Insight Economics

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Impacts of Emissions Trading on Western Australia

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EXECUTIVE SUMMARY

In this report, Insight Economics, McLennan Magasanik Associates and the Monash Centre of Policy Studies assess the impacts on Western Australia of the National Emissions Trading Taskforce's proposed emissions trading scheme.

Rationale for a carbon signal

Significant policy action by a single country — particularly one such as Australia with less than 2 per cent of global emissions — would not only have a negligible impact on climate change, but, in the absence of matching global action, would also lead to the export of wealth and jobs to other countries.

Nevertheless, there are a number of actions that can legitimately be taken unilaterally in Australia at this time that could enhance the welfare of the community, even if global action is delayed. The objective of these actions would be to position the Australian economy so that it could better adjust to subsequent participation in global action — in the expectation that significant action will occur in the medium term. Such actions need to strike a balance between being effective in terms of moderating present and future abatement, while not imposing substantial costs on the economy and driving investment offshore.

A criterion for justifying such action is that in measuring present costs against future expected benefits, there should be a positive net present value in terms of the impact on the welfare of the Australian community. Approaches that may satisfy this criterion include:

- as co-chair of the new group examining international action post-2012, driving an agenda to secure sustainable global action to drastically reduce emissions;
- 'no regrets' measures, such as increasing energy efficiency, that are worth doing anyway, irrespective of their greenhouse benefits, because they provide other net gains to the community;

- supply side measures, such as government support for greenhouse-friendly R&D, that may provide future benefits to the Australian community by means of positioning our economy to switch to new technologies in a carbon constrained world; and

- the provision of signals to investors so as to avoid investing in costly long-lived assets that may become stranded in the event of significant global action on greenhouse.

While the Commonwealth Government has been active in developing measures to address the first three elements, a policy 'gap' remains at the present time in relation the fourth element — the provision of signals to investors. While support for R&D is desirable both to reduce the cost of existing greenhouse-friendly technologies and to find new ones, the cost of these technologies is unlikely to be lower than existing greenhouse-unfriendly processes. A carbon price signal is therefore required if these processes are to be brought to market.

This issue is most significant in the stationary energy sector, particularly electricity generation, because of the length of life of capital assets. Generation plant can have an economic life of well over fifty years and so the choice of technology is a crucial one. But currently, in the absence of a carbon signal, coal provides the cheapest fuel sources for base load generation in most locations in Australia. In Western Australia, recent rises in new domestic gas contract prices into the South-West have made coal fired plant the most economic base-load option.

Given the likelihood of eventual global action to curtail emissions substantially, it may not be in the best interests of the community if investors in future base load generation plant select current technology black or brown coal as the fuel source. A more greenhouse-friendly fuel source could provide net benefits to the community in the longer term, in terms of lower electricity prices, and could reduce the likelihood that assets that are still technically efficient become stranded.

It is for this reason that there is a strong case for imposing a carbon signal into the market place before the next investment in base load generation is required. Given that the Commonwealth refuses to take action over this issue, this could be a highly prospective area for State government policy intervention.

The National Emissions Trading Scheme

In terms of economic theory, a cap and trade emissions trading scheme can be an efficient means of reducing emissions so as to meet a particular emissions reduction target.

The National Emissions Trading Taskforce (NETT) has proposed a possible design for a National Emissions Trading Scheme (NETS) in its recently released Discussion Paper. We consider that much of the proposed NETS design is reasonable, and would not disadvantage Western Australia relative to other jurisdictions.

Key issues from the perspective of Western Australia's interests involve the:

- ultimate objectives for the scheme, and related to this, scheme cap and penalty arrangements;
- boundaries of the scheme, including linking with international schemes; and
- detail of permit allocation.

Objectives for the scheme

The NETT outline the following objectives for a domestic NETS:

- ensuring environmental integrity;
- promoting investor certainty;
- minimising impacts on the economy;
- ensuring flexibility; and
- equity.

Environmental integrity

What really matters in achieving environmental integrity is that the global community engages in effective global action to reduce emissions. As Australia contributes less than 2 per cent of global emissions, it has limited direct influence over whether global emissions are constrained.

On the other hand, Australia as a developed country needs to lead by example — through contributing its efficient share of the required global emissions reductions. In this context, it is efficient if Australia contributes abatement up to the corresponding global marginal cost of abatement.

Investor uncertainty

The question for investor certainty is not the *quantity* of abatement required to be achieved by the NETS, but more importantly what carbon *price* will be faced by their specific project, adding to their costs. Given uncertainty, setting quantity targets through a NETS is likely to be less effective in reducing investor uncertainty than setting price targets, such as through a tax. Despite this, a NETS has a number of other advantages, and it is possible to gain the best features of a NETS and a tax through a hybrid system.

An efficient hybrid system could be achieved by setting the NETS penalty at a level which caps the price of permits on a trajectory equivalent to the expected global marginal cost of abatement — required to deliver cuts consistent with preventing dangerous anthropogenic climate change. Setting a clear maximum price trajectory in this way would improve certainty for investors, particularly given expectations that Australia will eventually join a global regime.

There is considerable uncertainty about the future global price of carbon. However, at this point it would be reasonable to expect that global efforts will focus on stabilising atmospheric concentrations of greenhouse gases at somewhere between 450 and 550 parts per million by 2100. On this basis, examination of a broad range of modelling of global outcomes suggests that a reasonable risk-weighted expectation could be that global carbon prices will be on an upwards trajectory that delivers a global carbon price of *at least* $ 25 per tonne of CO_2e (real 2005 Australian dollars) by 2020.

Such a carbon price trajectory could inform the setting of the penalty cap for non-compliance by liable parties in the NETS. The level of the penalty cap for the subsequent period after 2020 could be revised upon review of the NETS, slated by the NETT to occur around 2015.

Minimising impacts on the economy

A price cap would help to minimise impacts on the economy — by ensuring that the costs of abatement to achieve a specified quantity target in Australia are not greater, at the margin, than the expected global price for carbon.

Once the NETS penalty cap trajectory is established, then the targeted emissions cap, and hence the amount of permits created, could be set consistent with more optimistic expectations of what quantities of abatement will be achieved up to the specified penalty level. By capping marginal costs in this way, more ambitious targets could be attempted. While the certainty of achieving a precise level of emissions would decrease, the probability of bettering those levels would increase.

An optimistic target would provide maximum encouragement for innovation, while allowing abatement quantity 'discovery' within Australia. It would also maximise the benefits of 'positioning' for a future carbon constrained world, in terms of providing a price signal for the emissions intensity of long lived assets. The penalty cap would ensure that economic costs of transitioning to the expected international price for carbon are minimised.

A carbon price ramping up to around $25 per tonne of CO_2e by 2020 should be sufficient to:

- prevent most new conventional coal fired power in Australia; and
- in conjunction with an aggressive complementary policy for energy efficiency, put Australia on track to return emissions from electricity generation sector to around year 2000 levels by 2030.

Establishing a NETS in advance of a truly global system carries risks that NETS permits may not be fungible with the new system. This could lead to significant contingent liabilities for State governments:

- Investment decisions would be made on the basis of permits allocated under the NETS. The States and Territories would need to ensure these permits are recognised in any future system.
- If allocated permits were not recognised in a subsequent system, there would be a strong case that the States and Territories would need to compensate affected firms. This could be costly, particularly if the future price of carbon was higher than that applying in the domestic scheme.

These contingent liability issues suggest that alternative policy options to constrain domestic emissions — such as for harmonised emissions intensity benchmarks — could be a preferred transitional mechanism to a global carbon constraint for states and territories. There would not need to be any contingent liability with this option, as the governments would not be allocating permits to emit up front.

In the event that a domestic NETS is adopted in advance of a global system, then linking to other schemes delivers gains from trade — with the aggregate emissions cap met at lower cost. As the NETT note, this suggests that the design of a NETS should maximise the chances of future linking. Linking would help to reduce the chances that a domestic scheme would be out of step with emerging global arrangements.

Flexibility

Designing quantity flexibility (through gateways) and price flexibility (through regular review of the penalty) into a NETS would have clear benefits. Flexibility maximises the ability to respond to new information on the climate change science, international obligations, and the costs and nature of new technologies.

Equity

Equity considerations are important in terms of the political feasibility of any policy to address climate change. Pricing carbon would raise the price of fossil fuels directly, and also would flow on to increased electricity prices. The economic modelling undertaken for the NETT suggests that wholesale electricity prices could rise substantially.

This will have competitiveness and distributional impacts, particularly for existing generators, trade-exposed energy-intensive industries, and households.

The NETT propose to distribute permits to existing electricity generators and to trade-exposed energy-intense industry to compensate for these impacts. The NETT also propose that a proportion of permits be auctioned, with revenues then available to offset the impacts on the more severely affected households. Whether this will be successful in addressing equity issues will depend crucially on the permit allocation process and the revenue distribution method.

Proposed permit allocation arrangements for *generators* are judged to be reasonable, and not to create issues for Western Australia.

The rules defining whether *trade-exposed energy-intensive firms* qualify for compensation through permit allocation should be a key priority for further investigation in Western Australia:

- Western Austalia has a higher export propensity than the rest of Australia — in 2005 the value of exports was 33 per cent of Western Australia's GSP, compared to 17 per cent for the rest of Australia;
- the Western Australian Mining and Manufacturing industries are far more energy intensive (based on inputs of coal, gas and electricity) than the rest of Australia — these inputs accounted for 5.4 per cent of total operating expenses of these

industries in Western Australia *on average*, compared to 2.4 per cent for the rest of Australia.

A simple approach — such as a fixed threshold for energy as a share of operating expenses — would be a fairly arbitrary measure. It would discriminate at the margin, particularly for firms that fall just below the threshold. On the other hand, in some cases compensation may not be necessary to maintain competitiveness, even for energy shares higher than 3.5 per cent, as the overall impacts on firms will be depend on a number of factors, including the:

- degree of trade exposure;
- degree of competition from countries that do not have a greenhouse constraint;
- degree of energy intensity;
- extent of opportunities for fuel switching;
- position in the global cost curve; and
- whether the production is from an existing investment with largely sunk capital, as opposed to new production from an expansion of existing plant or from a green fields operation.

Overall, this raises uncertainty about whether compensation would provide windfall gains for some, while penalising others. An arbitrary threshold has potential to create significant distortions, with Western Australia more vulnerable than other jurisdictions by dint of its greater energy intensity, greater trade exposure, and greater reliance on less elaborately transformed products. A simple allocation approach — desired by the NETT — does not address this issue adequately.

There are no clear and easy solutions to this problem. The implication for Western Australia is that this issue requires detailed further investigation, on a sub-sectoral, enterprise and even establishment basis, to determine the overall impacts. It may be that variable thresholds are warranted, depending on sector, and depending on whether production is from new or old plant. The complexity of this issue points to the potential problems for Western Australia in implementing a broad based greenhouse constraint in advance of global action.

Modelling the impact of a NETS

The implications for Western Australia of six of the NETS scenarios modelled for the NETT, and two additional scenarios undertaken for the Western Australian Office of Energy, are compared:

- *Domestic Action (DA) Scenario 1* — electricity generation *combustion* emissions were capped at 176 Mt CO2 e by 2030. The 176 Mt CO2 e cap would be equivalent to returning electricity generation sector emissions to around year 2000 levels.

- *Domestic Action (DA) Scenario 1a* — as per DA Scenario 1, but with sensitivity for enhanced energy efficiency uptake, demand side 'induced technical change' and increased forestry biosequestration offsets. In this sensitivity analysis the targeted emissions quantity trajectory followed that of DA Scenario 1.

- *Domestic Action (DA) Scenario 4* — assesses the carbon price, from a NETS covering electricity sector *combustion* emissions, required to *just prevent* the uptake on new coal fired electricity generation in Australia.

- *Global Action (GA) Scenario 3* — Australia's electricity generation *full fuel cycle* emissions were capped at 176 Mt of CO2-e by 2030 — the target for 2030 was for both combustion *and* upstream emissions from electricity generation.

  - Combustion emissions only from electricity generation were covered by the NETS from 2010 to 2015, but thereafter the carbon price from the electricity generation sector was extended to the other Stationary Energy and Fugitive sector emissions. From 2020, all other emitting sectors in the economy faced the carbon price from the electricity generation sector.

  - The rest of the world progressively takes action on climate change, facing the same carbon price as that in Australia.

- *Global Action (GA) Scenario 3a* — targeted, through a NETS, the same emissions quantity profile for electricity generation Australia-wide as 'Global Action Scenario 3' in the NETT modelling. Scenario 3a differs from Scenario 3 in:

  - utilising Scenario HGP ('High Gas Price') modelling outputs as the starting point 'reference case' — to reflect the potential for rising Domgas prices in Western Australia;

    - in contrast, Scenario 3 deviations were measured against the respective model 'base cases'.

- *Domestic Action (DA) Scenario 4a* — targeted the same emissions quantity profile for a NETS Australia-wide as was targeted in the NETT modelling of Scenario 4. Scenario 4a differs from Scenario 4 in:

  - utilising Scenario HGP modelling outputs as the starting point 'reference case' — to reflect the potential for rising Domgas prices in Western Australia;

    - in contrast, Scenario 4 deviations were measured against the respective model base cases; and

  - not allowing banking — thus the carbon price reflects exactly that required to prevent uptake of coal in any year.

Carbon prices

The imposition of a NETS leads to a carbon price in the electricity generation sector. Depending on scenario, carbon prices ramp up steadily from 2010 to reach between $17 and 34 per tonne of CO2e at 2020, and between $28 and 37 per tonne of CO2e at 2030.

Electricity prices

Among other impacts, the carbon price encourages fuel switching in electricity generation — away from emissions intense electricity generation sources such as coal, and towards relatively less emissions intense generation sources such as renewables and gas. This raises the price of electricity in Western Australia:

- wholesale electricity price increase in the range of 27 to 63 per cent, depending on scenario;
- retail electricity prices increase in the range of 19 to 48 per cent, depending on scenario.

Emissions reductions

Generally, the carbon prices associated with the NETS reduce Western Australian electricity generation sector emissions by around -2.5 Mt CO2e at 2030, around -13 per cent below the business as usual base case. It is cheaper to achieve further emissions reductions beyond this amount in other sectors in Western Australia, and elsewhere in the eastern states.

Macroeconomic impacts

The macroeconomic impacts on the Australian economy of achieving the fixed domestic quantity targets are small at 2030. The economy continues to experience solid growth.

The Gross State Product (GSP) impacts of a domestic NETS on Western Australia is close to zero for Scenarios 1, 1a, 4 and 4a — delivering a slight boost for the Western Australian economy at 2020 and 2030 of between 0.1 and 0.3 per cent in level terms, compared to the base case. The positive impacts in these scenarios results from the relative shielding of Western Australia from the full impacts of the NETS, compared to other States:

- compensation for energy-intensive trade exposed industries such as Alumina mean that a greater proportion of the Western Australian economy is shielded from the impacts of the scheme; and
- the electricity generation sector in Western Australia contributes relatively small reductions, as it is cheaper to undertake emissions reductions in the eastern states.

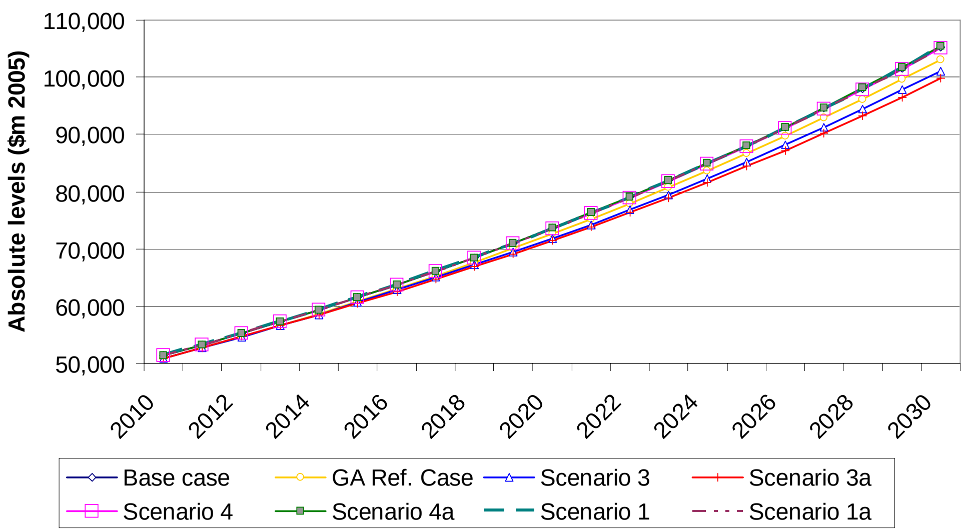
The GSP impacts on Western Australia in Scenario 3 and 3a, on the other hand, would be substantial. The majority of the economic impact on Western Australia in these scenarios arises from the actions to address climate change assumed to be undertaken in the rest of the world. Western Australia's GSP is down -3.2 per cent in level terms below the base case at 2030 from this effect alone — which occurs *irrespective* of whether domestic action is undertaken or not. This impact from actions in the rest of the world reflects the assumption of significant global carbon prices, and results from an ensuing reduction in demand for Western Australia's key exports, particularly for LNG.

The additional impact of *domestic* action, whether through the Scenario 3 or 3a domestic NETS, increases this impact, by -1.6 and -2.3 per cent respectively. Overall, the combined impact on GSP on Western Australia of action in the rest of the world and implementation of a domestic NETS is for GSP to be down by -4.8 and -5.7 per cent at 2030 in level terms, respectively, compared to the base case.

Private consumption is a good proxy for the impact of a NETS on the economic welfare of the community. The impact on private consumption in Western Australia of a domestic NETS follows the pattern observed for GDP, albeit amplified by the 'leakage' of compensation payments to foreign shareholders.

The impact of the domestic NETS on Western Australia's private consumption is close to zero for Scenarios 1, 1a, 4 and 4a — private consumption in the Western Australian economy at 2020 and 2030 is down in level terms compared to the base case by between 0.0 and -0.2 per cent. This is indistinguishable from zero (Figure ES.1).

FIGURE ES.1 – NATIONAL NETS — PRIVATE CONSUMPTION ABSOLUTE LEVELS – WESTERN AUSTRALIA



Source: MMA Strategist and CoPS MMRF-Green modelling

In *level terms* at 2030, contributing to the Scenario 3/3a emissions constraint results in Western Australia's private consumption:

- *absent higher gas prices (Scenario 3)* — being down a total of -4.2 per cent compared to the base case, comprising a -2.3 per cent reduction arising from the actions adopted by the rest of the world (the GA Ref. Case impact in Figure ES.1 — which again, occurs *irrespective* of the level of domestic action), and a -1.9 per cent reduction from the adoption of a domestic NETS (the Scenario 3 impact in Figure ES.1);
- *with higher gas prices (Scenario 3a)* — being down a total of -5.0 per cent compared to the base case, comprising:
  - a -2.3 per cent reduction arising from the actions adopted by the rest of the world (the GA Ref. Case impact in Figure ES.1 — which again, occurs *irrespective* of the level of domestic action);

- a -3.0 per cent reduction from the adoption of a domestic NETS (the Scenario 3a impact in Figure ES.1); and

- a positive 0.3 per cent impact of moving to higher gas prices.

Employment outcomes for Western Australia are positive in Scenarios 1, 1a, 4 and 4a, with impacts ranging between 0.3 and 0.4 per cent.

On the other hand, the impact on Western Australia's employment in Scenario 3/3a is negative. Employment is down by more than -1 per cent at 2020 and -0.5 per cent at 2030 in level terms compared to the base case — under the combined impact of action by the rest of the world and a domestic NETS.

Real wages experience marginally slower growth in Western Australia in all scenarios, to be down in level terms compared to the base case. The percentage deviation below the base case is small in most scenarios. However, in Scenario 3 and 3a, real wages are down by -3.8 and -4.9 per cent respectively.

Contracting industries in Western Australia which experience declines in value added as a result of the NETS, of below -10 per cent in 2020 compared to the base case, are dominated by Electricity-coal and Coal, irrespective of scenario. The contraction in these industries reflects the reduction in coal fired electricity generation required to achieve emissions targets in all scenarios.

The other industry which experiences a slowdown below -10 per cent is Alumina, in Scenario 3a.

- Alumina is little affected in Scenarios 1, 1a, 4 and 4a, because the compensation for energy price rises in these scenarios shields the industry from the impacts of the NETS.

- In Scenario 3, Alumina is up strongly at 2030, by 24 per cent compared to the base case, due to an expansion of global demand for alumina and aluminium in the presence of a global carbon constraint — which more than outweighs the loss in competitiveness experienced by Australia due to its fossil fuel based production.

- In Scenario 3a, on the other hand, Alumina contracts relative to the base case, particularly once compensation for energy price rises is removed at 2020. The positive impacts of an expansion in global demand for alumina and aluminium are outweighed by the negative impacts of higher domestic gas prices in this scenario. Nevertheless, the industry still experiences strong overall growth compared to current levels of output.

Costs per tonne abated

Private consumption is the best measure of the welfare effects of a policy. A range of scenarios were plotted in terms of the *cumulative private consumption cost per tonne of cumulative abatement* achieved.

For *Australia*, the cumulative private consumption costs per tonne of cumulative abatement appear to rise fairly linearly through to around $25 per tonne of CO2e, but thereafter have a tendency to climb more sharply.

For *Western Australia*, the cumulative private consumption costs per tonne of cumulative abatement also rise linearly, but in this case through to around $30 per tonne of CO2e before climbing sharply.

However, Western Australia's cumulative private consumption costs per tonne of cumulative abatement appear to be about *half* those of Australia's (as a whole) in the Domestic Action scenarios. This reflects the finding that much of the generation sector abatement task is achieved in States and Territories other than Western Australia, and also the fact that Western Australia's trade-exposed energy-intensive industries are 'shielded' from the impacts of the NETS in these scenarios.

In the Global Action scenarios on the other hand, Western Australia's cumulative consumption costs per tonne of cumulative abatement are very similar to those of Australia as a whole. This reflects in part the relatively greater impact that action by the rest of the world has on Western Australia, which will tend to make up for the lower costs of Domestic Action in Western Australia.

The other important measure of the cost of abatement is the marginal dollar cost of abatement — reflected in the cumulative abatement achieved for a rising NETS carbon price.

The analysis suggests that abatement in Australia tends to be fairly limited up to around $10 per tonne CO_2e — this is the price at which significant fuel switching to gas starts to occur for new electricity generation investments (in Victoria initially, and thereafter progressively in the other states).

Thereafter, abatement rises linearly with an increase in the carbon price, up to around $25 to $30 per tonne CO_2e. At $25 per tonne CO_2e, an indicative central estimate for *cumulative* abatement in:

- *Australia* is around 300 Mt CO_2e — which is around 5 per cent of Australia's total cumulative emissions in the base case through to 2020, and around 10 per cent of Australia's cumulative stationary energy emissions over the period;

- *Western Australia* is around 30 Mt CO_2e — which is around 3 per cent of Western Australia's total cumulative emissions through to 2020, and around 8 per cent of Western Australia's cumulative stationary energy emissions over the period.

The amount of cumulative abatement achievable then rises sharply at around $28 to $35 per tonne CO_2e — this reflects the assumption in the NETS modelling of cost effective carbon capture and storage becoming available at these prices, from around 2021 on.

CHAPTER 1

Introduction

Australia has yet to adopt a broad based national policy to mitigate greenhouse gas emissions. The Commonwealth Government maintains that it would not be in Australia's interests to adopt a national emissions trading scheme in advance of a global regime that included all major emitters.

