business as usual than governments expected.

When we see the same features repeated across eight phases of six different schemes, we are entitled to suspect there might be a pattern. We can probably predict that in future the forecasts for environmental schemes are *likely* to overestimate the costs of reducing pollution, and are *likely* to be wrong about which actions will deliver pollution reduction at the lowest cost.

How should policy be optimised to minimise the costs of limited government foresight?

2.1 Specific government actions to reduce emissions

First, experience suggests that a general price for carbon emissions is preferable to funding for specific measures. Governments (and other experts) have a demonstrably poor record of predicting accurately how targets will be achieved even six months in advance.

If governments do fund specific measures to reduce pollution, believing that they are the least cost, they may well be missing opportunities. In theory, markets are generally more efficient in encouraging innovation to reduce costs than direct government intervention. The experience of the schemes examined in this Report supports the theory.

This implies that government schemes aimed at particular actions to reduce emissions – for example, funding specific kinds of carbon sinks – are likely to be high cost relative to whatever would evolve from market forces.

Of course, there can be exceptions to this rule if behavioural biases discourage uptake of low cost energy efficiency options. For example, individual consumers tend to care more about up front expenditure than cumulative running costs. Consequently, most consumers will prefer a marginally cheaper television, even if the cost of its long-run electricity use will lead to a higher lifetime cost. Implicitly, consumers often apply very high discount rates. Government intervention may be justified in the form of minimum efficiency standards, or up-front capital incentives such as taxes on energy inefficient products or subsidies for energy-efficient products. However, the experience of market innovation suggests that the burden of proof should fall on those arguing for such exceptions, rather than an assumption that government is likely to do well in identifying lower cost abatement options.

It may also be rational for governments to encourage a technology that is not lowest cost at the moment, because market forces may not readily overcome substantial hurdles to commercial development and initial deployment.[35]

Even if this true in individual cases, experience suggests that support for emerging technologies should aim to minimise the role of government in making active selection decisions about specific projects to fund. In particular grant tendering schemes based on criteria open to wide interpretation are susceptible to the forecasting mistakes identified in this paper.

2.2 Trading scheme design

Experience also suggests that in designing trading schemes, governments should set price floors. The market price of carbon is likely to be lower than government forecasts. When governments over-estimate the cost of reducing emissions, they tend to choose a weak cap, or target, and make it easy to generate offsets. Governments (at least in theory) set pollution caps so that the expected benefit of reducing pollution is the same as the expected cost of reducing pollution. If the cost of reducing pollution is less than expected, it would be rational to set a lower cap. A floor price automatically corrects this tendency. A floor price effectively reduces the number of permits issued if the price falls to the floor.

Alternatively, governments could respond to lower costs than expected by resetting the cap on pollution. However, this inevitably raises concerns that government is changing the rules mid-stream. It undermines confidence in the certainty of the scheme rules, and thus reduces confidence in long-run investment to reduce emissions. Inherently a floor price announced at the start of a scheme provides more certainty than subsequent ad hoc government intervention to reset the cap in the light of experience.

There are other arguments for floor prices.[36] Floor prices provide certainty for the builders of low-emissions power plants that they will not be undercut by existing high-emissions generators if carbon prices turn out to be low. This is an important issue for financing power generation where the prospective financiers of a project look at the returns for a “plausible but bad case” (say the worst 15% of outcomes), and refuse to provide finance if this would result in a significant loss. If unlikely but plausible low carbon prices would lead to losses for new low emissions electricity generation, they will struggle to attract finance. Although in theory investment decisions should be driven by a full risk-adjusted return model, in practice power stations require such large sums of capital, that these are often board-level decisions. The output of a risk-adjusted Monte Carlo analysis will inevitably be a “black box” that conceals its assumptions from anyone not close to the project. Boards are likely to insist instead on a transparent (albeit more simplistic analysis) that shows the financial outcome under certain key assumptions, and reject finance when plausible assumptions lead to significant losses.[37] A floor price provides significant assurance that in the “plausible but bad” case, lower emissions electricity generation will still generate positive returns.

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[35] The rationales for government support to reduce emissions other than through pricing emissions will be explored in forthcoming Grattan Institute reports. For a brief overview of the kinds of issues involved, see Foxon *et al* (2007)

[36] Burtraw, Palmer and Kahn (2009); Wood and Jotzo (2009)

[37] Based on Grattan Institute interviews with finance company staff.

The experience of pricing schemes also suggests that floor prices should be delivered by setting a minimum price at which permits will be issued. This is preferable to setting up a government agency such as a central bank of carbon that intervenes in the market whenever prices fall below the floor price.[38] Such an institution would incur irrecoverable losses if prices never recover above the floor price. The experience of pricing schemes in this Report suggests this is a plausible – even likely – outcome. In many of the schemes studied in this Report, actual prices were substantially lower than forecast, and remained depressed despite tightening targets.

The design of a minimum price could be refined by defining an escalator. This is desirable given that it is likely that technology will continue to innovate to reduce costs at a faster rate than inflation. For example, in an Australian context the minimum carbon price might be set at \$20/t CO_2 in 2012, with this price increasing at a rate similar to that of a carbon tax outlined in the Garnaut Review of 4% per year plus the rate of inflation.[39]

Individuals and companies have not had strong financial incentives in the past to reduce carbon emissions. Consequently, surprises are likely.

Technology innovation is the key to reducing carbon emissions. Markets may not be perfect, but they are consistently effective at identifying lower cost opportunities, promoting innovation, and responding flexibly to changes. Markets are likely to deliver more innovation at lower cost than government programs committing funding to specific projects well in advance of delivery.

For markets to do this efficiently, however, they need clarity around the long-term stability of regulatory rules. A floor price on carbon will be an important element in providing greater clarity and long-term stability.

[38] McKibbin (2009)
[39] Garnaut (2008)

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