In contrast, the States and Territories' National Emissions Trading Taskforce (NETT) recently released a Discussion Paper setting out a possible design for a national emissions trading scheme (NETS).[1] The NETT's objective is 'to provide a framework for emissions reduction that give business and the community certainty and predictability'.[2]

1.1 The requirement

The Greenhouse and Energy Task Force engaged Insight Economics, McLennan Magasanik Associates and the Monash Centre of Policy Studies to examine emissions trading options for Western Australia.

The terms of reference for this consultancy project are as follows:

(a) Improve the knowledge and understanding of the Taskforce in regards to the potential impacts on the State's economy and WA based enterprises of the scheme currently being developed by the NETT;

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1 National Emissions Trading Taskforce 2006, *Possible Design for a National Greenhouse Gas Emissions Trading Scheme*, www.emissionstrading.net.au .

2 Ibid, pp i.

(b) Identify and inform the Taskforce about which aspects of the design of the NETT scheme might be in the State's best interests;

(c) Identify key design choices, whether already made as part of the model or still to be made, that are particularly significant from a Western Australian perspective or where Western Australia's different characteristics from other jurisdictions have a particular bearing;

(d) Develop a modelling approach to inform the Taskforce of the costs and benefits of aspects of the NETT scheme, including any modelling required to investigate the WA implications of design choices as per the above dot point;

(e) Undertake modelling by agreement with the Taskforce to determine the impacts of the scheme on the Western Australian economy; and

(f) Make recommendations for changes to the scheme to enhance the preferred aspects of the scheme or ameliorate areas of concern.

1.2 This report

This report considers the policy issues associated with a national emissions trading scheme from Western Australia's perspective. It also evaluates the likely economic impacts of a number of the NETT scenarios on Western Australia.

Chapter 2 considers objectives for greenhouse policy.

Chapter 3 identifies and assesses a number of key design features of the proposed NETS that are important for Western Australia.

Chapter 4 reports on the impacts on Western Australia of six NETS scenarios.

CHAPTER 2
Greenhouse policy

Emissions trading can provide an effective and efficient means to achieve significant reductions in greenhouse gas emissions. Implementing emissions trading in advance of global action on climate change presents challenges for maintaining the competitiveness of trade-exposed energy-intensive industries. Alternative policy instruments to a NETS may be a more cost effective transitional approach in the medium term to provide a carbon signal for new investments in electricity generation.

2.1 Rationale for a carbon signal

The fourth assessment report of the Intergovernmental Panel on Climate Change recently became available in draft on the US Government website. It is clear that the scientific consensus has strengthened in the last five years since the release of the third report. The median expectation is that average global temperature will increase by three degrees Celsius during this century and that there is little that can be done now to prevent this. While a three degree increase will have varying but significant consequences around the globe (and catastrophic implications for some Australian icons such as the Great Barrier Reef), the challenge now is to implement policies that enable us both to adjust to this major change and, as far as possible, to prevent further temperature increases occurring.

The difficulty with designing policies to meet the latter objective is that, obviously, climate change is a global problem. Presently there is a considerable disconnect between what the scientific experts tell us needs to be done and the policy actions to which the governments of the world are willing to commit at this stage. Although the situation may change quite rapidly, there is little sign at this point in time that concerted global action to achieve deep cuts in emissions will occur in the near future.

Yet significant policy action by a single country, particularly one such as Australia with less than 1.5 per cent of global emissions, would not only have a negligible impact on climate change, but, in the absence of matching global action, it would also lead to the export of wealth and jobs to other countries.

This is the dilemma for governments that are concerned about climate change and want to do something about it. In Australia's case, even if we reduced our emissions to zero tomorrow, the emissions associated with economic growth in China would, on their own, replace Australia's current emissions in less than one year. Overall, there seems to be little point in imposing a de facto tax on Australia's emitters when most of the rest of the world remains immune.

Nevertheless, there are a number of actions that can legitimately be taken unilaterally in Australia at this time that could enhance the welfare of the community even if global action is delayed. The objective of these actions would be to position the Australian economy so that it could better adjust to national participation in significant global action in the expectation that such action will occur in the medium term. Such actions need to strike a balance between being effective in terms of moderating present and future abatement while not imposing substantial costs on the economy and driving investment offshore.

A criterion for justifying such action is that in measuring present costs against future expected benefits, there should be a positive net present value in terms of the impact on the welfare of the Australian community. Approaches that may satisfy this criterion include:

- as co-chair of the new group examining international action post-2012, driving an agenda to secure sustainable global action to drastically reduce emissions;

- 'no regrets' measures, such as increasing energy efficiency, that are worth doing anyway, irrespective of their greenhouse benefits, because they provide other net gains to the community;

- supply side measures, such as government support for greenhouse-friendly R&D, that may provide future benefits to the Australian community by means of positioning our economy to switch to new technologies in a carbon constrained world; and

- the provision of signals to investors so as to avoid investing in costly long-lived assets that may become stranded in the event of significant global action on greenhouse.

In terms of the second of these points, Australia has been working to take up 'no regrets' opportunities for the last decade and beyond. In terms of energy efficiency, there remains much to be done to exploit the substantial opportunities that exist, but this is currently being addressed through CoAG processes. In other areas, there is also action that could be taken: for example, why does the fringe benefits tax encourage people to drive longer distances?

Turning to the third point, Australian governments at both the federal and State level have been active in providing funds to encourage R&D in greenhouse friendly technologies, particularly in the stationary energy sector with a recent focus on cleaner coal. The Commonwealth's LETD fund is the main example of this approach.

It is in regard to the fourth point that a policy 'gap' exists in Australia at present. While support for R&D is desirable both to reduce the cost of existing greenhouse-friendly technologies and to find new ones, the cost of these technologies is unlikely to be lower than existing greenhouse-unfriendly processes. A carbon price signal is therefore required if these processes are to be brought to market. This represents the main gap, and it is a significant one, that presently exists in Australia's climate change policies.

This issue is important in sectors such as transport, where Australia's car manufacturers produce vehicles with, on average, the highest greenhouse footprint in the world. But it is most significant in the stationary energy sector, particularly electricity generation, because of the length of life of capital assets. Generation plant can have an economic life of well over fifty years and so the choice of technology is a crucial one. But currently, in the absence of a carbon signal, black and brown coal provide easily the cheapest fuel sources for base load generation (gas, which is relatively greenhouse-friendly, is generally the most efficient fuel for intermediate and peaking plant) and they have relatively high emissions footprints.

Given the likelihood of eventual global action to curtail emissions substantially, it may not be in the best interests of the community if investors in future base load generation plant select current technology black or brown coal as the fuel source. A more greenhouse-friendly fuel source may provide net benefits to the community in the longer term, in terms of lower electricity prices, and would be less likely to lead to the stranding of assets in the presence of high carbon prices. But since greenhouse friendly fuels cannot compete effectively with coal to supply base load power, investors are unlikely to select them in the absence of a carbon signal.

It is for this reason that there is a case for imposing a carbon signal into the market place before the next investment in base load generation is required. Given that the Commonwealth refuses to take action over this issue, this could be a highly prospective area for State government policy intervention.

While we have not worked closely with the States regarding their policy objectives, they would seem mainly to be focussed on the fact that the lack of a carbon signal is bringing about investor uncertainty, particular in the electricity generation sector. In the overall national and international context of policy, it would seem entirely appropriate for sub-national jurisdictions to address this policy gap. While this represents a much more limited objective than the big bang aspirational targets that were initially being discussed, it would:

- clearly fill a gap in existing greenhouse policy with an approach that many industry representatives (including the Energy Supply Association of Australia) have called for;
- improve investor certainty because, provided it is designed carefully, it would be consistent with the jurisdictional powers of the States under the Australian constitution; and

- overall be likely to win wide community support on the basis that it would represent good policy in response to an issue of increasing public concern.

2.2 Is a States-based NETS the answer for Western Australia?

In terms of economic theory, a cap and trade NETS can be an efficient means of reducing emissions so as to meet a particular target. By taxing emitters, while allowing them to trade emissions permits, it will minimise the costs of adjustment. A global system of emissions trading is one means to allow the cheapest abatement opportunities worldwide to be exploited. As discussed above, a unilateral NETS has the problem that it may drive wealth and jobs offshore without producing any commensurate greenhouse benefit. Further problems arise when the NETS is restricted to just one emitting sector of the economy.

Nevertheless, if the States were resolved to introduce a NETS for stationary energy, first they would need to establish an appropriate cap. This could be achieved by using energy sector modelling to determine both projected emissions in 2020 under a business as usual projection for the electricity sector and when and where the next generators in the NEM will be required. The cap might then be set at a level that would enable future generation to be provided by natural gas combined cycle, clean coal technologies or renewables (and possibly by nuclear power post-2020).

Advantages and disadvantages of a NETS

Some advantages of this approach would be:

- the policy instrument would be closely attuned to the policy objective, in that it would provide clear market signals to prospective investors in new generation plant;
- the market would determine the technologies used in new generation plant;
- it would create an incentive for abatement in existing generation plant;
- it would create an additional incentive for R&D into new, greenhouse-friendly technologies;
- it could be extended to other sectors of the economy later; and
- this domestic policy measure could be readily tightened as required and may be able to be made consistent with an international instrument were a global agreement on deep cuts to be reached.

On the other hand, some possible disadvantages are:

- the carbon price under the scheme would be difficult to predict and, as in the EU, initially at least, may be higher than expected leading to a significant increase in the electricity price;

- if the electricity price rise were to be excessive, it could lead to the costs imposed on the community being greater than the projected future benefits from positioning;
- a significant electricity price rise may mean that special treatment for energy-intensive, trade-exposed businesses would be needed, with all its attendant difficulties;
- establishing a NETS would require a complex legal framework;
- it could give rise to a constitutional challenge, which would create more market uncertainty;
- allocative inefficiencies may arise from the application of a NETS to just one emitting sector of the economy;
- decisions on the permit allocation methodology would be required, which would raise a large number of equity considerations;
- some States would be more disadvantaged than others in terms of the economic impacts; and
- by allocating permits, the States would be incurring a contingent liability that could be realised in a significant way if their scheme was later replaced by a different NETS under the Commonwealth's jurisdiction.

Need for a NETS: objectives versus instruments

In order to decide whether or not it would be still worthwhile to introduce a NETS for stationary energy despite these disadvantages, it is necessary to re-visit the objectives of the policy and examine whether they may be achieved in a less elaborate way.

The third objective identified above, and the one that was relevant to the NETS, was: the provision of signals to investors so as to avoid investing in costly long-lived assets that may become stranded in the event of significant global action on greenhouse. There are two major issues here.

First, while the NETS would be capable of achieving this objective in terms of electricity generation, it would also place pressure to reduce emissions on the incumbent generators. In a situation where the rest of the world is not taking action, and we are not imposing similar pressures on incumbent emitters in other sectors of the Australian economy, the value of this must be open to question. This is particularly so if it leads to increases in electricity prices.

Secondly, before imposing a complex and far-reaching NETS, it is sensible to identify, in practical terms, the investments we are seeking to influence. Exactly what new investments in generation will be required in the National Electricity Market before 2020? The modelling undertaken by McLennan Magasanik Associates (MMA) for the NETT provides an answer to this question (and one with which there is wide agreement in the industry, including from NEMMCO and the ESAA).

BOX 2.1 - NEW BASE LOAD GENERATION FOR THE SWIS

A key issue in considering the need for a carbon signal in Western Australia is the timing of new major investments in electricity generation in the State's South West Interconnected System (SWIS)

For the medium term, the Independent Market Operator of Western Australia (IMOWA) has estimated that energy sent out on the SWIS is forecast to grow at 2.2 per cent per annum in the 'expected growth rate' scenario (through to 2015-16), with maximum demand increasing at 3.2 per cent per annum over the same period.

On the supply side, it is expected that this demand growth will be met through to 2009-10 by committed new plant — which include the successful Stage 2 bidder for the Western Power Independent Power Procurement process (the 320 MW NewGen gas combined cycle at Kwinana), a number of new cogeneration plants, the first 200 MW unit of Griffin Energy's Bluewaters coal-fired power station, new wind farms, as well as a tranche of available peak demand from Western Power's demand side management program.

Beyond that time, the demand for electricity is expected to increase at around 120 MW per year.

MMA's modelling suggests that there is little need for new base load capacity on the SWIS until around 2016. MMA's modelling indicates that early next decade there is a surplus of capacity compared with market needs, with this surplus arising from the commissioning of NewGen, commissioning of 240 MW of cogeneration plant by Alinta, commissioning of a 200 MW coal fired plant at Collie (Bluewaters), expansions at existing coal fired plant and the commissioning of a large amount of new peaking plant (including two new units at Wagerup).[3]

This modelling depends on the assumptions adopted. MMA uses demand forecasts based on the impact on energy demand of assumptions regarding GSP growth and other economic variables assumed in the wider economic modelling undertaken by the Centre of Policy Studies. These forecasts may not incorporate all the more recent information on load growth, particularly in the industrial sector. As a result, the assumptions on rate of growth are slightly lower than for other recent published forecasts (such as IMOWA's latest Statement of Opportunities).

Should overall demand grow faster than projected by CoPS, then new baseload plant may be required earlier than 2016.

Source: Insight Economics; Independent Market Operator of Western Australia 2005, *Statement of Opportunities South West Interconnected System*, www.imowa.com.au ; and W.Gerardi, MMA, personal communication, August 2006.

In the next decade, the main requirements will be for intermediate and peaking plant. This will be provided mainly by more greenhouse-friendly technologies in any case, through gas combined cycle and renewables. A NETS, or indeed any policy instrument, is not required to influence these investments since existing policy instruments and the relative effectiveness of various fuel types mean that greenhouse-friendly technologies will be selected anyway.

Coal, of course, is the fuel of choice for base load generation. We would wish to influence investors away from committing funds to long-lived coal plants, unless they utilised new CCS technologies which would be uneconomic without a substantial carbon price.

In the east, no more than two base load generators are likely to be required in the NEM before 2020. One will be required if the expansion of the Portland aluminium smelter goes ahead. A second base load plant will be required in the eastern States in about 2018.

3 The recent call by Synergy for 400 MW of supply by 2010, may not reflect the need for new capacity for load growth but may instead reflect the need under the vesting contract arrangements for Synergy to competitively tender part of their capacity needs to meet their vesting contract loads.

For Western Australia, there also is no *immediate* problem that needs to be addressed. However, new base load plant will be required sometime around the middle of the next decade. According to MMA, new base load capacity will be required in the State around 2016, although recent evidence suggests that this need might arise earlier (see Box 2.1). With rising domestic gas prices in Western Australia, there is now a strong chance that coal fired power could be the least cost choice.

In terms of influencing the technology choice for the plants needed before 2020, there may be more cost-effective policy options available than a NETS. One example is a regulation defining a maximum level of emissions per MWh from new electricity generation plant. It would be possible for all the States and Territories to adopt such a policy in harmonised fashion, as an alternative to a NETS. However, as electricity prices would rise, there would be similar issues to a NETS in terms of the need to address the competitiveness of energy-intensive, trade-exposed industry. There would also likely to be windfall gains for existing generators.

A large expansion in base load power will be required in the decade 2020-2030, but a policy is not needed to deal with this now. Hopefully, a first best global policy on climate change will have been established by that time, such that an intervention would not be required.

It is possible that Western Australia could participate in a NETS prior to 2020, either as part of Australia's participation in concerted global action on climate change, or as part of a broad-based national scheme that seeks to position Australia for a carbon constrained future. The next chapter considers optimal NETS design from Western Australia's perspective.

CHAPTER 3

Key NETS design considerations for WA

The National Emissions Trading Taskforce has proposed a possible design for a NETS. Many of the proposed features are beneficial from Western Australia's perspective. Key concerns from Western Australia's perspective relate to the NETS cap and penalty and the permit allocation arrangements.

3.1 NETS design considerations

A NETS is a potentially efficient approach to mitigating greenhouse gas emissions if a number of conditions are met, including:

- marginal costs of abatement are relatively well known — such that the overall cost of taking action can be balanced against the benefits over time;
- the scheme design facilitates uptake of new technologies;
- the property rights associated with emissions can be established cost effectively;
- the covered emissions can be estimated and reported accurately at relatively low cost;

- other transactions cost are reasonably low;
- the primary externality is associated with price — other market failures or barriers obstructing efficient abatement are limited (or at least able to be addressed through other complementary policy measures);
- the emissions trading scheme permits are allocated efficiently;
- the scheme coverage is sufficiently broad, and other policy instruments introduce comparable marginal costs of abatement for other non-covered sectors, such that distortions for competition, innovation and production across the economy are minimised;
- distorting effects on the traded goods sector are minimised.

The NETT Discussion Paper

The NETT Discussion Paper outlines a design for a NETS that aims to meet a range of stated objectives. We consider that much of the proposed NETS design is reasonable, and would not disadvantage Western Australia relative to other jurisdictions,

Key issues from the perspective of Western Australia's interests involve the:

- ultimate objectives for the scheme, and related to this, scheme cap and penalty arrangements;
- boundaries of the scheme, including linking with international schemes; and
- detail of permit allocation.

In what follows, we consider these elements from the perspective of Western Australia's interests.

3.2 Objectives

The NETT outline the following objectives for a domestic NETS:

- ensuring environmental integrity;
- promoting investor certainty;
- minimising impacts on the economy;
- ensuring flexibility; and
- equity.

Environmental integrity

Section 2.1 outlined the problem of climate change. It noted that effectively addressing climate change will require a global solution. Hence, achieving environmental integrity requires that Australia work to engage the global community in *effective global* action. This is global is what really matters in relation to 'environmental integrity'.

There is an emerging consensus on the need to stabilise global emissions concentrations in the range of 450 to 550 ppmv to significantly reduce the likelihood of dangerous anthropogenic global warming — where the global average temperature increase does not exceed 2 degrees Celsius. As a corollary, there is a growing consensus that prudent global action will require global emissions to be reduced by 50 per cent on 2000 levels by 2050, with developed countries to contribute 60 per cent reductions.[4] The recent report by Sir Nicholas Stern proposes a lesser global reduction — based on more recent analysis of multi-gas pathways options — of around 25 per cent by 2050.[5]

However, as Australia contributes less than 2 per cent of global emissions, it has limited direct influence over whether global emissions can be constrained. Instead, Australia as a developed country needs to lead by example — and to be seen to be contributing its fair share of emissions reductions.

In this context, it is efficient if Australia contributes abatement *up to the global marginal cos*t of abatement required to constrain global emissions.

Global marginal costs of abatement

A number of modelling projects have sought to estimate the carbon price implications of achieving stabilisation.

One approach, utilising a range of top down and bottom up models, was the 2003 European Union ACROPOLIS project. It examined a consistent scenario for stabilising GHG at 550 ppm by 2100, following a trajectory very similar to that of the Wigley et al 1996 study referencd above.

In this exercise, the results point to potential carbon prices in the range of $25 to $50 per tonne CO_2e at 2020, and $20 to $70 per tonne CO_2e at 2030 in real 2005 Australian dollars (Figure 2.1).

On the other hand, achieving stabilisation at 450 ppm would require earlier, more stringent action. Modelling meta-analysis suggests that required carbon prices could rise to:[6]

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4 While there is a range of modelling, a typical study (Wigley et al 1996) suggests that under a least-cost pathway, global emissions would have to peak no later than 2030 at no more than 11 GtC and then decline, reaching 6 GtC by 2100. This would call for developed countries to reduce their emissions 60 percent by 2050 relative to 2000 levels, and for developing countries to control their own emissions starting around 2030 at the latest. See Wigley, T.M.L., Richels R. and Edmonds J.A. 1996, 'Economic and environmental choices in the stabilisation of atmospheric CO2 concentrations', *Nature*, 379: 242-245. (Note that the Wigley et al study examines CO2 only – multigas analyses can be more optimistic about the estimated reductions required.)

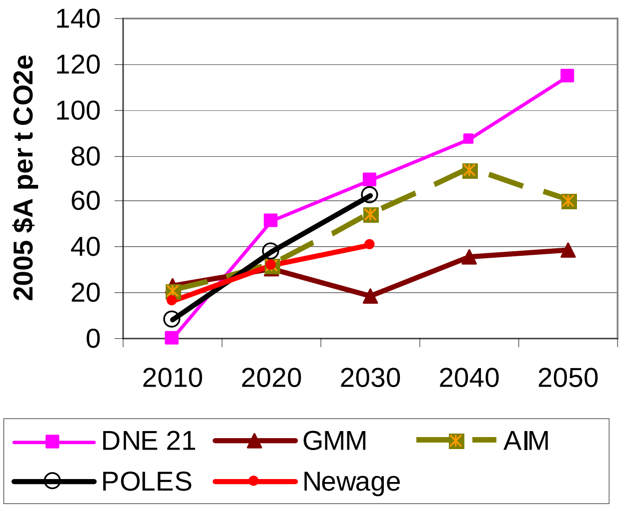
5 Stern Review 2006, *The Economics of Climate Change,* www.hm-treasury.go.uk.

6 Edenhofer O., Lessmann K., Kemfert C., Grubb M, and Köhler J 2006, Induced Technological Change: Exploring its Implications for the Economics of Atmospheric Stabilization: Synthesis Report from the Innovation Modeling Comparison Project, *Energy Journal*, Special Issue on Endogenous Technical Change, pp 98. Carbon prices drawn from the original paper was converted to 2005 Australian dollar prices per tonne of CO2–e in accordance with the US GDP deflator and an assumed $A/US exchange rate of 0.75.

- between 1995 (US) $ 0 to 140 per tonne of *carbon* by 2020 (Figure 3.2) — equivalent to between $ 0 to 60 per tonne CO_2e in real 2005 Australian dollars;

- between 1995 (US) $ 10 to 160 per tonne of *carbon* by 2030 — equivalent to between 2005 (A) $ 5 to 70 per tonne CO_2e in real 2005 Australian dollars.

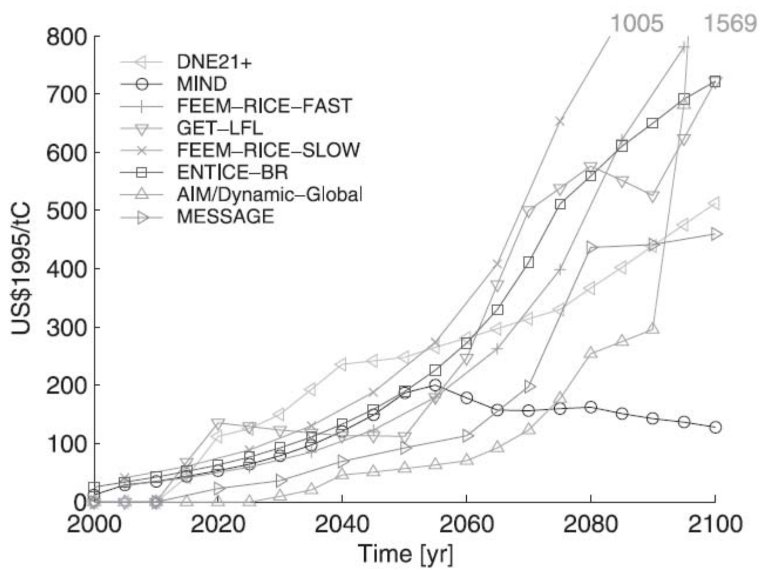
FIGURE 3.1 – LONG RUN CARBON PRICE ESTIMATES UNDER GLOBAL EMISSIONS TRADING – 550 PPM STABILISATION



Source: N. Kouvaritakis 2003, Climate Policy Models: Climate Change Forum organised by ICCF and FORATOM, *Are we ready for COP9?*, www.iccfglobal.org/ppt/NKouv.PPT, accessed 11 August 2005.

Note: Carbon prices drawn from the original papers were converted to 2005 Australian dollar prices per tonne of CO2–e in accordance with a Eurozone GDP deflator (from http://epp.eurostat.cec.eu.int) and an assumed $A/€ exchange rate of 1.6

FIGURE 3.2 – CARBON PRICE TO ACHIEVE 450 PPM STABILISATION



Source: Edenhofer O., Lessmann K., Kemfert C., Grubb M, and Köhler J 2006, op. cit., pp 98.

Since the assets that make the largest contribution to Australia's greenhouse gas emissions, namely electricity generators, have an economic life of about 50 years, these studies point to a significant carbon price risk for investors in this industry.

Investor uncertainty

A steadily increasing price for carbon in the future has clear implications for near term policy in Australia — particular the need to influence the emissions intensity of major new investments in emissions intense projects with long lives. For example, the forthcoming investments in the electricity sector for base load power in the next decade ideally should still be operating in 2050. These 'need a signal now to ensure that likely future emissions constraints are taken into account when investments are made in such long-lived assets'.[7]

However, the question for investor certainty is not the *quantity* of abatement required to be achieved by the NETS, but more importantly what carbon *price* will be faced by their specific project, adding to their fuel costs. Given uncertainty, setting quantity targets is likely to be less effective in reducing investor uncertainty than setting price targets, such as through a tax. Despite this, a NETS has many other advantages, and it is possible to gain the best features of a NETS and a tax through a hybrid system (see Box 3.1).

The NETT have recognised this in the need for a penalty that will serve the purpose of 'capping the cost of compliance and providing certainty to investors about the maximum costs of the scheme'. To this end, the NETT propose that 'the penalty should be set at a level that caps the cost of the scheme at an acceptable level but also encourages compliance'.[8] This is particularly important in the event that Australia was not part of an international trading scheme — whereby the availability of permits at the international price creates an cap on the price of domestic permits.

Given that the NETS is proposed as a unilateral policy in advance of participation in an international scheme, it is of concern that the NETT propose to set the level of the penalty to 'avoid a shortfall in abatement and thereby maintain the environmental integrity of the scheme'. This appears to be giving up an opportunity to limit costs in Australia to that which is reasonably likely internationally, or to a level that is considered economically prudent in the medium term. The corollary is that Australia may undertake inefficient abatement, if the penalty is set too high, or if a subsequent global mechanism offered abatement at a lower cost than could be achieved in Australia.

7 National Emissons Trading Taskforce 2006, op. cit., pp 10.
8 National Emissons Trading Taskforce 2006, op. cit., pp 59.

BOX 3.1 – THE ECONOMICS OF EFFICIENT CLIMATE CHANGE POLICY

The pervasive uncertainty surrounding the degree and impacts of climate change presents challenges for designing an optimal economic policy to address the problem. This uncertainty relates not just to what degree of abatement is prudent, over what timeframe, but also to what the costs of achieving that abatement might be.

Standard economic theory suggests that a given quantum of abatement will be achieved at least cost if the marginal cost of abatement is equated among sources. An instrument such as a tax on emissions or trading of emissions permits under a NETS can achieve this efficiently.

However, under uncertainty, when marginal benefits and costs are uncertain, a NETS may not be as efficient as a tax — the relative slopes of the supply and demand curves for abatement determine which policy is superior.

As noted by McKibben and Wilcoxen:

> A tax is likely to be far more efficient than a permit system. All evidence to date suggests that the marginal cost curve for reducing greenhouse gas emissions is very steep, at least for developed countries. At the same time, the nature of climate change indicates that the marginal benefit curve for reducing emissions will be very flat…
>
> Although a tax would be more efficient than a permit system for controlling greenhouse gas emissions (given flat marginal benefits, rising marginal costs and high levels of uncertainty), a tax has a major political liability: it would induce large transfers of income from firms to the government…
>
> Although marketable pollution permits and pollution taxes can have serious economic and political disadvantages when used alone, those problems can be mitigated by a hybrid policy that combines the best elements of both. For efficiency, the hybrid policy should act like an emissions tax at the margin: it should provide incentives for abating emissions that can be cleaned up at low cost, while also allowing flexibility in total abatement if costs turn out to be high. For political viability, the hybrid should avoid unnecessarily large transfers and have the distributional flexibility of a permit system.

To this end, McKibben and Wilcoxen propose a hybrid system, whereby countries could distribute (in whatever way they chose) long term 'perpetual' permits up to a specified quantity target (for example, returning emissions to 1990 levels) – these would provide a right to emit one tonne of emissions per year for 20 years. These perpetual permits could be bought and sold, which would create a futures market for the price of carbon, much like long term bonds do for the interest rate.

In addition, the government would stand by to sell additional short-term (1 year) permits at a specified price, say $20 per tonne of CO2e. This would cap the cost of the scheme for participants, at the margin, at this price. The cost of the short term permits could be set by international agreement and review, and could respond to the emerging science on the severity of climate change impacts.

Source: McKibbin W. and Wilcoxen P. 2002, The Economics of Climate Change, *Journal of Economic Perspectives*, Vol. 16 No. 2, Spring, pp 107-129

Instead, we believe the NETS penalty should be set at a level which caps the price of permits, informed by the expected (global) marginal cost of abatement required to deliver cuts consistent with preventing dangerous anthropogenic climate change. This will improve certainty for investors, particularly given expectations that Australia will eventually join a global regime.

There is considerable uncertainty about the future price of carbon, as evidenced by the ranges reported in previous section. However, at this point it would be reasonable to expect that global efforts will focus on stabilising at somewhere between 450 and 550 ppm by 2100. On this basis, a reasonable risk-weighted expectation could be that global carbon prices will be *at least* $ 25 per tonne of CO_2e (real 2005 Australian) by 2020.

Given uncertainty about the exact course and stringency of future global action, this could provide a reasonable end point for a penalty cap for the decade 2010 to 2020 *at* *the current time*. The expected global trajectory and the domestic penalty could be revised upon review of the NETS, slated by the NETT to occur around 2015.

Minimising impacts on the economy

Setting a price for carbon and constraining emissions is a significant economic change, which must be managed carefully. The NETT observes:[9]

> Economic impacts would be minimised if the scheme is constructed as efficiently as possible, promotes least cost reductions in emissions, and caps the cost of compliance. Also, until such time as there is widespread international action on emissions reductions, the competitiveness of Australian trade-exposed industries must be protected.

As noted in the previous section, a key consideration for investor certainty is to clearly cap carbon prices in Australia to levels that are informed by emerging global action. A cap also will help to minimise impacts on the economy. A cap of $25 per tonne CO_2e — to be reached by 2020 — was proposed.

If a trajectory for the NETS penalty is established consistent with this end point, then the targeted quantity, and hence the amount of permits created, could then be set consistent with more optimistic expectations of what quantities of abatement will be achieved at the specified penalty level. As noted by the IEA:[10]

> … price caps or indexed targets would lower the expected costs of targets. Their use could thus facilitate the adoption of more ambitious policies than without it, resulting in higher expected environmental benefits. In other words, while the certainty of achieving at least some precise levels of emissions would decrease, the probability of bettering these levels would significantly increase.

An optimistic target would provide maximum encouragement for innovation, while allowing abatement quantity 'discovery' within Australia. It would also maximise the benefits of 'positioning' for a future carbon constrained world, in terms of providing a price signal for the emissions intensity of long lived assets. The penalty cap would ensure that economic costs of transitioning to the expected international price for carbon are minimised.

A carbon price ramping up to around $25 per tonne of CO_2e by 2020 (see the modelling results in Chapter 4) should be sufficient to:

- prevent most new conventional coal fired power in Australia; and
- in conjunction with an aggressive complementary policy for energy efficiency, put Australia well on track to return emissions from electricity generation sector to around year 2000 levels by 2030.

9 National Emissons Trading Taskforce 2006, op. cit., pp 12.

10 Philibert C. 2006, *Certainty versus Ambition — Economic Efficiency in Mitigating Climate Change*, IEA Report Number LTO/2006/03, www.iea.org .

Energy efficiency as complementary policy

Ensuring uptake of cost effective energy efficiency is an important complement for a NETS, and has clear economic benefits in terms of minimising the costs of meeting abatement targets. Cost effective energy efficiency has the potential for a double dividend — not only does it reduce energy demands at low cost, it also allows eventual energy supply abatement to be met potentially at a lower overall emissions cost.

The secondary benefits of energy efficiency for the costs of energy supply are related to optimal timing for abatement. By allowing investments in emissions reductions in electricity generation to occur *later*, investments in cost effective energy efficiency increases the time available for technological advance, In turn, this can reduce the costs of achieving a cumulative reduction, particularly where there is an aggressive policy for low emissions RD&C. This is so-called 'when efficiency' — technological developments and associated abatement costs through time dictate an optimal trajectory for reaching a cumulative emissions reduction / steady state emissions concentration target.

The need for complementary policy for cost effective energy efficiency arises because *non-price* market failures prevent optimal levels of investment in energy efficiency. As a result, raising the price of energy through a carbon price signal may do little to bring forward increased investments in energy efficiency — even though these low cost opportunities have become even more attractive in the presence of a positive carbon price. The implication is that policy to encourage energy efficiency is a vital complement to a NETS.

On the other hand, where there *is* investment in new electricity generation, then economic costs will be minimised over the longer term if the emission intensity of that new investment is reduced, consistent with projected future carbon prices. Analysis for the Victorian Government demonstrated that taking action on greenhouse — sooner rather than later — can involve lower costs to economic welfare over the longer term, where *significant* carbon prices are expected. This results from early action leading to reduced emissions intensities for long lived assets such as coal fired generation, reducing costs of electricity provision over the longer term, and avoiding stranded assets.[11]

Flexibility

Whatever climate change policy is adopted needs to be flexible in order to respond to new information on the climate change science, international obligations, and the costs and nature of new technologies.

The NETT propose that the principle mechanisms to achieve this flexibility would be:

- use of 'gateways that would allow caps to adjust for any future international arrangements; and

[11] See Allen Consulting Group 2004, *The Greenhouse Challenge for Energy* and The Allen Consulting Group 2005, *Deep Cuts in Greenhouse Gas Emissions — Economic, Social and Environmental Impacts for Australia.*

- ensuring that the scheme design is generally consistent with emerging emissions trading schemes overseas, allowing for the possibility of more comprehensive linking in the future.

It is our view that it is not clear at all at the current time what the shape of a future global regime may look like. This raises a potential contingent liability for the States and Territories (see section on International Linkages below).

That said, if a domestic NETS was judged to be a preferred policy approach, then designing in quantity flexibility (through gateways) and price flexibility (through regular review of the penalty) is to be encouraged.

Equity

Equity considerations are important in terms of the political feasibility of any policy to address climate change. Pricing carbon will raise the price of fossil fuels directly, and also will flow on to increased electricity prices. The economic modelling in Chapter 4 suggests that wholesale electricity prices could rise substantially — by more than 40 per cent on average in the decade through to 2020 under some scenarios.

This will have distributional impacts in terms of:

- *emissions-intense industry* :
  - *trade-exposed* industries may not able to pass on costs due to competition from overseas competitors who may not face the same cost of carbon;
  - existing emissions intense *energy supply* businesses will face reduced demands for their output, reducing profits and potentially shortening the effective life of their assets (the converse is likely to be true for low emission intense energy sources);
- *other industry* — energy costs tend to be less than 2 per cent of the overall cost of inputs, and will be passed on in part to consumers by industries that are not trade-exposed;
- *households* —energy costs are *generally* a small proportion in overall household expenditures, and there are many cost effective opportunities to invest in energy efficiency, which could more than offset the price impacts of the NETS policy.

The NETT propose to distribute permits to existing electricity generators and to trade-exposed energy-intense industry to compensate for these impacts. The NETT also propose that a proportion of permits be auctioned, with revenues then available to offset the impacts on the more severely affected households. Whether this will be successful in addressing equity issues will depend crucially on the permit allocation process.

From Western Australia's perspective, it will be important to ensure that adequate compensation is received to offset the impacts on the State. As noted in Section 3.5 — Permit allocation, this is a key challenge for ensuring Western Australia's interests are protected under a domestic NETS.

3.3 Boundaries for the scheme

The boundaries of the NETS will have large impact on its effectiveness in reducing emissions, and the associated economic costs. Boundaries relate to:

- sectoral coverage of the scheme domestically; and
- international linkages.

Sectoral coverage

The NETT preferred option is for the sectoral coverage of a NETS to commence initially with the combustion emissions of the electricity generation sector only, followed by coverage of other Stationary Energy combustion emissions from gas, coal, oil and other fossil fuels, five years after scheme commencement.

Part of the rationale for a phased approach is that it allows the approach to be fine-tuned as experience is gained, particularly because the non-electricity generation elements are more complex in terms of reporting and monitoring.

It is also considered that the electricity generation sector has greatest need for investor certainty. We agree with this. Shortfalls in electricity supply resulting from an investment 'strike' would be very disruptive, involving substantial economic costs — given that electricity is an essential service underpinning activity in every sector of the economy. As noted above, addressing investor uncertainty through a price signal would help to bring forward needed new investment.

However, we question whether sectors other than electricity generation need a NETS carbon price signal in *advance* of an effective global international regime.

An investment 'strike' in emissions-intense industry would:

- have some costs for the economy, but would be replaced to a degree by investment in other non-emissions-intense industry, limiting the overall economic impacts;
- reduce Australia's future emissions growth, allowing time for technologies to reduce emissions at lower cost than otherwise.

On the other hand, emissions-intense investments that *were* made absent a carbon price signal:

- could subsequently became stranded or operate at reduced profitability under a future carbon price signal — noting that a proportion of the reduction in profits would accrue to foreign investors, rather than to Australians.

Finally, preventing adverse competitive effects on the emissions-intense trade-exposed industries under a NETS scenario requires a relatively complex compensation approach.[12] For greenhouse over the longer term, it is the new entrants and major capacity expansions that really matter. It is proposed to allocate permits for these entities according to 'best practice energy intensity for product, using commercially viable technology'.[13]

It could be far less complicated to set emissions intensity benchmarks for these emissions-intense industries directly. Such an approach would have the added benefit of removing the issue of contingent liability associated with granting permits to these entities.

Thus we recommend caution in relation to extending the NETS to sectors other than electricity generation in advance of a clear global system. Our judgement is that the costs could outweigh the benefits.

International linkages

A first best approach to addressing the threat of climate change would be to join an effective global NETS. If expectations are that a truly global system will emerge in the next decade — that incorporated Australia's major trade competitors — then implementing a broad-based NETS, sooner rather than later, could be a justified, as part of managing the transition. The NETS could provide valuable 'learning by doing', and allow fine-tuning of the domestic reporting and verification arrangements needed for future participation in a global scheme.

However, the downside is that a future global scheme could involve significantly different arrangements to that being proposed by the NETT. Adopting a NETS in advance of a truly global system carries risks that NETS permits may not be fungible with the new system. This could lead to significant contingent liabilities for State governments:

- Investment decisions would be made on the basis of permits allocated under the NETS. The States and Territories would need to ensure these permits are recognised in any future system.

- If allocated permits were not recognised in a subsequent system, there would be a strong case that the States and Territories would need to compensate affected firms. This may be costly, particularly if the future price of carbon was higher than that applying in the domestic scheme.

- The scale of the potential liability is illustrated by the total net present value of permits nationwide under the NETS. For example, in Domestic Action Scenario 1, the Net Present Value of all permits allocated for the period 2010 to 2030 is estimated at over $74 billion. Of this, $24 billion would be allocated to generators (based on compensation to portfolios), some $13 billion would be allocated to trade-exposed energy-intensive industry, and the remaining $47 billion would provide revenue from auctioning permits.

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12 It is proposed that the NETS would involve compensation to existing industry based on a simple threshold for energy intensity. Given the differential competitive pressure faced by enterprises, this is likely to provide windfall gains to some enterprises at the margin, while penalising others. See Section 3.4 — Permit Allocation.

13 National Emissons Trading Taskforce 2006, op. cit., pp 137.

Contingent liabilities could be limited by only allocating permits and guaranteeing the penalty price for a shorter span of time — say for the decade through to 2020. Nevertheless, the value of liabilities remains substantial.

These contingent liability issues add weight to the case that a simpler alternative policy option — such as for emissions intensity benchmarks — may be a preferred transitional mechanism to a global carbon constraint. There would not need to be any contingent liability with this option, as the government would not be allocating permits to emit up front.

In the event that a domestic NETS *is* adopted in advance of a global system, then linking to other schemes delivers gains from trade — with the *aggregate* emissions cap met at lower cost.[14] As the NETT note, this suggests that the design of a NETS should maximise the chances of future linking.[15]

Whether the price of carbon would rise or fall domestically would depend on the relative price in the scheme that was being linked to. In part this would be driven by the aggregate scheme cap, and also by the aggregated marginal cost of abatement required to meet that cap.

To the extent that a domestic NETS scheme was linked to a higher priced scheme, this would drive the price of carbon up in the domestic scheme, all other things equal. Greater abatement would be undertaken domestically — up to the new marginal cost for carbon that cleared both schemes. Joining a lower priced scheme would have the opposite effect. Either way, *all other things equal*, there could be net gains for participants in both schemes, although the *distribution* of costs and benefits would change.

- Joining a higher priced scheme would involve greater emissions reductions in Australia. However, the marginal benefits would outweigh the costs, due to the infra-marginal surplus for every unit of additional abatement undertaken in Australia. The gains to sellers would outweigh the losses for buyers.

- Joining a lower priced scheme would lead to lower emissions reductions in Australia. The gains for buyers would more than outweigh the losses for sellers.

In principle then, linking has benefits. However, a decision on whether to link to another scheme should account for efficient global levels of abatement and associated prices — it would not be sensible economically for Australia to link to a scheme that had carbon prices higher than judgements for the long run global price for carbon.

Western Australia is likely to be a net buyer of permits. Its interests are best served in linking to lower priced schemes.

In this context, the proposed one way linking of the NETS to the Clean Development Mechanism (for purchase of Certified Emissions Reductions or CERs) provides clear

14 See for example, Anger N., Brouns B. and Onigkeit J. 2006, Linking the EU Emissions Trading Scheme under Alternative Climate Policy Stringencies: An Economic Impact Asssessment, Working Paper II/06, www.wupperinst.org/download/3214/linking-NETS.pdf /

15 National Emissons Trading Taskforce 2006, op. cit., pp 195

benefit for Australia, and for Western Australia in particular. The NETT quote estimates for the price of CERs in the range of A$ 17 to 25, which provides a relatively low cost option for abatement.[16] [17]

Whether Australia should ratify the Kyoto Protocol is fast becoming an academic question. Complete participation in the first commitment period 2008-12 requires a range of milestones to be achieved by early 2007. This would clearly now be impossible. Participating later in the first commitment period may still be possible, however.

If Australia *did* join and the United States did not, it would be likely that Australia would be a small net seller or buyer of permits.[18] Kyoto would make little difference to overall abatement for the period 2010 to 2012 compared to the NETS proposals. However, ratification would allow Australian firms to become more significant players in the Clean Development Mechanism — which has huge trade potential.

On balance, if adequate compensation arrangements for trade-exposed energy intensive industries were established, then ratification of the Kyoto Protocol could make sense, given the small costs of compliance, the price cap provided by Kyoto permits to 2012, and the large benefits from the ability of Australian firms to participate more fully in the Clean Development Mechanism.

3.4 Permit allocation

Permit allocation is a key element influencing the efficiency and equity of a NETS, and is thus a key consideration for Western Australia.

The NETT proposes to:

- adopt allocation mechanisms that avoid rules that encourage firms to continue to emit;
- avoid market power problems in the permit market through combination of allocations to generators, trade-exposed, energy-intensive industries and auctioning;

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16 National Emissons Trading Taskforce 2006, op. cit., pp 200.

17 Introduction of lower priced abatement from outside the domestic NETS, such as through the Clean Development Mechanism, may limit the amount of fuel switching domestically — for example by allowing conventional coal generation to operate in conjunction with CER-sourced offsets. From an environmental integrity and economic efficiency perspective, this should not be a concern, provided that the CERs are considered to achieve equivalent emissions reductions to a domestic NETS permit, and provided these are recognised in a future global scheme. One way to address concerns about lack of equivalence would be to establish a discount for CERs in terms of a reduced 'exchange rate' for domestic offsets.

18 Current estimates for the carbon price under Kyoto, absent participation by the United States, is around the A$13 to 15 per tCO_2e mark (see for example www.treasury.govt.nz/release/kyoto/). Whether Australia was a net buyer or seller under Kyoto would depend on whether the 2020 NETS targets were in place — the two schemes could interact. The Kyoto price is entirely comparable to the $12 to 15 per tCO_2e expected under NETS Domestic Action Scenarios 1 and 2 for the period 2010 to 2012, but higher than the price under Scenario 1a. In this case, Australia could become a small net seller. Absent a NETS price signal, Australia is likely to overshoot its Kyoto target by 1 or 2 per cent, and so is likely to be a small net buyer (the 2006 emissions projections have not been released by the Commonwealth, but there it is likely they will show Australia overshooting its target slightly).

- make the allocation mechanisms as simple as possible, consistent with the need for them to be equitable, transparent and robust;
- as a key objective of permit allocation, assist those who are likely to be most adversely affected by implementation of the scheme.

To this end, permit allocation is to be used as the primary mechanism to provide assistance to those likely to be most adversely affected by the implementation of the scheme:

- some permits to be allocated for free to existing generators;
- some permits to be allocated for free to trade-exposed, energy intensive industries; and
- the remainder of the permits to be auctioned, and the proceeds distributed among States and Territories on a basis yet to be determined, but in a manner that recognises the differing impacts of the scheme.

Allocation to existing generators

The NETT proposes to:

- not to allocate free permits to new entrant generators or generators likely to be made better off as a result of the scheme, such as renewable generators;
- compensate existing generators for estimated negative effects on profitability for the next 20 years, through a once off allocation at the start of the scheme.

Overall, these arrangements are unlikely to discriminate against existing or new generation in Western Australia.

However, the timing threshold for new versus old generation is an important consideration — in Western Australia the Bluewaters power station reached Final Investment Decision, obtained environmental approvals and has commenced construction prior to the NETT's proposals for a domestic NETS. This would suggest that the cut off for new plant should be any that are *commissioned* from 2009 on.

Finally, from an economic perspective, it would be preferable to compensate generating portfolios. This would ensure symmetry between 'unders' and 'overs' from existing generation, while minimising the amount of compensation required. The latter is important, as it leaves greater amounts of revenue on the table to provide compensation for affected groups and to fund complementary policy (particularly R&D and energy efficiency).

Allocation to trade-exposed energy-intense industries

Imposing additional costs on domestic industry through a NETS will have relative competitiveness effects. Depending on the emissions intensity of production, some firms will gain and some will lose. This is an inevitable part of the adjustment required to reduce emissions.

A problem arises however if domestic firms compete internationally with firms located in countries not subject to an emissions constraint. This can lead to carbon leakage (Box 2.2).

To address this, the NETT propose to compensate *firms* that:

- are highly energy intensive (requires definition);
- experience higher energy costs as a result of the scheme;
- face a high degree of global competition, mostly from countries that do not impose emissions constraints.

The NETT propose to calculate energy price rises according to a baseline energy use — to be calculated based on the firm's average energy intensity over the period 2002-05. After the first decade, the NETT propose Australian best practice energy intensity for an industry sector could be adopted.

However, this is a difficult task to get right, and creates a large information requirement. It is not clear whether historic energy data will be available for every firm — which would then require default approaches to estimation. In principle, however, use of energy intensity baselines is feasible and should not create any particular issues for Western Australia.

What is of importance for Western Australia is the definition of the threshold to allow firms to qualify for compensation:

- Western Austalia has a higher export propensity than the rest of Australia — in 2005 the value of exports was 33 per cent of Western Australia's GSP, compared to 17 per cent for the rest of Australia;
- the Western Australian Mining and Manufacturing industries are far more 'Stationary Energy' intensive (based on inputs of coal, gas and electricity) than the rest of Australia — these inputs accounted for 5.4 per cent of total operating expenses of these industries in Western Australia *on average*, compared to 2.4 per cent for the rest of Australia.

BOX 3.2 - CARBON LEAKAGE

There is potential for loss of domestic competitiveness due to the higher cost structures imposed by a domestic carbon constraint — leading to a relative contraction in local industry and an offsetting expansion in an 'unconstrained' competitor. This activity 'leakage' is likely to be a greater risk for those industries that are emissions intense and highly trade exposed. The greenhouse intensity of new plant offshore may be worse than the domestic alternative, such that there is a net global GHG emissions deterioration.

The loss of a new alumina plant overseas could provide an example of this potential effect — if the new Australian plant were to be gas fired whereas the new plant overseas was coal fired. The leakage effect provides a well documented rationale for exempting emissions intense domestic industry. For example, Light notes:[19]

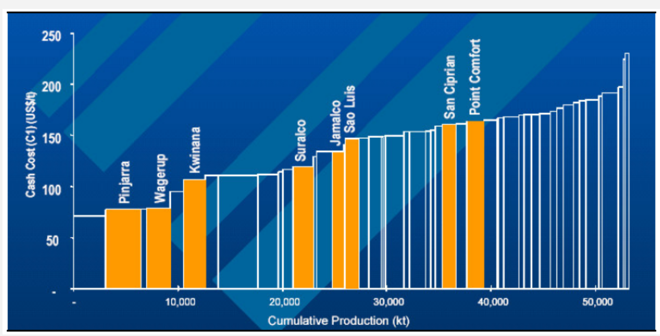
> …the benefits of carbon leakage mitigation borne from industry specific tax exemptions could overcome the distortion associated with non-uniform environmental taxation… when the possibility of carbon leakage is acute, then efforts to mitigate carbon leakage are always more cost effective than efforts to minimize domestic tax distortions. In the limit, when international trade is homogeneous, it is optimal to completely exempt energy-intensive industries from carbon taxes. The sole reason for this exemption is to mitigate leakage.

However, despite this rationale, the degree of exemption needed to counteract leakage depends on range of factors, including the extent to which production is internationally substitutable. To quote Light again:

> Estimates of the potential for carbon leakage range widely between various global abatement studies. At the low end, McKibbin and Wilcoxen (1995) and Burniaux et. al. (1991) assume that international fossil fuel trade does not respond well to price changes, they found global leakage rates between 2 to 5 percent. At the high end Light, Kolstad and Rutherford (1999) argue that the price response in world coal trade could be substantial, especially if China and India become coal intensive and if the law of one price applies in international coal markets. They found that leakage could reach 40% if unchecked.

Substitutability, which drives leakage effects, will depend on the nature of the product. Raw alumina is likely to be more substitutable — and all other things equal, leakage for this commodity higher — than elaborately transformed products, such as aluminium fast ferries.

However, even this conclusion may not be straightforward — substitutability will also depend on relative cost structures. If the emissions intense commodity is among the lowest cost product in the world, then that product may be able to bear a considerable price penalty without changing its quartile in the global supply curve.



For example, Western Australia's alumina production is among the cheapest in the world (see Figure immediately above). With gas costs around 15 per cent of total input costs into aluminium, this suggests that gas costs could double before even the worst performing existing Australian operation would approach the costs of even the third quintile producers, all other things equal. An increase of this magnitude in Western Australian gas prices would require an extremely large emissions price — of more than $90 per tonne of CO_2e.

Source: Insight Economics and ACIL-Tasman 2004, *Greenhouse Gas Abatement, Impacts on Western Australian Industry and Industrial Development*, pp 17.

[19] Light M.K. 1999, Optimal Taxation and Transboundary Pollution, Discussion Papers in Economics Working Paper No. 99-22, Department of Economics, University of Colorado at Boulder, pp 13.

TABLE 3.1 – AGRICULTURE MINING AND MANUFACTURING INDUSTRIES WITH STATIONARY ENERGY INPUTS[a] GREATER THAN 2% OF OPERATING EXPENSES

Industry	Australia	WA	Comment on WA composition
Other non-ferrous ore	9.3	8.3	Mainly electricity
Food products – animal	2.0	3.8	Mainly electricity
Food products – other	1.6	3.1	Electricity, gas
TCF	1.1	2.8	Mainly electricity
Petrol. Refining	3.4	5.7	Mainly gas as feedstock input
Basic chemical products	4.3	9.8	Electricity, gas equally
Plastic and rubber products	1.7	3.4	Mainly electricity
Non-metal. mineral products	3.8	9.1	Electricity, gas equally
Cement	6.4	18.2	Electricity, gas
Iron and steel	8.0	20.7	Electricity, coal
Alumina and aluminium	21.8	24.4	Gas, some electricity
Other metal products	1.9	3.2	Mainly electricity
Total	**2.4**	**5.4**	**64% electricity, 30% gas, 6% coal in total for WA**

Source: MMRF-Green

Note: Stationary energy input defined as inputs of coal, natural gas and electricity.

The NETT *modelling* was based on an assumption that compensation should apply to those sectors with energy more than 3.5 per cent of total operating expenses. This threshold was an attempt to capture a *limited* set of industries — where energy is a substantial proportion of total inputs. There is a trade-off between offsetting competitiveness impacts through compensation, and maintaining the integrity and effectiveness of the scheme.

Australia-wide, the 2 digit ANZSIC industries that qualified at the 3.5 per cent threshold were (Table 3.1):

- Other non-ferrous ore (energy estimated at 9.3 per cent of total operating expenses across Australia);
- Non-metallic mineral products (energy estimated at 3.8 per cent of total operating expenses);
- Cement (energy estimated at 6.4 per cent of total operating expenses);
- Iron and steel (energy estimated at 8.0 per cent of total operating expenses);

- Aluminium and alumina (energy estimated at 21.8 per cent of total operating expenses).

Overall, it is these same industries that meet the 3.5 per cent threshold in Western Australia. However, there is one additional industry in Western Australia that would qualify for the threshold at the 3.5 per cent level (Table 3.1):

- Food products – animal (energy estimated at 3.8 per cent of total operating expenses in Western Australia, compared to 2.0 per cent for Australia overall).

As noted above, the energy intensity of Western Australian Mining and Manufacturing is significantly greater than that of the rest of Australia. Examination of more detailed 4 digit ANZSIC input-output data for Australia as a whole suggests that many more industry *sub-sectors* would qualify for the 3.5 per cent threshold. Given Western Australia's greater energy intensity overall, this pattern would be even more pronounced for Western Australia.

Breaking this down to specific firms or establishments could further expand the level of compensation at this threshold level. As a result, there is large uncertainty about the eventual amount of permits required to be applied as compensation. A corollary is that it is not clear that the NETT modelling provided an accurate portrayal of the actual outcomes of compensation.

A fixed threshold for energy as a share of operating expenses is a fairly arbitrary measure. It discriminates at the margin, particularly for firms that fall just below the threshold. On the other hand, in some cases compensation may not be necessary to maintain competitiveness, even for energy shares higher than 3.5 per cent, as the overall impacts will be based on a number of factors, including the:

- degree of trade exposure;
- degree of competition from countries that do not have a greenhouse constraint;
- degree of energy intensity;
- opportunities for business as usual and low cost fuel switching;
- position in the global cost curve (see Box 3.2 for the status of existing alumina plants in Western Australia);
- whether the production is from an existing investment with largely sunk capital, as opposed to new production from an expansion of existing plant or from a green fields operation.

Overall, this raises uncertainty about whether compensation would provide windfall gains for some, while penalising others. An arbitrary threshold has potential to create significant distortions, with Western Australia more vulnerable than other jurisdictions by dint of its greater energy intensity, greater trade exposure, and greater reliance on less elaborately transformed products. A simple allocation approach — desired by the NETT — does not address this issue adequately.

There are no clear and easy solutions to this problem. The implication for Western Australia is that this issue requires detailed further investigation, on a sub-sectoral, enterprise and even establishment basis, to determine the overall impacts. It may be that variable thresholds are warranted, depending on sector, and depending on whether production is from new or old plant. Either way, the complexity of this issue points to the potential problems for Western Australia of implementing a broad based greenhouse constraint in advance of global action.

In summary, an allocation of permits to trade-exposed energy-intensive industries based on a threshold for energy intensity has potential to create significant windfall gains for some firms, while under-compensating others. Western Australia is likely to be most vulnerable to this provision. Further investigation of this issue should be a priority for Western Australia.

Distribution of permit auction proceeds

The NETT propose to auction the remaining permits, and to divide the revenue among the States and Territories on a basis yet to be determined, but 'in a manner that recognises the differing impacts of the scheme'.[20]

Auctioning the remaining permits is efficient from an economic perspective, and will help to eliminate the windfall gains associated with excessive gratis allocations seen in other schemes, such as the European Union's. Distributing revenue to jurisdictions to address identified impacts of the NETS also makes sense, allowing greater flexibility to address adverse impacts at the local level.

However, in terms of ensuring a fair distribution, the devil is in the detail. In this case, simplicity again may be exactly that — overly simplistic. An alternative that seeks to recognise the differing circumstances of the various States and Territories (for example, that accounts for the impacts on the Commonwealth Grants Commission formulae), could be a better starting point.

[20] National Emissons Trading Taskforce 2006, op. cit., pp 145.

CHAPTER 4

Modelling of emissions constraints

Implementing a carbon constraint through domestic emissions trading in Australia is likely to result in a small cost to economic activity and slower growth in consumption. Relative impacts on Western Australia are not uniform, and depend on the specific scenario.

There have been number of reports in the last few years examining the impact of an emissions trading system on the Western Australian economy.[21] These reports have now been supplemented by comprehensive modelling undertaken for the National Emissions Trading Taskforce.

4.1 NETT modelling results

Modelling for the National Emissions Trading Taskforce (NETT) encompassed a range of NETS scenarios, incorporating assumptions of either global or unilateral action. In this chapter we report on the implications for Western Australia for four of the scenarios modelled for the NETT (see Appendix C for further detail):

- *Domestic Action (DA) Scenario 1* — electricity generation *combustion* emissions were capped at 176 Mt CO2 e by 2030. The 176 Mt CO2 e cap would be

[21] Appendix A summarises the major reports since the year 2000.

equivalent to returning electricity generation sector emissions to around year 2000 levels.

- *Domestic Action (DA) Scenario 1a*— as per DA Scenario 1, but with sensitivity for enhanced energy efficiency uptake, demand side 'induced technical change' and increased forestry biosequestration offsets. In this sensitivity analysis the targeted emissions quantity trajectory followed that of DA Scenario 1.

- *Domestic Action (DA) Scenario 4* — assesses the carbon price, from a NETS covering electricity sector *combustion* emissions, required to *just prevent* the uptake on new coal fired electricity generation in Australia.

- *Global Action (GA) Scenario 3* — Australia's electricity generation *full fuel cycle* emissions were capped at 176 Mt of CO2-e by 2030 — the target for 2030 was for both combustion *and* upstream emissions from electricity generation.

  - Combustion emissions only from electricity generation were covered by the NETS from 2010 to 2015, but thereafter the carbon price from the electricity generation sector was extended to the other Stationary Energy and Fugitive sector emissions. From 2020, all other emitting sectors in the economy faced the carbon price from the electricity generation sector.

  - The rest of the world progressively takes action on climate change from 2010 on, facing the same carbon price as that in Australia.

In addition, we refer to separate work undertaken for the Western Australian Office of Energy, examining the sensitivity of the results for Global Action Scenario 3 and Domestic Action Scenario 4 to the *impact of higher domestic gas prices* in Western Australia (see Appendix D for further detail):

- *Global Action (GA) Scenario 3a* — targeted, through a NETS, the same emissions quantity profile for electricity generation Australia-wide as 'Global Action Scenario 3' in the NETT modelling. Scenario 3a differs from Scenario 3 in:

  - utilising Scenario HGP ('High Gas Price') modelling outputs as the starting point 'reference case' — to reflect the potential for rising Domgas prices in Western Australia; and

  - in contrast, Scenario 3 deviations were measured against the respective model 'base cases'.

- *Domestic Action (DA) Scenario 4a* — targeted the same emissions quantity profile for a NETS Australia-wide as was targeted in the NETT modelling of Scenario 4. Scenario 4a differs from Scenario 4 in:

  - utilising Scenario HGP modelling outputs as the starting point 'reference case' — to reflect the potential for rising Domgas prices in Western Australia;

    - in contrast, Scenario 4 deviations were measured against the respective model base cases; and

- not allowing banking — thus the carbon price reflects exactly that required to prevent uptake of coal in any year.

The focus in this report is on comparing impacts *on Western Australia* for the various scenarios. For further detail of the modelling undertaken, and for impacts on Australia, the reader should refer to the separate reports produced for the NETT and the Western Australian Office of Energy.[22]

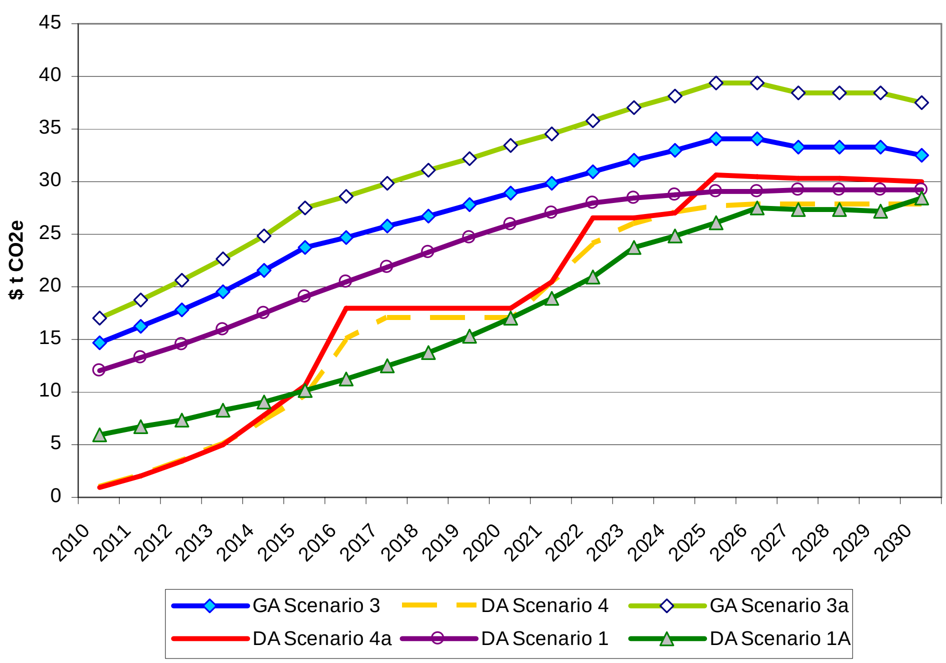
Electricity market impacts

The imposition of a NETS leads to a carbon price in the electricity generation sector. Among other impacts, the carbon price encourages fuel switching in electricity generation — away from emissions intense electricity generation sources such as coal, and towards relatively less emissions intense generation sources such as renewables and gas. This leads to a range of economic impacts for Western Australia.

Carbon prices

The highest carbon prices occur in Scenario 3a, peaking at around $40 per tonne CO_2e (Figure 4.3). These prices are up by around $5 per tonne compared to Scenario 3, due to the need to offset the greater emissions in Western Australia from additional coal fired power (in the presence of higher domestic gas prices in the Scenario 3a Reference Case).

FIGURE 4.1 – CARBON PRICES – NETS SCENARIOS – AUSTRALIA



Source: MMA

[22] The Allen Consulting Group 2006, The Economic Impacts of a National Emissions Trading Scheme, www.emissionstrading.net.au; and Insight Economics 2006, *National Emissions Trading — Impacts with Higher WA Domgas Prices*, Report to the WA Office of Energy.

Scenario 4, on the other hand, would require a lower carbon prices in the electricity generation sector than Scenario 3, 3a or 1. The cumulative reduction in emissions required to just prevent uptake of new coal fired power is less than these other scenarios.

The presence of higher domestic gas prices in Scenario 4a results in only slightly higher carbon prices, compared to Scenario 4. This arises because:

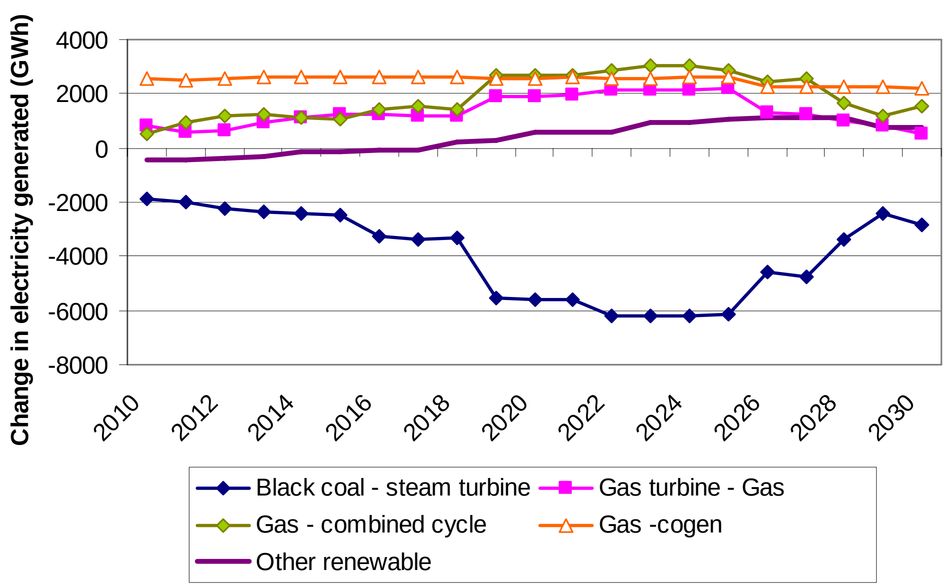
- In Scenario 4, gas generation is competitive with coal generation in Western Australia in the basecase — new base load supply is provided by cogeneration. Thus the carbon price to prevent coal has no influence in Western Australia. The carbon price in this scenario reflects the carbon penalty required to prevent new coal in *eastern* Australia (around $15 per tonne CO_2e at 2016).

- In Scenario 4a, there is now a need to prevent coal fired generation in Western Australia — due to the influence of higher domestic gas prices in the *west*. The resulting carbon penalty required to prevent coal in Western Australia is slightly higher than in Scenario 4 (which recall, reflected the prices over east) — in this case the price is around $18 per tonne CO_2e at 2016.

Domestic Action Scenario 1 carbon prices plateau at around $29 per tonne CO2e in the early 2020s. Carbon prices in this scenario reflect the total level of abatement mid-way between Scenarios 4 and 4a and Scenarios 3 and 3a.

Domestic Action Scenario 1a has the lowest carbon prices of any of the scenarios, despite achieving a similar total abatement to Scenario 1. The presence of cost effective energy efficiency, greater low cost forestry offsets and faster technical change all combine to lower the carbon price in this scenario.

FIGURE 4.2 – CHANGE IN SOURCE OF ELECTRICITY GENERATED – SCENARIO 3A RELATIVE TO HIGH GAS PRICE REFERENCE CASE – SWIS



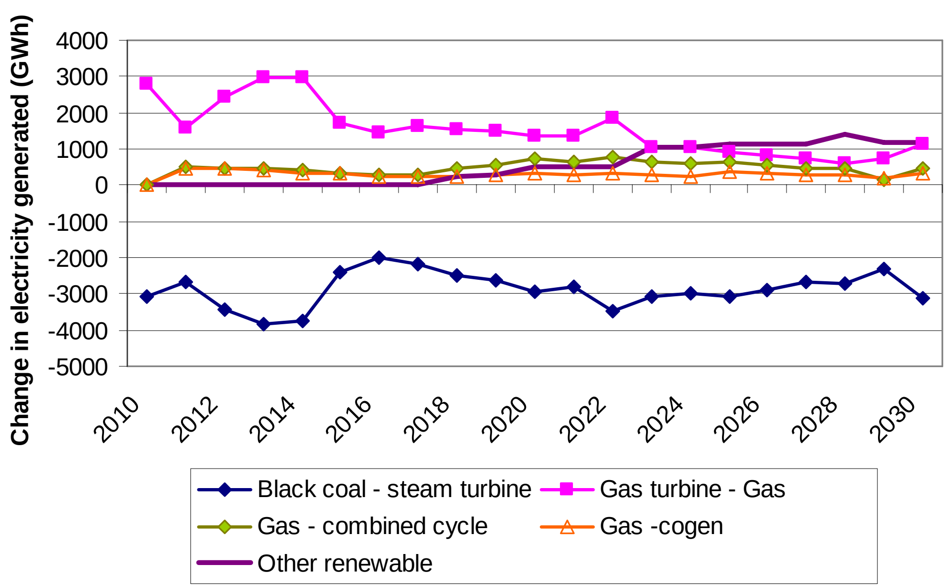
Source: MMA

Electricity generation in Western Australia

Under Scenario 3a, coal fired generation in Western Australia would be expected to be down significantly in level terms relative to the high gas price reference case, replaced by gas fired generation (Figure 4.2).

Under Scenario 3, similar outcomes are observed, although the reduction in coal dispatch is significantly less, reflecting the lower quantities of coal generation in Western Australia in the (lower gas prices) base case (Figure 4.3).

FIGURE 4.3 - CHANGE IN SOURCE OF ELECTRICITY GENERATED – SCENARIO 3 RELATIVE TO THE BASE CASE – SWIS

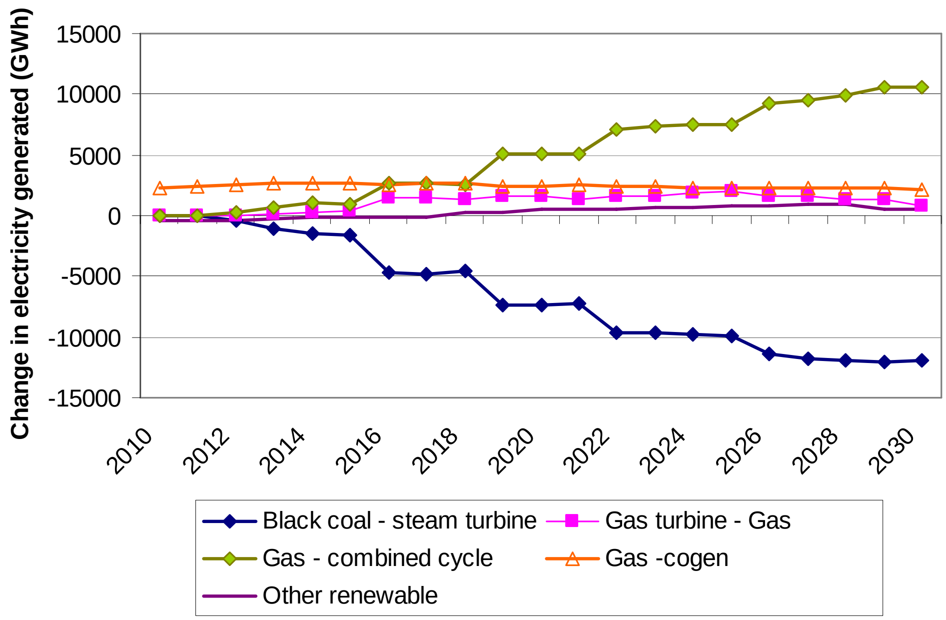


Source: MMA

In Scenario 4a, coal fired generation is reduced further in Western Australia, replaced mainly by gas combined cycle generation (Figure 4.4).

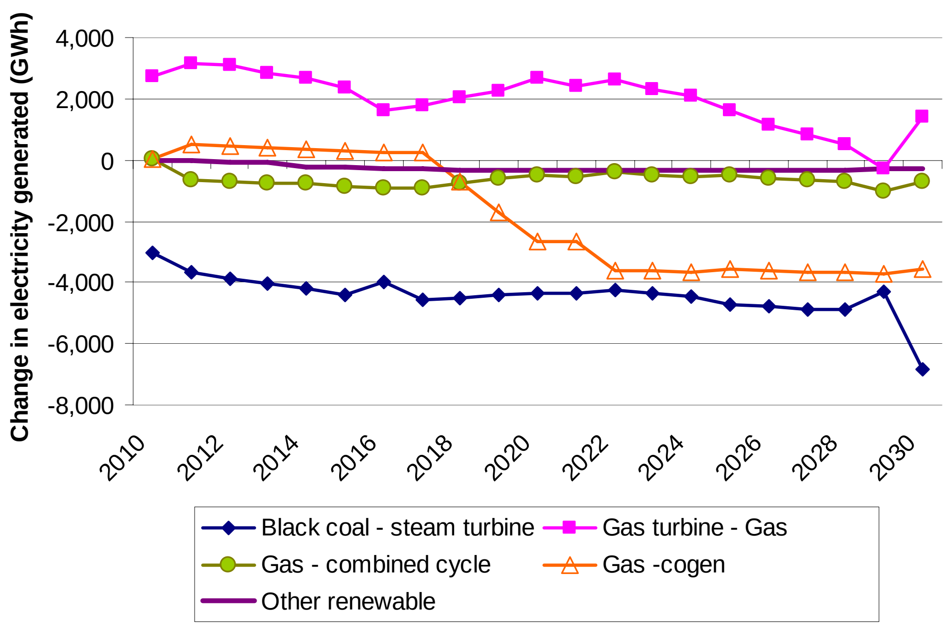
Scenario 4 also involves very similar trends, albeit with fewer reductions in coal fired electricity compared to Scenario 4a, given that there is less coal generation to displace with the lower gas prices of Scenario 4.

FIGURE 4.4 - CHANGE IN SOURCE OF ELECTRICITY GENERATED – SCENARIO 4A RELATIVE TO HIGH GAS PRICE REFERENCE CASE – SWIS



Source: MMA

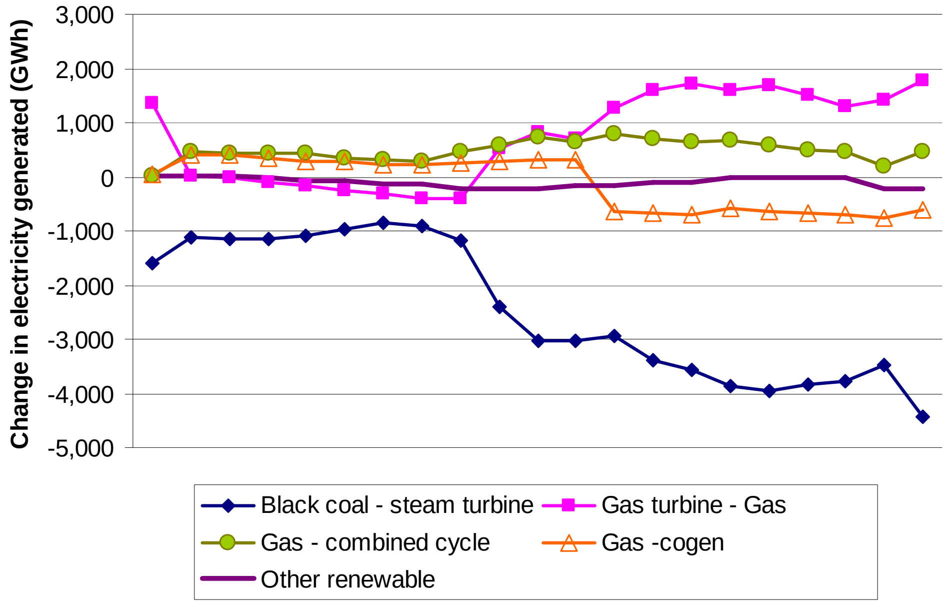
FIGURE 4.5 - CHANGE IN SOURCE OF ELECTRICITY GENERATED – SCENARIO 1 RELATIVE TO BASE CASE – SWIS



Source: MMA

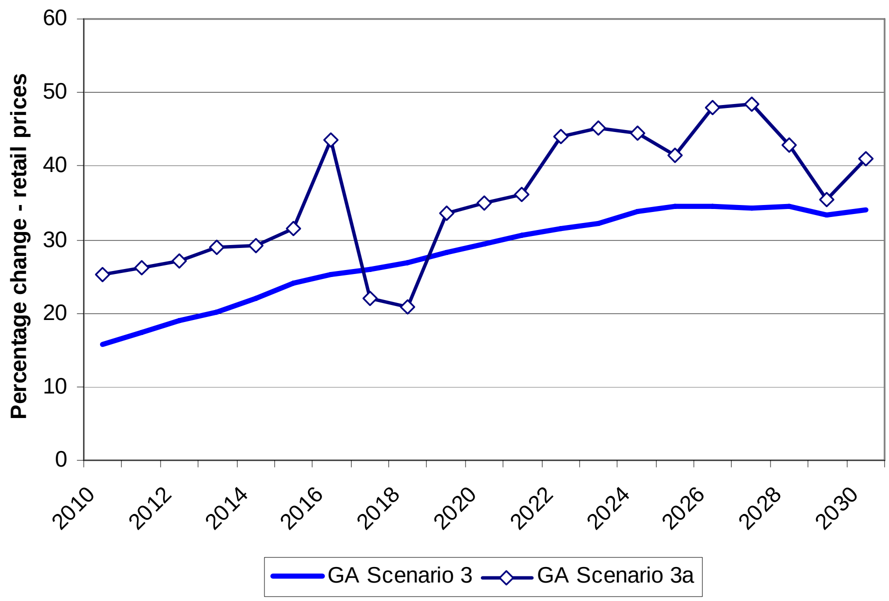
Scenario 1 has a similar pattern of electricity generation change to Scenario 3 (Figure 4.5). Scenario 1a involves slightly lower reductions early on due to greater quantities of energy efficiency reducing electricity demand growth, such that the pattern of reduction is closer to Scenario 4 (Figure 4.6).

FIGURE 4.6 - CHANGE IN SOURCE OF ELECTRICITY GENERATED – SCENARIO 1A RELATIVE TO BASE CASE – SWIS



Source: MMA

FIGURE 4.7 – RETAIL ELECTRICITY PRICE INCREASES – SWIS – SCENARIO 3 AND 3A



Source: MMA

Electricity prices in Western Australia

Wholesale and retail electricity prices rise as a result of the imposition of the NETS, and a resulting flow-through of the carbon price in generator costs.

Reflecting the highest carbon prices, the electricity price rises in Western Australia are greatest in Scenario 3a.

In Scenario 3a over the period to 2030:

- wholesale electricity prices in the SWIS are up by an average of 43 per cent over the high gas price reference case (on top of an average 20 per cent rise in moving from the base case to the high gas price reference case), compared to an average 41 per cent for Scenario 3 over the base case; and

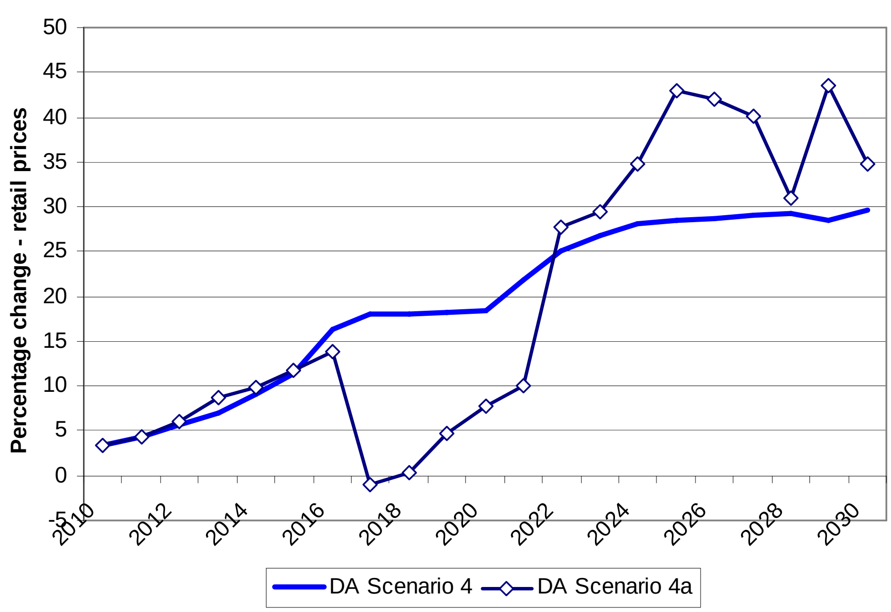
- corresponding average retail price rises are up 36 per cent over the period in Scenario 3a over the high gas price reference case (Figure 4.7 — this increase comes on top of an average 12 per cent rise in moving from the base case to the high gas price reference case), compared to an average 28 per cent for Scenario 3 over the base case.

Because banking was switched off in Scenario 4a, year to year electricity price changes are not strictly comparable with Scenario 4. However, average price increases over the period do indicate slightly higher prices overall, reflecting the slightly higher carbon prices in Scenario 4a compared to Scenario 4:

- average wholesale prices are up by 25 per cent in Scenario 4a over the high gas price reference case (on top of an average 20 per cent rise in moving from the base case to the high gas price reference case), compared to 27 per cent for Scenario 4 over the base case;

- average retail prices are up by 19 per cent in Scenario 4a over the high gas price reference case (on top of an average 12 per cent rise in moving from the base case to the high gas price reference case),compared to 19 per cent for Scenario 4 over the base case (Figure 4.8).

FIGURE 4.8 – RETAIL ELECTRICITY PRICE INCREASES – SWIS – SCENARIO 4 AND 4A



Source: MMA

Note: The percentage shown for DA Scenario 4 is compared to the base case, while the percentage change for Scenario 4a is compared to the high gas price reference case (which is on average 12 per cent higher than the base case).

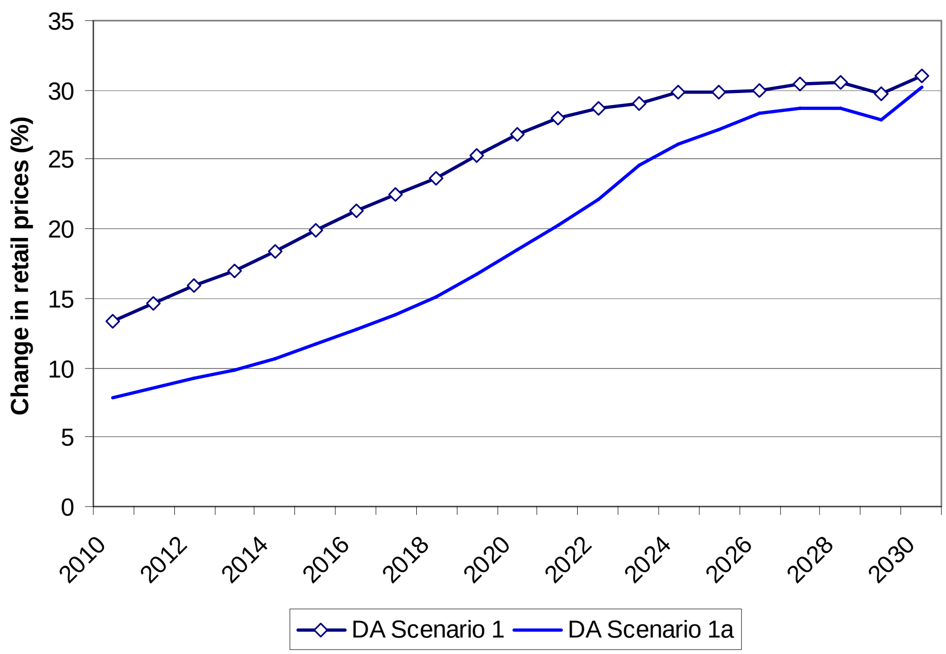
In Scenario 1, the electricity price rises are slightly greater than Scenario 4/4a (particularly in the decade to 2020) but less than Scenario 3/3a:

- wholesale prices are up by 36 per cent on average over the base case for the whole period 2010 to 2030;
- retail prices are up by 25 per cent on average over the base case for the period to 2030 (Figure 4.9).

Greater energy efficiency in Scenario 1a results in the lowest retail electricity price increases of any scenario:

- wholesale prices are up by 27 per cent on average over the base case for the whole period 2010 to 2030;
- retail prices are up by 19 per cent on average over the base case for the whole period 2010 to 2030 (Figure 4.9).

FIGURE 4.9 – RETAIL ELECTRICITY PRICE INCREASES – SWIS – SCENARIO 1 AND 1A



Greenhouse gas emissions in Western Australia

Scenario carbon prices induce fuel switching away from emissions intense fuels. In addition, higher energy prices lead to reduced demands at the margin, further reducing emissions

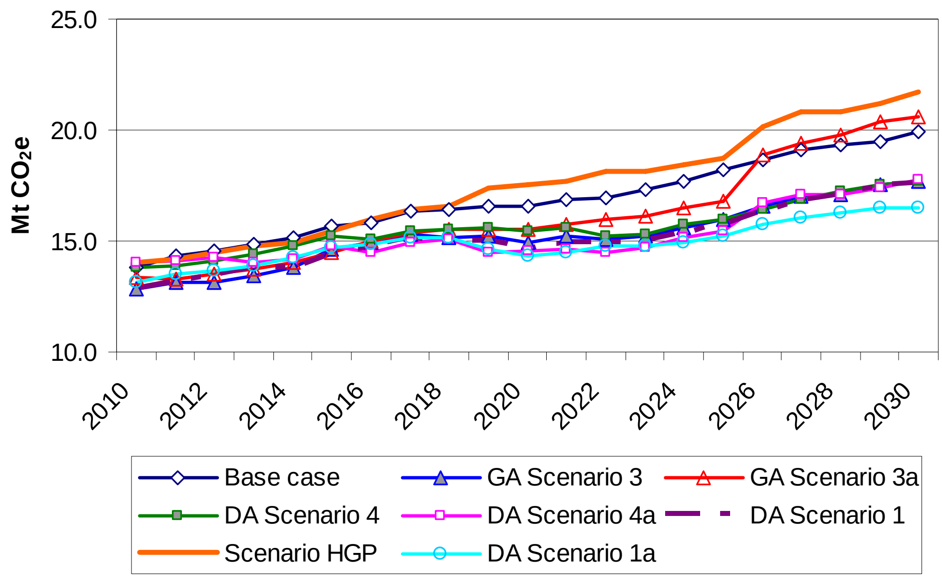
Electricity sector

Cumulative greenhouse gas emissions from electricity generation in Western Australia over the period 2010 to 2030 are reduced compared to the base case in all greenhouse gas constraint scenarios (Figure 4.10).

It can be observed that in all scenarios, except 3a, the carbon prices associated with the NETS reduce Western Australian electricity generation sector emissions by around -2.5 Mt CO_2e at 2030, below the business as usual base case. It is cheaper to achieve further emissions reductions beyond this point in other sectors in Western Australia, and elsewhere in the eastern states.

On the other hand, in Scenario 3a, the higher starting point for emissions in the scenario reference case (recall, 'Scenario HGP'), and the existence of less costly emissions reductions elsewhere in Western Australia and in the eastern states, results in Western Australia ending up with higher emissions compared to the other scenarios.

FIGURE 4.10 – ELECTRICITY SECTOR EMISSIONS – SWIS



Source: MMA

In contrast, this relatively higher emission outcome does not occur in Scenario 4a, despite the same higher emissions starting point as Scenario 3a — eliminating all coal in Western Australia in Scenario 4a leads to the same emissions outcome as Scenario 4, irrespective of the starting point. As a corollary, the emissions reductions required to achieve Scenario 4a from Scenario HGP are greater than the corresponding reduction to hit the Scenario 4 target, from the base case.

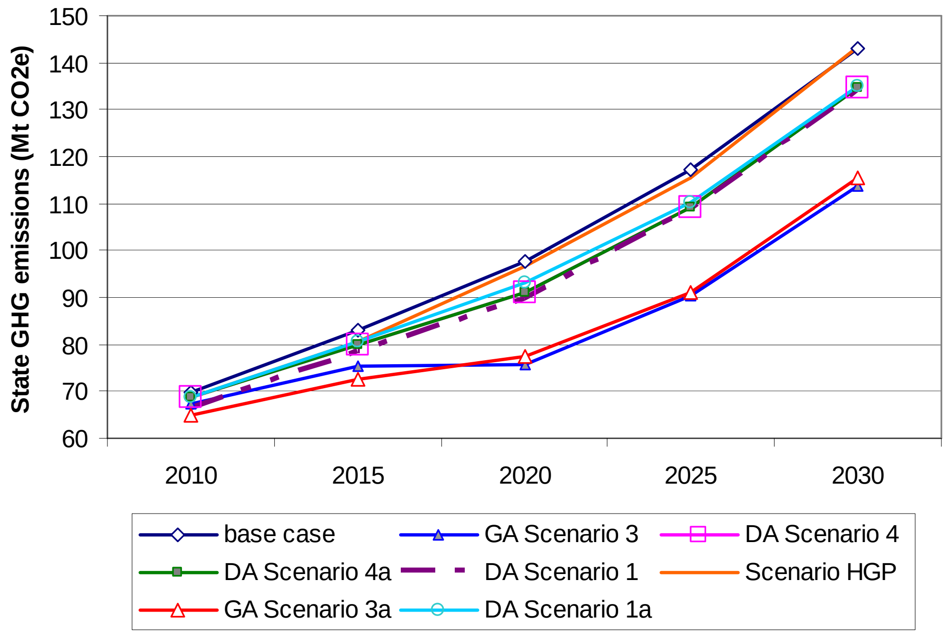
Scenario 1 achieves very similar outcomes to Scenario 4 by the end of the period, but delivers greater cumulative emissions in the electricity sector overall, due to greater emissions reductions early in the period, when carbon prices are higher.

Scenario 1a delivers slightly greater emissions reductions again, due to slower growth in electricity demand.

Total emissions in Western Australia

Total emissions (covering all sectors) in Western Australia tell a slightly different story when compared to that for the electricity generation sector alone. This is because, as noted, Western Australia tends to do more emissions reductions work elsewhere — in its other (non-electricity) Stationary Energy sector — in order to contribute to more stringent targets (specifically, through reduced emissions from direct use of gas, such as in the Alumina sector).

FIGURE 4.11 – ALL SECTORS EMISSIONS – WESTERN AUSTRALIA



Source: MMRF-Green

This is illustrated with reference to Scenario 3 and 3a. In both these scenarios, Western Australia reduces its emissions significantly, by around -20 Mt CO_2e by 2030 below the base case (Figure 4.11). Comparison with Figure 4.10 shows that there are additional emissions reductions in Scenario 3 and 3a coming from sectors other than electricity generation in Western Australia.

Scenario 1, 1a, 4 and 4a all achieve very similar outcomes for total emissions, which mirrors the similar outcomes for the electricity generation sector.

Macroeconomic impacts

The macroeconomic impacts on the Australian economy of achieving the fixed quantity targets are small in overall terms.

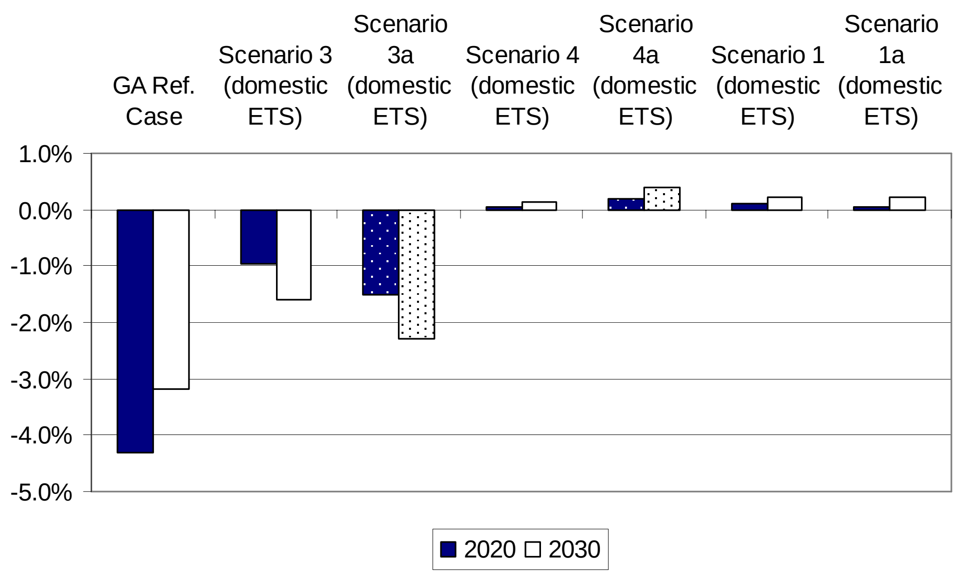
GSP

Overall, the impact of the domestic NETS component on Western Australia is small for Scenarios 1, 1a, 4 and 4a — delivering a slight boost for the Western Australian economy at 2020 and 2030 of between 0.1 and 0.3 per cent in level terms, compared to the base case (Figure 4.12). This positive impact occurs because Western Australia is relatively shielded from the impacts of the NETS compared to other States:

- compensation for energy-intensive trade exposed industries such as Alumina allow a greater proportion of the Western Australian economy to be shielded from the impacts of the scheme; and

- the electricity generation sector in Western Australia contributes reductions up to a point, after which it becomes cheaper to undertake emissions reductions in the eastern states.

FIGURE 4.12 – NATIONAL ETS – CHANGES IN GSP – WESTERN AUSTRALIA



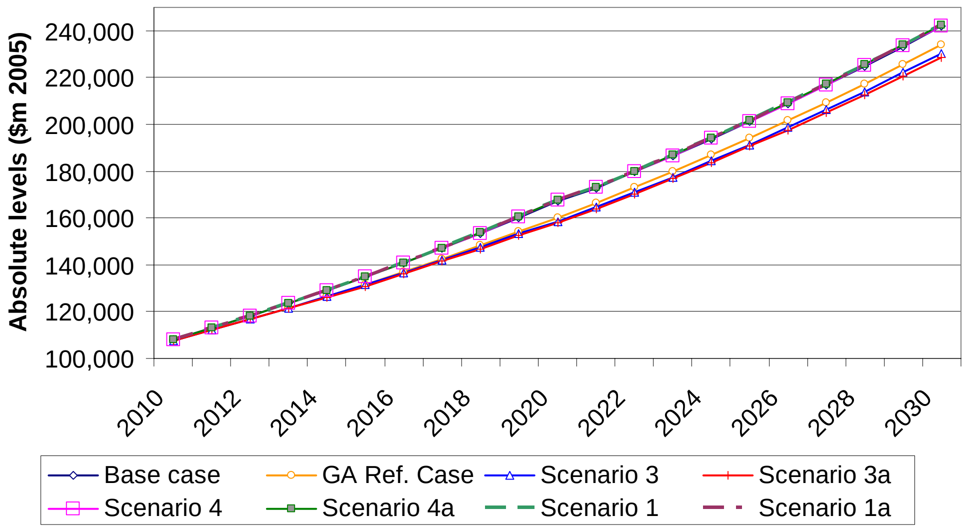
Source: MMRF-Green

Overall, the rate of growth in Scenarios 4, 4a, 1, and 1a are indistinguishable from the base case (Figure 4.13).

In Scenario 3 and 3a, on the other hand, the greatest economic impact on Western Australia arises from the action being undertaken in the rest of the world — GSP is down -3.2 per cent in level terms below the base case at 2030 from this effect alone (the 'GA Ref. Case' impact in Figure 4.12 and 4.13). This impact from the rest of the world is transmitted primarily through a reduction in demand for Western Australia's key exports, particularly for LNG.

Adding in the impact of domestic action through the Scenario 3 NETS ('Scenario 3 domestic NETS in Figure 4.12) adds a further impact of around -1.6 per cent at 2030, leading to a total of combined impact of -4.8 per cent in level terms from global and domestic action at 2030 (Scenario 3 in Figure 4.13).

FIGURE 4.13 – NATIONAL ETS – GSP ABSOLUTE LEVELS – WESTERN AUSTRALIA



Source: MMRF

With Scenario 3a, the economic impacts of the *domestic* NETS are increased compared to Scenario 3 in Western Australia (compare 'Scenario 3a domestic NETS' with 'Scenario 3 domestic NETS' in Figure 4.12). This is because of the higher carbon prices required in Scenario 3a, recall because of the higher domestic gas prices in Western Australia.

However, the impacts on Western Australia of the rest of the world taking action (the 'GA Ref. Case' impact) are assumed not to change, as these impacts would be invariant to increased quantities of coal fired power in Western Australia. Hence, the differences between Scenario 3a and Scenario 3 are due entirely to the different *domestic* economic impacts of meeting the fixed Scenario 3/3a quantity target in Australia.[23]

- It is worth noting at this point that the impact of moving to higher gas prices under Scenario High Gas Price has a negative impact on Western Australia's GDP of -0.2 per cent in level terms at 2030, compared to the base case. This is not shown in the above figures. However, this negative impact would *add* to the

23 To the extent that Australia was part of an international emissions trading scheme, then these costs could rise or fall depending on the international price of carbon. For example, if international carbon prices were lower than those required to achieve the Scenario 3a quantity target in Australia, then Australia could purchase emissions credits internationally — lowering the economic costs of meeting the domestic target. On the other hand, if international carbon prices were higher than those required domestically, then Australia could undertake greater domestic abatement and sell excess emissions credits internationally, This also could reduce the overall economic costs for Australia, but would have distributional consequences in terms the incidence of the costs and benefits of Australia taking action. Consideration of these elements is beyond this study.

The alternative would be to conceptualise the rise in domestic carbon prices as being matched by an equivalent rise in the international carbon price (reflecting the impacts of high international gas prices). Given the findings of the Scenario 3 analysis, it is reasonable to expect this would result in greater impacts on Western Australia — from actions in the rest of the world — by an amount exceeding 10 per cent of the Scenario 3 impact. The impact of international action on Western Australia in Scenario 3 was 4.3 per cent at 2020 in level terms, which if increased by 10 per cent, might rise to 4.5 per cent or more at 2020.

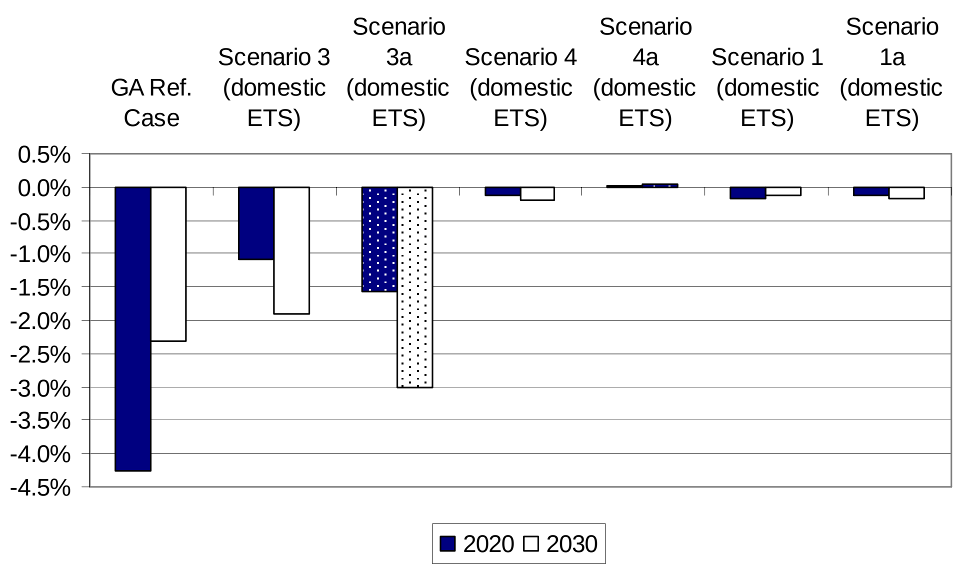
further negative impact of Scenario 3a domestic NETS (a net -0.7 per cent compared to Scenario 3), and result in Western Australia's GSP being down by a total of -5.7 per cent below the base case at 2030 from the combined impact of higher gas prices, global action and domestic action, in level terms.

Private consumption

The impact on private consumption in Western Australia of a domestic NETS follows the pattern observed for GDP, albeit amplified by the 'leakage' of compensation payments to foreign shareholders (Figure 4.14).[24]

The impact of the domestic NETS component on Western Australia is close to zero for Scenarios 1, 1a, 4 and 4a — with private consumption in the Western Australian economy at 2020 and 2030 down in level terms compared to the base case by between 0.0 and -0.2 per cent (Figure 4.15). The leakage of compensation revenues to overseas shareholders offsets, to a degree, the positive impact of the domestic NETS in these scenarios — transforming the overall impact to neutral to slightly negative.

FIGURE 4.14 – NATIONAL NETS — CHANGES IN PRIVATE CONSUMPTION – WESTERN AUSTRALIA

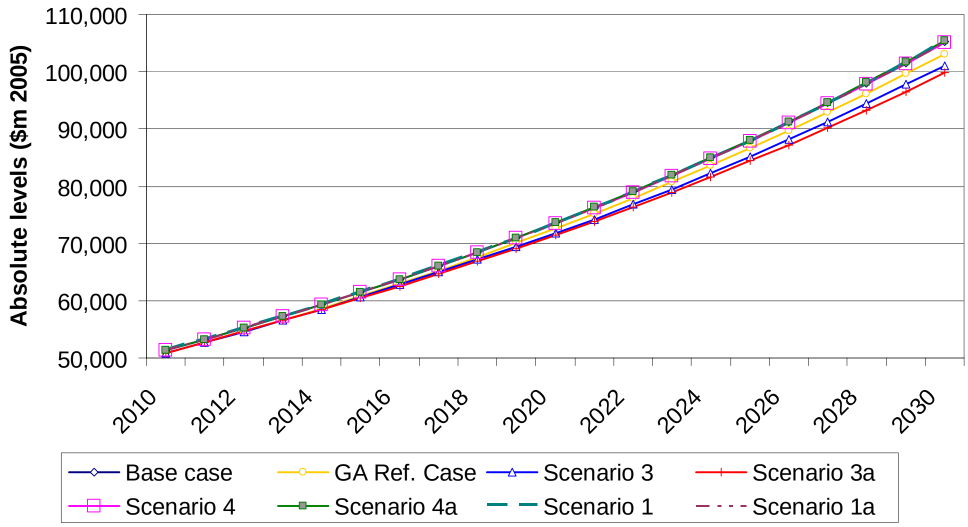


Source: MMRF-Green

Again, however, overall consumption levels are not distinguishable from the base case in absolute level terms (Figure 4.15).

[24] In the domestic action scenarios, compensation is provided to existing generators for loss of profits, and to trade-exposed energy-intensive industries to offset increases in energy costs. As Western Australia receives a relatively greater proportion of compensation to trade-exposed energy-intensive industries, it will also experience greater leakage, all other things equal. This will lead to a greater difference in the impacts of the domestic NETS on private consumption than GSP, compared to other states.

FIGURE 4.15 - NATIONAL NETS — PRIVATE CONSUMPTION ABSOLUTE LEVELS – WESTERN AUSTRALIA



In *level terms* at 2030, contributing to the Scenario 3 emissions constraint results in Western Australia's private consumption:

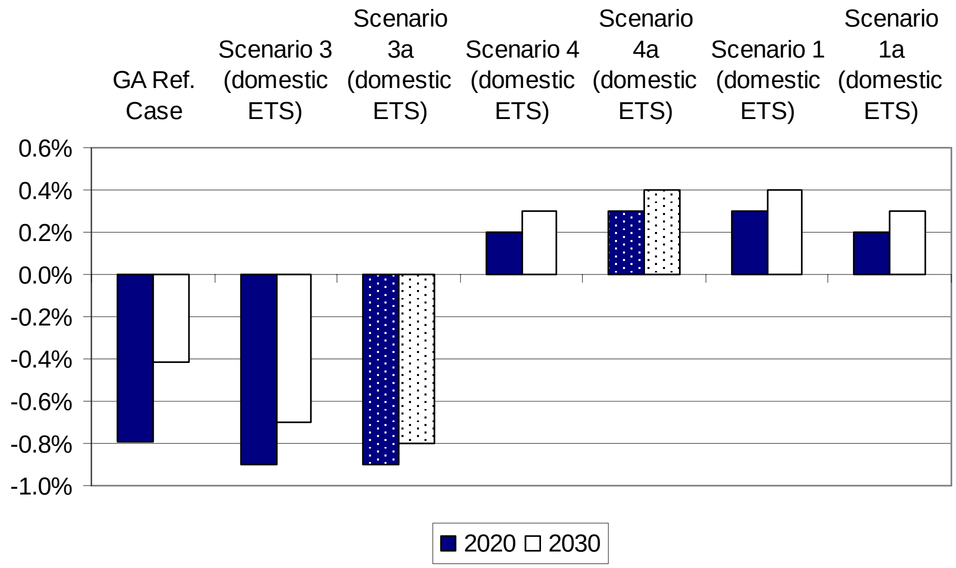
- *absent higher gas prices (Scenario 3)* — being down a total of -4.2 per cent compared to the base case, comprising a -2.3 per cent reduction arising from the actions adopted by the rest of the world (the GA Ref. Case impact in Figure 4.14), and a -1.9 per cent reduction from the adoption of a domestic NETS (the Scenario 3 impact in Figure 4.14);
- *with higher gas prices (Scenario 3a)* — being down a total of 5.0 per cent compared to the base case, comprising:
  - a -2.3 per cent reduction arising from the actions adopted by the rest of the world (the GA Ref. Case impact in Figure 4.14);
  - a -3.0 per cent reduction from the adoption of a domestic NETS (the Scenario 3a impact in Figure 4.14);
  - a positive 0.3 per cent impact of moving to higher gas prices.

Employment and real wages

Employment outcomes for Western Australia are positive in Scenarios 1, 1a, 4 and 4a, with impacts ranging between 0.3 and 0.4 per cent (Figure 4.13).

On the other hand, the impact on Western Australia's employment in Scenario 3/3a is negative. Employment is down more than 1 per cent at 2020 and 0.5 per cent at 2030 in level terms — under the combined impact of action by the rest of the world *and* a domestic NETS.

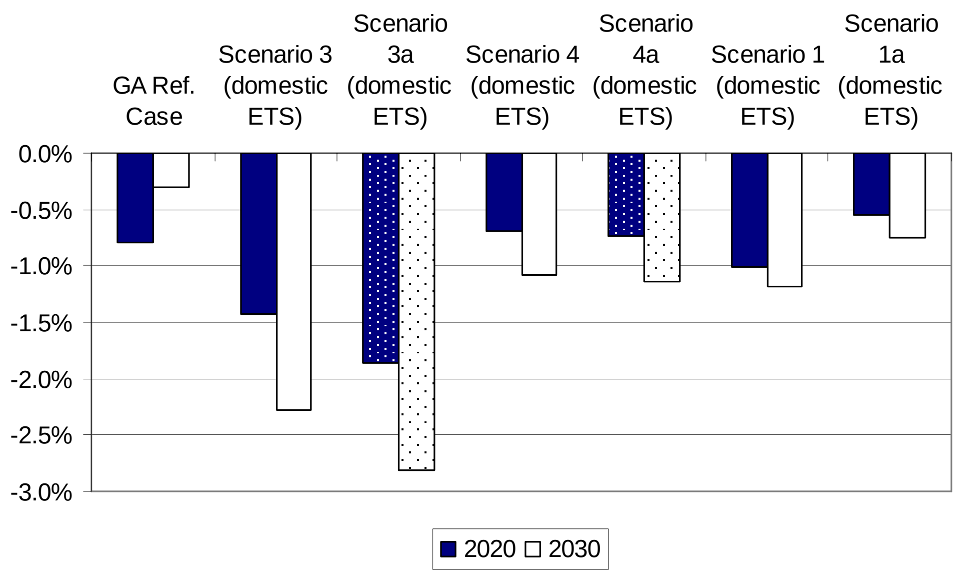
FIGURE 4.16 – EMPLOYMENT IMPACTS ON WESTERN AUSTRALIA



Source: MMRF-Green

Real wages experience slower growth in Western Australia in all scenarios, to be down in level terms compared to the base case (Figure 4.17).

FIGURE 4.17 – REAL WAGE IMPACTS ON WESTERN AUSTRALIA

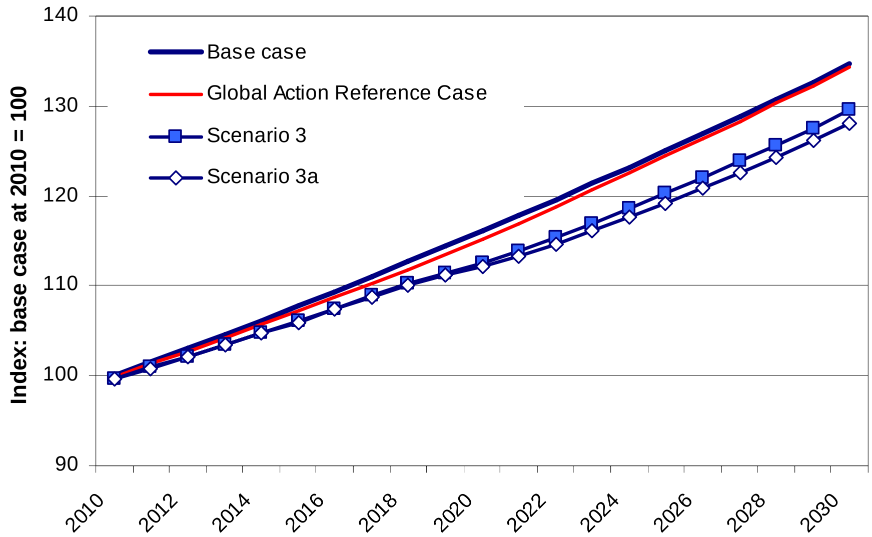


Source: MMRF-Green

Real wages are down by between 0.7 per cent and 1.2 per cent at 2020 and 2030 in level terms compared to the base case in Scenarios 1, 1a, 4 and 4a.

Real wages slow quite markedly under the combined impact of action by the rest of the world and the domestic NETS in Scenario 3/3a. Overall, real wages are down by between 3.8 per cent and 4.9 per cent at 2020 and 2030 in level terms compared to the base case. Nevertheless, real wages continue to grow in overall terms (Figure 4.18).

FIGURE 4.18 – REAL WAGES – SCENARIO 3 AND 3A

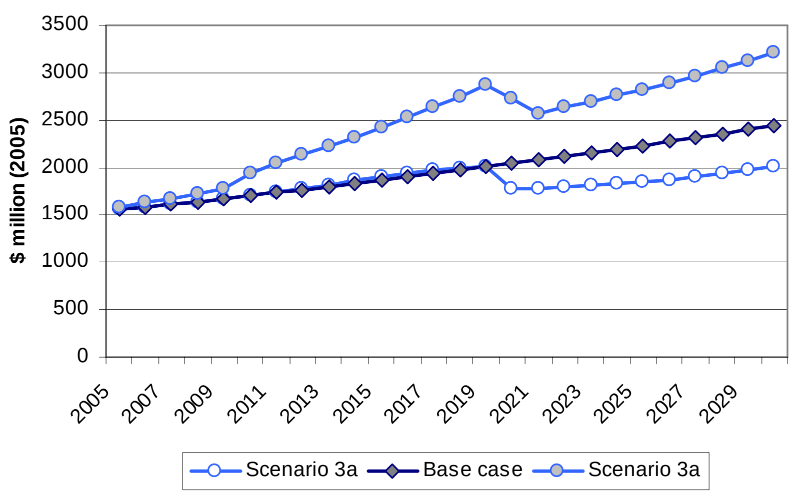


Source: MMRF-Green

Impacts on selected industries in Western Australia

Contracting industries in Western Australia which experience declines in value added of below -10 per cent in 2020 are dominated by Electricity-coal and Coal, irrespective of scenario. The contraction in these industries reflects the reduction in coal fired electricity generation required to achieve emissions targets in all scenarios.

FIGURE 4.19 – ALUMINA INDUSTRY – WESTERN AUSTRALIA – SCENARIOS 3 AND 3A



Source: MMRF-Green

The other industry which experiences a slowdown below -10 per cent is Alumina, in Scenario 3a (Figure 4.19).

- Alumina is little affected in Scenarios 1, 1a, 4 and 4a, because the compensation for energy price rises in these scenarios through the whole period to 2030 shields the industry from the impacts of the NETS.
- In Scenario 3, Alumina is up strongly at 2030, by 24 per cent compared to the base case, due to an expansion of global demand for alumina and aluminium in the presence of a global carbon constraint — which more than outweighs the loss in competitiveness experienced by Australia due to its fossil fuel based production.
- In Scenario 3a, on the other hand, Alumina contracts relative to the base case, particularly once compensation for energy price rises is removed at 2020. The positive impact of an expansion in global demand for alumina is outweighed by the negative impacts of higher gas prices in this scenario. Nevertheless, the industry still experiences overall growth.

The industries that expand significantly, at rates greater than 10 per cent in level terms at 2020 and 2030 compared to the base case, tend to be the renewables industries (Electricity-biomass, Electricity-biogas and Electricity-wind) plus Electricity-gas and Forestry.

Most other industries experience moderate positive or negative impacts close to zero in level terms relative to the basecase. As a result, these industries experience overall average annual growth rates similar to the base case.

4.2 Costs of abatement

A range of NETS scenarios were modelled for the NETT and for the Western Australian Office of Energy. These provide information about the welfare costs of reducing emissions in Australia, and the marginal cost of abatement. In what follows, we combine the information from a range of the scenarios.

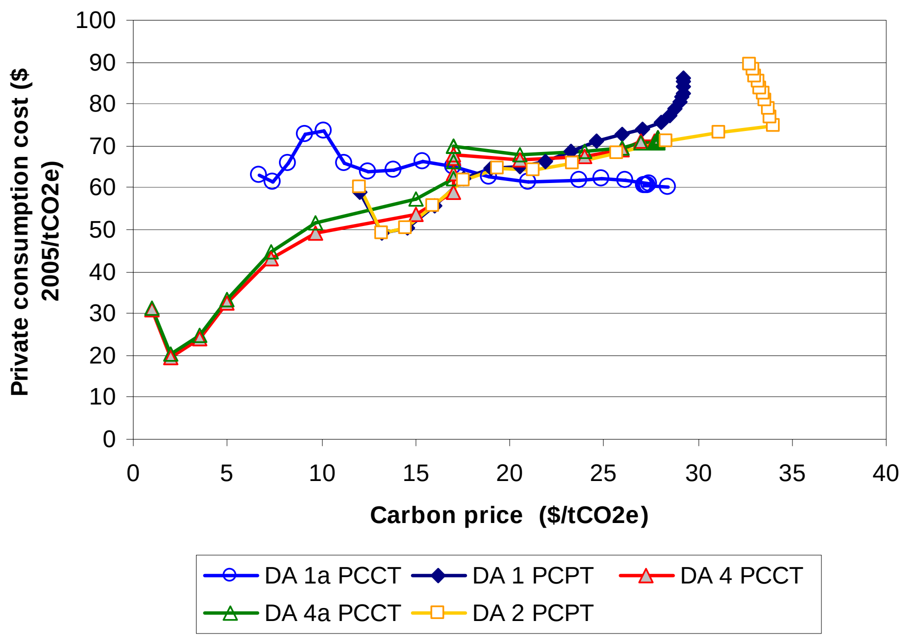
A caveat — the scenarios all involved a NETS, however, there are differences among the scenarios in terms of their sectoral coverage, and the required rate of change in terms of emissions reductions. Two of the scenarios involved impacts on Australia arising from action on climate change in rest of the world. One of the scenarios incorporated assumptions about significantly greater amounts of cost effective forestry offsets and energy efficiency. These elements also create differences. Nevertheless, the following analysis is suggestive of some clear patterns in terms of the marginal cost of achieving abatement in Australia from the Stationary Energy sector, and the associated welfare costs.

Welfare costs of abatement

Private consumption is the best measure of the welfare effects of a policy. The question arises — what are the welfare effects, expressed as cumulative changes in private consumption, of cumulative emissions reductions below business as usual for Western Australia?

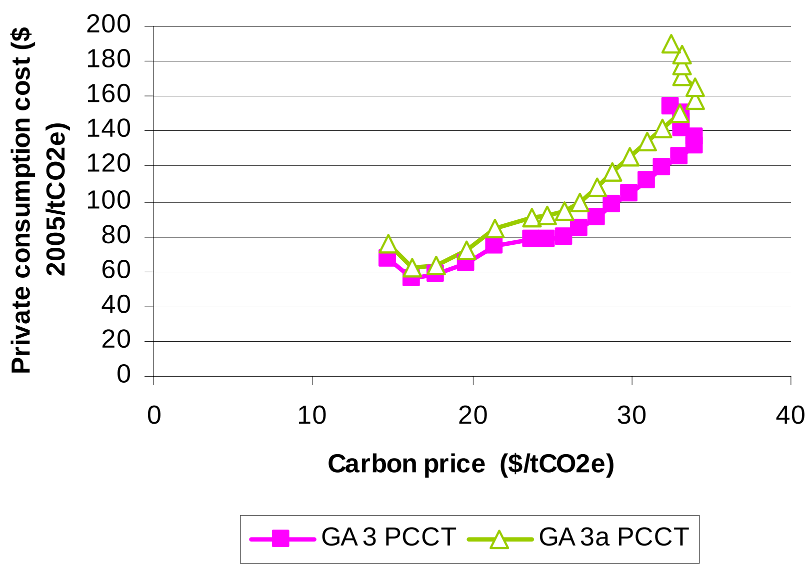
The following four figures compare each scenario's cumulative private consumption change per cumulative tonne of abatement (PCCT) graphed against the various scenario carbon prices, first for Australia (Figures 4.20 and 4.21) and then for Western Australia (Figures 4.22 and 4.23).

FIGURE 4.20 – PRIVATE CONSUMPTION CHANGE PER TONNE OF ABATEMENT – DOMESTIC ACTION SCENARIOS 1, 1A, 2, 4, 4A –AUSTRALIA



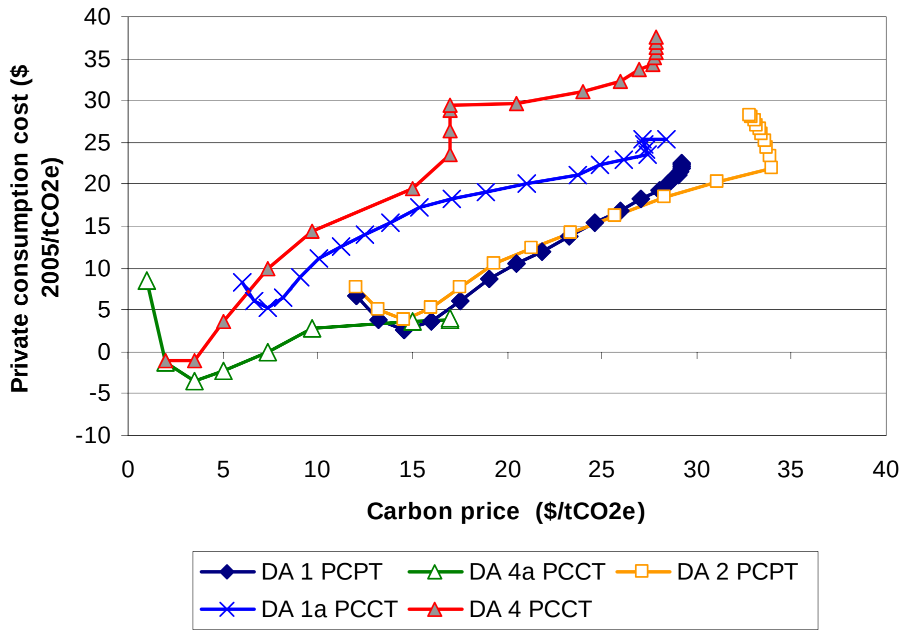
Source: MMRF-Green

FIGURE 4.21 – PRIVATE CONSUMPTION CHANGE PER TONNE OF ABATEMENT – SCENARIOS GA 3, 3A – AUSTRALIA



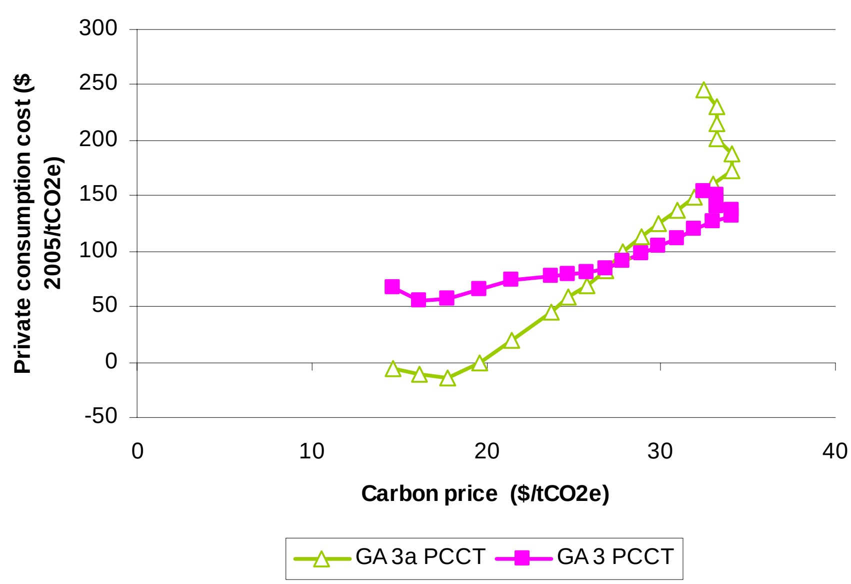
Source: MMRF-Green

FIGURE 4.22 – PRIVATE CONSUMPTION CHANGE PER TONNE OF ABATEMENT – DOMESTIC ACTION SCENARIOS 1, 1A, 2, 4, 4A – WESTERN AUSTRALIA



Source: MMRF-Green

FIGURE 4.23 – PRIVATE CONSUMPTION CHANGE PER TONNE OF ABATEMENT – SCENARIOS GA 1, 3, 3A – WESTERN AUSTRALIA



Source: MMRF-Green

For *Australia*, Figures 4.20 and 4.21 suggest that the cumulative private consumption costs per tonne of abatement rise fairly linearly through to around $25 per tonne of CO2e, but thereafter have a tendency to climb more sharply.

The exception to this is Scenarios 1a — the presence of enhanced energy efficiency, greater low cost forestry offsets and faster technical change maintains a fairly constant cumulative private consumption cost per tonne of abatement over the range of carbon prices. This scenario is initially more costly because of the early investment required to lift energy efficiency. Over time, however, these investments return positively for the economy, progressively reducing the PCCT of achieving the Scenario 1a target.

For *Western Australia*, Figures 4.22 and 4.23 suggest that the cumulative private consumption costs per tonne of abatement also rise linearly, but in this case through to around $30 per tonne of CO2e, before climbing sharply. However, Western Australia's cumulative private consumption costs per tonne of abatement appear to be about *half* those of Australia's (as a whole) in the Domestic Action scenarios. This reflects the finding in this report that much of the generation sector abatement task appears to be achieved in States and Territories other than Western Australia.

In the Global Action scenarios on the other hand, Western Australia's cumulative consumption costs are very similar to those of Australia as a whole. This likely reflects the relatively greater impact that action by the rest of the world has on Western Australia, compared to the rest of Australia, which will tend to make up for the lower impacts of Domestic Action in Western Australia.

Marginal cost of abatement curve

The following figures plot the cumulative abatement achieved across the various NETT modelling scenarios against the relevant scenario carbon price — for Australia as a whole (Figure 4.24), and for Western Australia (Figure 4.25).

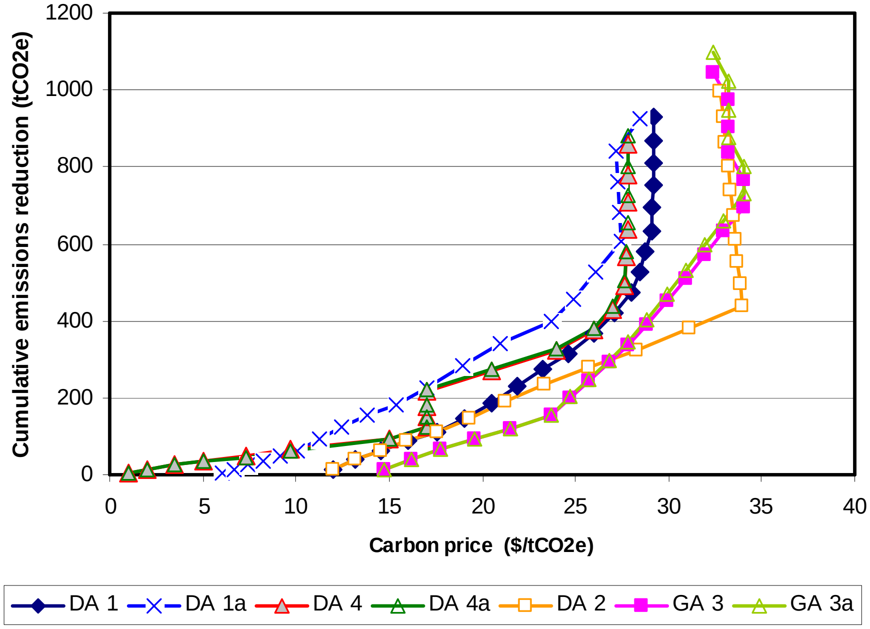
Abatement for Australia tends to be limited up to around $10 per tonne CO_2e — this is the price at which significant fuel switching to gas starts to occur for new electricity generation investments (in Victoria initially, and thereafter progressively in the other states).

Thereafter, abatement rises fairly smoothly with an increase in the carbon price, up to around $25 to $30 per tonne CO_2e (Figure 4.24). At $25 per tonne CO_2e, a central estimate for *cumulative* abatement in:

- *Australia* is around 300 Mt CO_2e — which is around 5 per cent of Australia's total cumulative emissions in the base case through to 2020, and around 10 per cent of Australia's cumulative stationary energy emissions over the period;
- *Western Australia* is around 30 Mt CO_2e — which is around 3 per cent of Western Australia's total cumulative emissions through to 2020, and around 8 per cent of Western Australia's cumulative stationary energy emissions over the period.

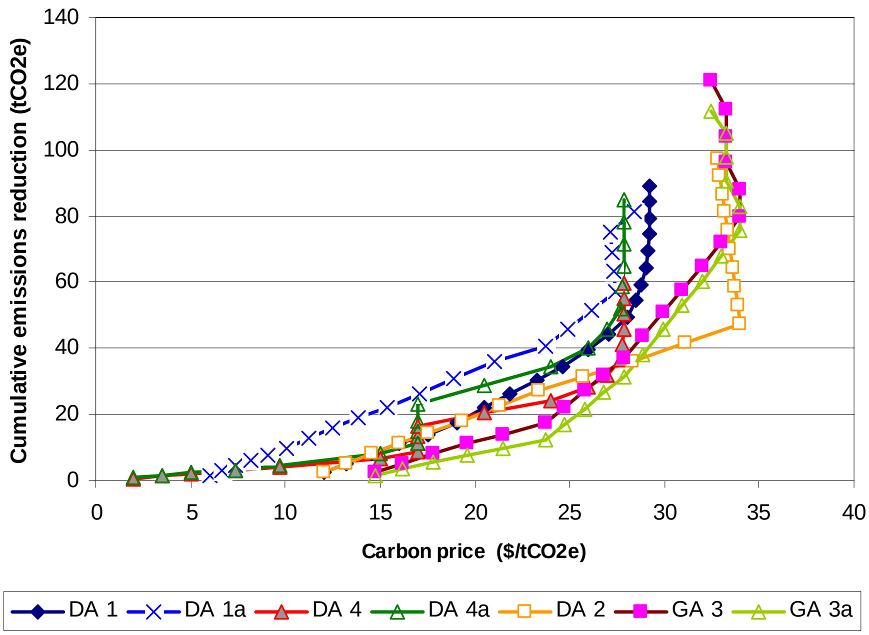
The cumulative abatement achievable then rises sharply at around $28 to $35 per tonne CO_2e — this reflects the assumption of cost effective carbon capture and storage becoming available at these prices from, around 2021 on.

FIGURE 4.24 - MARGINAL COST OF ABATEMENT - AUSTRALIA



Source: MMRF-Green

FIGURE 4.25 - MARGINAL COST OF ABATEMENT – WESTERN AUSTRALIA



Source: MMRF-Green

APPENDIX A

Abbreviations

ANZSIC	Australia New Zealand Standard Industrial Classification
CCS	Carbon Capture and Storage
GHG	Greenhouse Gas
IMOWA	Independent Market Operator of WA
NETS	Emissions Trading Scheme
NETT	National Emissions Trading Taskforce
PCCT	Cumulative Private Consumption Change per Cumulative Tonne of Greenhouse Gas Emissions Abated
SWIS	South West Interconnected System

APPENDIX B

NETT modelling — scenario design and assumptions

The National Emissions Trading Taskforce modelling utilised MMA 'bottom up' electricity sector modelling to determine emissions permit prices of electricity sector caps and associated changes in electricity supply technologies. These results were then used as an input to the MMRF-Green general equilibrium model to assess the economy-wide outcomes of the NETS.[25]

B.1 Modelling methodology

The impacts of national emissions trading scheme (NETS) scenarios were investigated using MMA's suite of energy market models and the Monash Centre of Policy Studies' MMRF-Green computable general equilibrium model.

MMA modelling

As an initial step, the caps for electricity sector GHG emissions relating to each NETS scenario were run through MMA's suite of 'Strategist' electricity and gas market models.

[25] This Appendix draws heavily on previous reports by Insight Economics and The Allen Consulting Group for the NETT — see or example The Allen Consulting Group 2006, *The Economic Impacts of a National Emissions Trading Scheme: Final Report to the National Emissions Trading Taskforce*, www.emissionstrading.net.au .

Modelling of a NETS cap and trade system in the MMA electricity market model is achieved by setting a target of total carbon emissions for each year. The model adds a price per unit of GHG emission and adjusts this price incrementally until the target is reached. This price is another variable cost, which impacts on the dispatch cost of each generator. The price at which the target is met is effectively the carbon permit price.

The MMA modelling of the NETS scenarios accounted for estimates of available forestry biosequestration offsets. These forestry offsets reduced the amount of abatement required from the electricity generation sector, in order to meet the NETS cap under each scenario. The amounts of biosequestration offsets varied by scenario and in proportion to the carbon price, and were calculated from separate modelling conducted by MMA.

The MMA models can also allow for banking, whereby instead of setting an annual target, an overall cumulative emissions target is set for, say, a twenty year period (2010 to 2030). The dynamic programming element of the model then determines selection of new plant and dispatch of existing and new plant, taking into account different levels of the permit price. The model selects the optimal level of banking by selecting the optimal level of GHG emissions abatement in each year to meet the overall target. The permit price in each year is then the price at which the optimal annual levels of emissions are achieved.

Caps on the permit price can also be placed in the model. Compensation through permit allocation is handled by allocating rights to emit to the relevant plant.

The MMA modelling provides a comprehensive picture of the impact of a NETS on the electricity market. The MMA modelling will reflect assumptions about the availability and uptake of new technologies on the supply side of the electricity generation market in response to a price for carbon. The model is used to determine the dispatch levels for each generating plant to meet a typical week of hourly demand profiles for each month of the study period.

MMRF-Green modelling

In order to understand the impact on the wider economy, some of the outputs from the MMA modelling are transferred as exogenous inputs to MMRF-Green. These outputs are changes in:

- the carbon permit price;
- the wholesale price of electricity in the National Electricity Market, South West Integrated System and Darwin Katherine Integrated System electricity markets, which reflect the impact of the carbon price required to achieve the NETS cap;
- the resulting fuel mix for the generated electricity; and
- the pattern and location of future investment in generation capacity and transmission/distribution, as well as operating resource costs.

These inputs provide the basis for the MMRF-Green policy simulation. In addition, other exogenous adjustments can be included in the MMRF-Green policy simulation to reflect assumptions about the international carbon price, the extension of the NETS to other sectors in the model, the impact of the carbon price on technological change in end-use efficiency on the demand side of the electricity market, and policy for other sectors of the domestic economy.

The output from the MMRF-Green model then quantifies a range of impacts from the NETS, including on economic aggregates at the national, State and regional level as well as on the household sector and individual industries.

B.2 The MMRF-Green model

MMRF-Green is a detailed dynamic, multi-sectoral, multi-regional model of Australia. The current version of the model distinguishes 49 industries, 54 products, 8 States/territories and 56 sub-state regions.[26] The regions are based on the Statistical divisions defined in the Australian Standard Geographical Classification (ABS catalogue number 1216.0), albeit with some aggregation differences.

There are five types of agents in the model: industries, capital creators, households, governments, and foreigners. The industry sectors each produce a single commodity and the capital creators each produce units of capital that are specific to the associated sector. Each region in MMRF-Green has a single household and a regional government. There is also a federal government. Finally, there are foreigners, whose behaviour is summarised by export demand curves for the products of each region and by supply curves for international imports to each region.

MMRF-Green determines regional supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital. Labour supply at the national level is determined by demographic factors, while national capital supply responds to rates of return. Labour and capital can cross regional borders so that each region's stock of productive resources reflects regional employment opportunities and relative rates of return. e of Policy Studies (Monash University)

The specifications of supply and demand behaviour coordinated through market clearing equations comprise the general equilibrium (GE) core of the model. There are two blocks of equations in addition to the core. They describe regional and federal government finances and regional labour markets.

The GE core of MMR requires a multi-regional input-output table together with values for the elasticities of substitution in the CES nests[27] of the specifications of

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26 Public documentation of the MMRF-Green model is available at: Pezzey, J.C.V. and Lambie, N.R., 2001, *Computable general equilibrium models for evaluating domestic greenhouse policies in Australia: A comparative analysis*, Report to the Productivity Commission, AusInfo, Canberra; and Adams, P.D., Horridge, J.M. and Parmenter, B.R., 2000, *MMRF-Green: A Dynamic, Multi-sectoral Model of Australia, Centre of Policy Studies, Monash University*, Melbourne.

27 CES stands for a Constant Elasticity of Substitution (CES) production function. A CES nest refers to a nested production function in which a series of independent decisions on what inputs to use for production are made. For example, a three-level nested production technology is used for current production in MMRF. At the top level, there is no substitution between different materials (chemicals, steel, etc.) or between them and primary

technologies and preferences. The government finance block requires data on regional and Federal government revenues and outlays. The regional labour market block requires regional demographic, employment and labour force data.

MMRF-Green business-as-usual assumptions

The MMRF-Green model utilises a range of assumptions to develop a no policy change 'business as usual' 'Base Case' projection for the national and regional economies. Subsequent modelling of policy scenarios can be compared to this Base Case. The Base Case business-as-usual projections to 2030 are generated using:

- State/territory macroeconomic forecasts from Access Economics to 2014, supplemented by information from the Commonwealth's government's Intergenerational Report;
- national-level assumptions for changes in industry production technologies and in household preferences from the Centre of Policy Studies (CoPS);
- estimates of the net impacts of energy-related measures from CoPS and MMA; and
- forecasts through to 2010 for the quantities of agricultural and mineral exports from the Australian Bureau of Agricultural and Resource Economics (ABARE), and estimates of capital expenditure on major minerals and energy projects from various sources, such as state government agencies, ABARE, and the National Electricity Market Management Company (NEMMCO).

The Domestic Action scenarios reported on here were modelled against the MMRF-Green Base Case, as it is consistent with a continuation of the current policy settings for climate change in the rest of the world.

- The 'Domestic Action Base Case' was the standard MMRF-Green Base Case projection to 2030, incorporating existing domestic greenhouse measures and current global action on climate change (that is, incorporating actions by parties that have ratified the Kyoto Protocol, but no further global action on climate change post 2012).
- Considerable work has been undertaken to harmonise the Base Case assumptions for the MMRF-Green and MMA models. Key elements include alignment of assumptions about the availability and prices of gas and oil supplies going forward, and of the general drivers of energy demand, including growth in final demand for electricity and gas. However, no further iterations were undertaken in this modelling exercise.
- In the MMRF-Green model Base Case oil prices assumptions were adjusted to conform to the International Energy Agency's World Energy Outlook 2005 Reference Case, for oil prices reaching US ($2004) $39 by 2030. It should be noted

factors. At the second level, we have CES functions describing substitution possibilities between imported and domestic goods of the same type and among primary factors. At the third level, which applies only to labour inputs, we have a CES function that allows us to recognise that labour possessing one skill can be substituted for labour of another skill.

that the model projections incorporate lower current price levels compared to actual current oil prices, and hence the World Energy Outlook projection represents a significant increase in the price of oil over time in the model.

Existing measures

The MMRF-Green Base Case assumes that only those energy-related measures currently in place in Australia and overseas operate over the simulation period. In effect, the Base Case shows what might be expected to happen if there were no additional energy policy measures here and overseas.

Both of the models account for the following domestic measures in their respective Base Cases:

- the Mandatory Renewable Energy Target and extension to Green Power;
- Greenhouse Gas Abatement Program;
- Greenhouse Challenge Plus, including Generator Efficiency Standards and Greenhouse Friendly;
- the NSW and ACT Greenhouse Gas Abatement Scheme, the Queensland Cleaner Energy Strategy (incorporating the 13 per cent gas scheme) and other State and territory programs;[28]
- MEPS and other energy efficiency measures;
- other State and territory measures.

As a general principle in the scenario modelling, existing policy measures were retained. However, in the modelling of scenarios, the NSW and ACT Greenhouse Gas Abatement Scheme was assumed to cease in 2009 and be replaced by the NETS.

Limitations and modifications to the MMRF-Green model

The MMRF-Green model does not include the effects of climate change (as might be the case in an integrated climate change model). Therefore it also does not show the benefits of GHG mitigating policy action, such as the Kyoto Protocol and other regional trading schemes.

MMRF-Green is a single country model. It does not include *endogenous* (model determined) interaction between Australia and the rest of the world arising from the NETS. Instead, the effects on Australia of rest of the world responses to an international carbon price have been modelled via exogenous changes to Australia's export demand and import supply schedules (further detail is provided in Box 2.2 in Section 2.5).

There is no feedback from the endogenously-determined changes in the Australian economy, arising from the introduction of domestic carbon prices, on the rest of the

[28] The modelling excludes the Victorian Renewable Energy Target Scheme.

world's export demand and import supply schedules for Australia's traded goods. This is unlikely to be significant, however, given the small size of the Australian economy in overall global activity.

The model also does not endogenously predict the emergence of new industries. New industries must be exogenously introduced, with the size and timing of that new industry also exogenously determined.

B.3 Reference case

Two global policy contexts were considered in modelling the impacts of a NETS on the Australian economy for the NETT.

The first assumed no additional global action on climate change. The set of 'Domestic Action' scenarios adopted this assumption and were modelled against the 'Domestic Action Base Case'.

As noted above, the 'Domestic Action Base Case' was the standard 'business as usual' MMRF-Green Base Case projection to 2030, incorporating (most) existing domestic greenhouse measures and current global action on climate change (that is, incorporating actions by parties that have ratified the Kyoto Protocol, but no further global action on climate change post 2012).

The second policy context assumed additional global action on climate change going forward. The 'Global Action' scenarios adopted this assumption and were modelled against their own 'Global Action Reference Case' — in which it was assumed that the world would progressively adopt policies designed to substantially reduce emissions by 2050.

- The 'Global Action Reference Case 2' incorporated the macroeconomic impacts on Australia of terms of trade and income effects arising from an assumption of moderate global action on climate change (consistent with 'Scenario 3') — with full global trading at prices of up to A$34 per tonne carbon dioxide equivalent.

Simulation results were then reported as deviations away from these Reference Cases.

In addition, the economic impacts of moving from the MMRF-Green Base Case to the Reference Cases were evaluated. This allowed the impact on Australia of the rest of the world taking action, absent action by Australia, to be estimated. In addition, the combined impact of moving from the Base Case to action by Australia and the rest of the world could also be estimated.

B.4 NETT NETS scenarios

Four NETT NETS scenarios are reported on here — Global Action Scenario 3, Domestic Action Scenario 1, Domestic Action Scenario 1a (labelled Domestic Action Scenario 2 in the original Allen Consulting Group report) and Domestic Action Scenario 4

Domestic Action Scenarios

Scenario 1, Scenario 1a and Scenario 4 were 'Domestic Action' scenarios. These scenarios were configured as indicative targets to achieve moderate abatement without large domestic economic impacts. There was no assumption of global action. Thus the economic activity in the rest of the world was assumed to continue growing in line with current policy settings.

- *Domestic Action Scenario 1* — national electricity generation *combustion* emissions were capped at 176 Mt CO2 e by 2030. The 176 Mt CO2 e cap would be equivalent to returning electricity generation sector emissions to around year 2000 levels.

- *Domestic Action (DA) Scenario 1a* — as per Domestic Action Scenario 1, but with sensitivity for enhanced energy efficiency uptake, demand side 'induced technical change' (ITC) and enhanced forestry biosequestration. In this sensitivity scenario the targeted emissions quantity trajectory followed Domestic Action Scenario 1, but the emissions permit price was reduced due to the enhanced energy efficiency, ITC and forestry biosequestration offsets reducing the abatement required from the electricity generation sector.

- *Domestic Action Scenario 4* — assesses the carbon price, from a NETS covering *combustion* emissions, required to *just prevent* the uptake of new coal fired electricity generation in Australia.

In all of the Domestic Action scenarios, the permit *prices* arising from application of domestic NETS electricity sector caps were applied to the rest of the domestic Stationary Energy sector (that is, non-electricity sector activities involving the direct combustion of gas and coal) from 2015 on, but not to other domestic sectors.[29] As a result, from 2015 on, the whole of the Stationary Energy sector faces the same marginal cost of abatement as that applying in the electricity generation sub-sector. This extension thus provides the impact of a NETS applying to the whole of the Stationary Energy sector from 2015 on. In addition, the Forestry sector was stimulated exogenously from 2010 on — to achieve the amounts of forestry biosequestration credits, calculated by MMA, that were assumed to apply in each of the scenarios.

Key assumptions for MMRF-Green for the Domestic Action scenarios included:

- *Coverage* — only combustion emissions for electricity generation and other sub-sectors of the Stationary Energy sector were included in the Domestic Action scenarios. As noted above, electricity is included from 2010 on, while other Stationary Energy emissions — direct use of gas and coal — were included from 2015 on, facing the same permit price arising from the electricity sector modelling.

- *Permit allocation to electricity generators* — MMA modelling was used to determine the reduction in profits experienced by electricity generators as a result

[29] The definitions of GHG emitting sectors used in this report are consistent with those used in Australia's National Greenhouse Gas Inventory. Detail is available at www.greenhouse.gov.au.

of the NETS, calculated for each technology class in each state. NETS permits to equivalent value were then allocated in the MMRF-Green modelling to each electricity generator technology class in each state to offset the profit loss.

- *Compensation for energy intensive trade exposed industries* — sufficient permits were provided gratis to downstream energy intensive industries to exactly compensate for increases in energy costs. The amount of permits required for this compensation was calculated in the MMRF-Green model.

TABLE B.1 - DOMESTIC ACTION SCENARIO ASSUMPTIONS

Assumption	Details
Counterfactual	MMRF-Green business-as-usual Base Case. • This involves the standard MMRF-Green Base Case projection to 2030, incorporating existing domestic greenhouse measures and current global action on climate change (that is, incorporating actions by parties that have ratified the Kyoto Protocol, but no further global action on climate change post 2012). • Considerable work has been undertaken to harmonise the Base Case assumptions for the MMRF-Green and MMA models. Key elements include alignment of assumptions about the availability and prices of gas and oil supplies going forward, and of the general drivers of energy demand, including growth in final demand for electricity and gas. • In both the MMRF-Green and MMA models, Base Case oil prices were adjusted to conform to the International Energy Agency's World Energy Outlook 2005 Reference Case, for oil prices reaching US (2004) $39 by 2030.
Coverage	Phased coverage of sectors under the NETS: • Electricity generation combustion-only emissions were capped from 2010 on according to Scenario emissions trajectory required to hit the relevant Scenario target — generating the Scenario carbon price. • Non-electricity Stationary Energy sector (that is, direct use of gas and coal) was included in NETS from 2015 on — these sectors then faced the same carbon penalty as the electricity generation sector. • Other sectors (for example Fugitive, Agricultural etc) did not face the carbon penalty in the Domestic Action modelling.
Permit allocation to electricity generators	Permits were allocated to electricity generators over the whole period 2010 to 2030: • Emissions permits were allocated, by 'technology class' by state, sufficient to offset each 'technology class' net loss in profits. • Generators were free to use permits to optimize profits (so still had incentives to improve efficiency of fuel use etc.)
Compensation for trade exposed energy intensive industries	Energy intensive trade exposed industries were compensated for 100 per cent of increased energy costs for the period 2010 to 2030. Compensation was applied to those sectors which have non-transport energy costs with a more than 3.5 per cent share of total operating expenses in 2003-04 in the MMRF-Green model (share of energy in operating expenses in 2003-04 in brackets): • Other non-ferrous ore (10.6%); • Non-metallic mineral products (3.9%); • Cement (6.7%); • Iron and steel (8.1%); • Aluminium and alumina (22.7%). Compensation amounts were calculated in MMRF-Green and applied for: • 2010-2014: for Electricity cost rises for the specified sectors; • 2015 to 2030: for Coal, Gas and Electricity cost increases for specified sectors. Compensation funds were returned as a production subsidy.
Recycling of surplus revenue	Remaining permits — beyond those used to compensate generators and trade exposed energy intense sectors — were assumed to be auctioned, with surplus revenue recycled as a lump sum to households. Shares were apportioned to each state and territory in

	proportion to population.
Banking	Unconstrained banking was allowed but no borrowing: The impact of banking was reflected in MMA modelling for electricity generation sector and thus influenced the carbon price adopted in the MMRF-Green modelling. Banking allows arbitrage between the higher permit prices later in the NETS period and lower permit prices early in the period. This has the effect of increasing the amount of (cheaper) abatement undertaken early, and reducing the amount of (more expensive) abatement undertaken later.
Biosequestration offsets	Modest amounts of biosequestration offsets reaching 3.2 Mtpa by 2030 were assumed in Domestic Action Scenarios 1 and 4 respectively — reducing the amount of abatement required to achieve the specified annual targets in the electricity generation sector. More substantial biosequestration offsets approaching 5 Mtpa at 2020 and 15 Mtpa at 2030 were assumed to be available under the sensitivity simulations (Domestic Action Scenario 1a). (The MMA modelling report provides detail.)
Enhanced energy efficiency	Modest amounts of energy efficiency were assumed to be available in Scenarios 1 and 3. Additional investments in energy efficiency were simulated in both the MMA and MMRF-Green modelling for Domestic Action Scenario 1a to reflect an assumed complementary policy to overcome market failures and organisational barriers impeding uptake of cost effective energy efficiency. The level of end use energy demand was reduced by approximately 6 per cent at 2020 and by 13 per cent by 2030 (below that in Domestic Action Scenario 1)
Induced technical change	In Domestic Action Scenario 1a, the presence of a carbon price is assumed to accelerate development of demand side energy end use technologies: An additional 0.1 per cent of technical change (in end use energy productivity or tastes) was applied in the MMRF-Green model, in proportion to every $10 / tCO2e change in carbon price. The additional technical change in response to the change in the carbon price was introduced with a 5 year lag, and lasted for 10 years, before returning to historic rates of change (which are for 0.4 to 0.8 per cent improvements in annual intermediate input-using technical productivity and 0.4 to 0.5 per cent shifts in household tastes away from energy).

- *Complementary policies* — sensitivities allowing for enhanced uptake of energy efficiency and forestry biosequestration in response to emissions permit prices in Domestic Action Scenario 2 assumed complementary policies were implemented to overcome market failures and other barriers preventing optimal uptake.

Table C.1 summarises in greater detail the assumptions adopted for the Domestic Action modelling.

BOX B.1 - USE OF GTAP-E

GTAP-E is an energy-environmental version of the Global Trade Analysis Project (GTAP) model developed at Purdue University.[30] The GTAP-E model was used to deduce the trade impacts on Australia of a global carbon trading scheme which did not include Australia. The trade impacts involve shifts in demand curves for our major energy and metals exports, and in the supply curves for our imports, arising from the global carbon price. These shifts will derive in part from relative price changes (arising from the application of the carbon price) and income effects (given changes in the various countries' output and income arising from the application of the carbon price).

Two simulations were run, corresponding to Global Action Scenario 2 (peak carbon price of AUD $53) and Global Action Scenario 3 (peak carbon price of AUD $34). Because GTAP-E is not dynamic, only one carbon price from each scenario was used - the peak price. The simulation was long-run comparative static. The schedules for export quantities at prices (in foreign currency) faced by Australian energy and metals exporters and for import quantities at prices (in foreign currency) paid by Australian energy importers (principally importers of oil) from the GTAP-E simulations were estimated and used as input to MMRF-Green simulations.

These inputs provided the effects of the changes to Australia's trading environment arising from global action, and were used to develop the relevant MMRF-Green Global Action Reference Cases. These Reference Cases show the economic impacts of action on climate change by the rest of the world, in the absence of action by Australia.

Subsequent impacts of adopting a domestic NETS — corresponding to each Global Action scenario — were then modelled using MMRF-Green as deviations from the relevant Global Action Reference Case.

Source: Insight Economics

Global Action Scenario 3

The 'Global Action' scenarios considered domestic greenhouse action against an assumed back drop of concerted global action targeting substantial GHG emissions cuts by 2030, as a prelude to further cuts in GHG emissions by 2050.

- *Global Action Scenario 3: 'Stabilising Domestic Emissions'* — cap electricity generation emissions at 176 Mt of CO2-e by 2030 (the 176 Mt of CO2-e cap is equivalent to returning electricity generation sector emissions at 2000). The targeted quantity trajectory was reduced from 2016 to 2024 to smooth permit prices through this period.

Global Action scenarios were modelled against the appropriate Global Action Reference Case — it was assumed that international action on climate change in each Global Action scenario involved a carbon price identical to that applying within Australia. These scenarios thus are representative of Australia participating in global action on climate change, with an equivalent domestic carbon price to that applying globally.

The macroeconomic impacts on Australia arising from adoption internationally of the carbon price were estimated using GTAP-E, and were used to develop the relevant Global Action Reference Cases (Box C.1).

30 Further detail on GTAP-E can be found at https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=923 .

The Global Action scenarios apply the emissions permit price, arising from the electricity sector cap, progressively to other sectors in the economy — extending first to the other Stationary Energy (direct use of coal and gas) and Fugitive sectors from 2015 on, and *then to all other sectors* in the economy from 2020 on. Thus from 2020, the whole economy faces the same carbon penalty as that set by the NETS targets in the electricity sector.

Key assumptions used in the MMRF-Green modelling of the Global Action scenarios include (Table C.2):

- *Coverage* — all the GHG emissions sectors were subject to a carbon penalty equivalent to that arising from the emissions cap on the electricity sector, albeit with variable phasing in.
- *Compensation for generators* — as with the Domestic Action scenarios, permits were allocated to electricity generators to compensate for loss of profits arising from the NETS, over the whole period 2010 to 2030.
- *Compensation of trade exposed energy intensive industries* — compensation was provided through to 2020, after which time the need for compensation was judged to lapse due to the assumption of a full global emissions trading regime in the Global Action Scenarios.
- *Revenue recycling* — surplus permits left after compensation of electricity generators and the energy intensive trade exposed sectors were auctioned, and the revenue recycled to households.

TABLE C.2 - GLOBAL ACTION SCENARIOS ASSUMPTIONS

Assumption	Details
Counterfactual	The relevant Global Action Reference Case — Reference Case 3 for Global Action Scenario 3
Coverage	Coverage of sectors under the NETS was phased in over time: • Electricity generation combustion-only emissions were capped, from 2010 on, according to Scenario emissions trajectory — this generated the Scenario carbon price. • The non-electricity Stationary Energy sector (that is, direct use of gas and coal) and Fugitive sectors were included in the NETS from 2015 on — these sectors faced the same carbon penalty as the electricity generation sector. • The carbon penalty was applied to all other GHG sectors in the MMRF-Green model from 2020 on (including the Transport, Agriculture and Industrial Processes sectors). The extension of the carbon price to these other sectors could reflect inclusion in the NETS, or perhaps alternative policies in these industries driving adoption of abatement measures up to the same marginal cost of abatement.
Permit allocation to generators	Permits were allocated to electricity generators over the whole period 2010 to 2030: • Emissions permits were allocated, by 'technology class' by state, sufficient to offset each 'technology class' net loss in profits. • Generators were assumed free to use permits to maximise profits (that is, permits were provided as a lump sum return).
Trade exposed energy intensive industries	Compensation was provided to energy intensive trade exposed industries at 100% of increased energy costs for the period 2010 to 2020. Compensation was provided to those sectors with energy more than 3.5 % in total costs: • Other non-ferrous ore (10.6%); • Non-metallic mineral products (3.9%); • Cement (6.7%); • Iron and steel (8.1%); • Aluminium and alumina (22.7%). • Compensation amounts were calculated from MMRF-Green for: • 2010-2014: for Electricity cost rises for the specified sectors; • 2015 to 2019: for Coal, oil, gas, Electricity and Gas supply cost increases for specified sectors. • Compensation funds were returned as a lump sum production subsidy. • After 2020, compensation to trade exposed sectors ceased, reflecting the assumption of subsequent global coverage of the carbon price.
Recycling of surplus revenue	Remaining permits — beyond those used to compensate to generators and trade exposed energy intense sectors — were assumed to be auctioned, with surplus revenue recycled as a lump sum to households.

Banking	Unlimited banking was assumed but no borrowing: • The impact of banking was reflected in MMA modelling for electricity generation sector and thus influenced the carbon price adopted in the MMRF-Green modelling. • Banking allows arbitrage between the higher permit prices later in the NETS period and lower permit prices early in the period. This has the effect of increasing the amount of (cheaper) abatement undertaken early, and reducing the amount of (more expensive) abatement undertaken later.
Biosequestration offsets and energy efficiency	Modest amounts of biosequestration offsets and energy efficiency opportunities were assumed to be implemented under the NETS (the MMA modelling report provides detail).

Source: National Emissions Trading Taskforce and Insight Economics

APPENDIX C

Other modelling of the impacts of greenhouse action on the WA economy

Over the last seven years, various reports have been produced using different models to estimate the economic impact of greenhouse gas abatement measures. Many reports have used the MMRF-Green model, developed and operated by the Centre of Policy Studies at Monash University. Overall, modelling results suggest that an emissions trading scheme generally would have a greater negative impact on Queensland and Western Australia than on other States. Examples include:

- *Greenhouse Gas Abatement: Impacts on Western Australian Industry and Industrial Development* (ACIL Tasman 2004) — reports on a Kyoto emissions trading scenario using the MMRF-Green model, in which it is assumed that the international price of carbon reaches AUD21.90 per tCO2-e by 2012, Australia signs but the US does not;
  - the amount of abatement achieved is not reported;
  - WA's GSP was estimated to be 2.6 percent smaller in 2012 than it otherwise would have been (equating to annual growth rate in GSP around 0.2 percent less than it would have otherwise have been);
  - the relative effect on WA's GSP is found to be the most substantial reduction of all states.

- *Meeting the Kyoto Target* (The Allen Consulting Group 2000) — examines the cost of complying with the Kyoto Protocol, in a world where international carbon prices are assumed to rise from $30 to $35 per tCO2e over the Kyoto period 2008 to 2012 (informed by prior work by ABARE);
  - emissions trading is used to bridge an assumed 17 per cent gap to the Kyoto target of 108 per cent;
  - the report suggested that cost of complying with the Protocol would reduce Australia's GDP by around 1.9 per cent a year (over $140bn over a decade), with Gross State Product (GSP) in Western Australia being 3.3 per cent lower than otherwise;
- *The Economic Impact of Reducing Greenhouse Gas Emissions in WA* (H. Ahammed, Dept of Economics, University of WA, undated) — uses a carbon price of $35 per tCO2e to assess abatement policy instruments, including emissions trading;
  - the report suggests that there will be a contraction in WA's GSP in the range of 1-3 percent and a 2-6 percent reduction in consumption.

APPENDIX D

Impacts of higher domestic gas prices in Western Australia

The following summary of the impacts of higher domestic gas prices is taken from the separate report for the Office of Energy.[31]

The Western Australian Office of Energy engaged Insight Economics, McLennan Magasanik Associates (MMA) and the Monash Centre of Policy Studies to explore:

- the implications of higher future gas prices on the competitiveness of Western Australian gas and coal fired electricity generation going forward;
- the implications of higher future gas prices on the economic impacts of a National Emissions Trading Scheme (NETS); and
- alternative policy options (to participation in a NETS) for Western Australia to ensure that there is no new coal fired electricity generation.

Domestic gas prices in Western Australia

In undertaking its 2006 modelling for the National Emissions Trading Taskforce, MMA adopted a value for new domestic gas contract prices in Western Australia of $3.10/GJ (real 2005 dollars) from 2006 on:

[31] Insight Economics 2006, *National Emissions Trading — Impacts with Higher WA Domgas Prices*, Report to the WA Office of Energy

- the new domestic gas supply would be priced at $2.00/GJ ex-wellhead;

- the Dampier Bunbury Pipeline transport charge assumption would be $1.10/GJ.

For the modelling in this report, a value for new domestic gas contract prices in Western Australia of around $4.70/GJ delivered into the South West was assumed (the *full impact* of these domestic gas price rises do not occur until 2025 — by which time all existing as well as new gas contracts are assumed to have been rolled over the new gas price).

- This would represent a close to 50 per cent increase in *delivered* gas prices into the South West — up from $3.10/GJ in the MMA base case.

- The transport cost component rises only marginally in this scenario, from $1.10 to $1.20/GJ. Thus the scenario's ex-wellhead gas prices — excluding transport costs — increase from $2.00/GJ to $3.50/GJ, a rise of 75 per cent.

This higher gas price scenario is towards the lower end of the range of possible future domestic gas prices that could have been chosen. It recognises upward pressure on domestic gas prices from increasing international demand for LNG, but also acknowledges that at these higher prices it would be attractive for smaller gas fields in Western Australia to be brought on stream to service domestic gas demands.

Choosing the lower end of the range also recognised that this scenario would be least likely to constrain new major load growth in the South West. This was considered important, because this modelling exercise is also about exploring the costs of greenhouse policy — too high a domestic gas price may have ended up crimping economic growth significantly, thereby reducing the growth in future greenhouse gas emissions, and lowering the subsequent costs of meeting a particular greenhouse target in Western Australia.

Modelling the impact of higher gas prices

The following modelling was undertaken using MMA's Strategist and the Centre of Policy Studies MMRF-Green models:

1. *Scenario 'High Gas Price'* — evaluates the impacts of moving from a 'business as usual' base case to 50 per cent higher prices for Australia's exports of LNG, which flows on to 50 per cent higher domestic gas prices in the south-west of Western Australia going forward;

2. *Scenario 3a* — re-evaluates NETT *Global Action* Scenario 3 impacts, against the new Scenario High Gas Price as the 'reference case', to explore the impact of returning greenhouse gas emissions from Australia's electricity generation sector to around 2000 levels by 2030; and

3. *Scenario 4a* — re-evaluates NETT *Domestic Action* Scenario 4, against the new Scenario High Gas Price as the 'reference case', to determine the minimum carbon price required to prevent new coal electricity generation in Australia.

Impact of higher international LNG export prices

Higher global gas prices for LNG would be largely neutral for Australian economic activity. However, there would be a significant stimulus for private consumption — reflecting higher revenues from LNG exports, higher profits, and ultimately, higher dividends to shareholders.

In contrast, economic activity in Western Australia would grow marginally more slowly with higher LNG exports prices, as this flows through to higher domestic gas prices, resulting in:

- downstream increases in electricity prices — wholesale electricity prices rise on average by 28 per cent over the base case in the decade 2020 to 2030; and
- a substantial slowing in the growth of the alumina industry — growth slows from an average 2.9 per cent per annum in the base case over the period to 2030 to 1.9 per cent per annum.

This slowing in economic growth in Western Australia reduces, but does not completely offset, the positive stimulus to private consumption in Western Australia from higher LNG export revenues.

In summary, GDP/GSP changes, *in level terms* at 2030, compared to the base case, are:

- 0.0 per cent Australia-wide — increased private spending counterbalances declines in domestic production; and
- -0.2 per cent in Western Australia — a reduced output from gas-dependent industries tends to dominate increased private spending.

Private consumption, and hence the welfare of Australians, is up strongly in level terms at 2030 compared to the base case by:

- 0.6 per cent Australia-wide; and
- 0.3 per cent in Western Australia.

Meeting carbon constraints with higher gas prices

In general terms, higher global gas prices make the task of meeting a given domestic greenhouse quantity target more difficult, and hence more costly in economic terms. Depending on scenario, this additional cost tends to offset — either partially or completely — the boost provided by higher global gas prices.

For Western Australia, there are mixed outcomes, depending on the greenhouse constraint scenario. First, the boost to private consumption for Western Australia is smaller compared to the rest of Australia — Western Australia pays a penalty in terms of higher domestic gas prices. Secondly, there can be associated benefits or costs of contributing to a NETS, depending on the scenario and the exact assumptions adopted. The combined result is that the net impact of higher gas prices can be a net positive or a net negative for the State.

TABLE ES.1 – ECONOMIC IMPACTS OF ACHIEVING SCENARIO 3/3A GREENHOUSE GAS EMISSIONS CONSTRAINT AT 2030

	Australia		Western Australia	
Scenario 3/3a at 2030	**GDP %**	**Priv. Cons. %**	**GDP %**	**Priv. Cons. %**
Impact of the world taking action on climate change	-0.5	-0.4	-3.2	-2.3
Impact of Scenario 3 domestic ETS	-1.3	-1.7	-1.6	-1.9
Total **Scenario 3** impact compared to the base case	**-1.8**	**-2.1**	**-4.8**	**-4.2**
Impact of moving to higher gas prices	0.0	0.6	-0.2	0.3
Impact of the world taking action on climate change	-0.5	-0.4	-3.2	-2.3
Impact of Scenario 3a domestic ETS	-1.8	-2.3	-2.3	-3.0
Total **Scenario 3a** impact compared to the base case	**-2.3**	**-2.1**	**-5.7**	**-5.0**

TABLE ES.2 – ECONOMIC IMPACTS OF ACHIEVING SCENARIO 4/4A GREENHOUSE GAS EMISSIONS CONSTRAINT AT 2030

	Australia		Western Australia	
Scenario 4/4a at 2030	**GDP %**	**Priv. Cons. %**	**GDP %**	**Priv. Cons. %**
Impact of Scenario 4 domestic ETS	-0.5	-0.6	0.1	-0.2
Total **Scenario 4** impact compared to the base case	**-0.5**	**-0.6**	**0.1**	**-0.2**
Impact of moving to higher gas prices	0.0	0.6	-0.2	0.3
Impact of Scenario 4a domestic ETS	-0.5	-0.7	0.4	0.0
Total **Scenario 4a** impact compared to the base case	**-0.5**	**-0.1**	**0.2**	**0.3**

Source: MMRF-Green

In *level terms* at 2030, achieving the Scenario 3/3a emissions constraint results in Australia's private consumption (Table ES.1):

- *absent higher gas prices* — being down a total of -2.1 per cent compared to the base case, comprising a -0.4 per cent reduction arising from the actions adopted by the rest of the world, and -1.7 per cent from the adoption of a domestic NETS;
- *with higher gas prices* — being down a total of -2.1 per cent compared to the base case, comprising a -0.4 per cent reduction arising from the actions adopted by the rest of the world, a positive 0.6 per cent boost from moving to high gas prices, and a -2.3 per cent reduction from the adoption of a domestic NETS.

In *level terms* at 2030, preventing uptake of coal fired electricity generation in Scenario 4/4a results in Australia's private consumption (Table ES.2):

- *absent higher gas prices* — being down a total of -0.6 per cent compared to the base case from the adoption of a domestic NETS;
- *with higher gas prices* — being down a total of -0.1 per cent compared to the base case, comprising a 0.6 per cent boost from moving to high gas prices, and a -0.7 per cent reduction from the adoption of a domestic NETS.

In *level terms* at 2030, contributing to the Scenario 3/3a emissions constraint results in Western Australia's private consumption (Table ES.1):

- *absent higher gas prices* — being down a total of -4.2 per cent compared to the base case, comprising a -2.3 per cent reduction arising from the actions adopted by the rest of the world, and a -1.9 per cent reduction from the adoption of a domestic NETS;
- *with higher gas prices* — being down a total of -5.0 per cent compared to the base case, comprising a -2.3 per cent reduction arising from the actions adopted by the rest of the world, a 0.3 per cent boost from moving to high gas prices, and a -3.0 per cent reduction from the adoption of a domestic NETS.

In *level terms* at 2030, preventing uptake of coal fired electricity generation in Scenario 4 results in Western Australia's private consumption (Table ES.2):

- *absent higher gas prices* — being *down* a total of -0.2 per cent compared to the base case from the adoption of a domestic NETS;
- *with higher gas prices* — being *up* a total of 0.3 per cent compared to the base case, comprising a 0.3 per cent boost from moving to high gas prices, and a 0.0 per cent reduction from the adoption of a domestic NETS.

Policy options to ensure gas fired generation

An emissions intensity standard for new electricity generation provides a reasonably straightforward option to ensure uptake of gas fired electricity generation in the presence of higher domestic gas prices in Western Australia.

It could be feasible to combine an emissions intensity standard with an upfront subsidy to generators to limit the impact on electricity prices. This has a number of advantages for unilateral greenhouse action by an individual state such as Western Australia:

- electricity prices in Western Australia would not rise, all other things equal;
- trade-exposed electricity-intense industries would not suffer the cost impact of higher electricity prices — minimising the distortionary impacts of a unilateral greenhouse gas emissions constraint in Western Australia;
- existing electricity generators would not receive windfall returns from higher electricity prices at the margin; and
- Western Australia and Australia would benefit from the ‘positioning’ effects of preventing new coal fired power stations, reducing the economic costs of meeting specified future greenhouse gas emissions constraints, all other things equal.