MEDIA RELEASE

AUSTRALIAN INDUSTRY GREENHOUSE NETWORK

Tougher emissions targets cost more

18 November 2008

The Australian Industry Greenhouse Network (AIGN) today released a report by Access Economics challenging the view that tougher greenhouse gas emission reduction targets need not cost Australians more than lower targets.

"Common sense tells us that higher electricity prices make all Australians less well-off, yet the report by McLennan Magasanik Associates for the Climate Institute, *A comparison of emission pathways and policy mixes to achieve major reductions in Australia's electricity sector greenhouse gas emissions*, claims to have discovered otherwise", Chief Executive Officer of the AIGN, Michael Hitchens, said.

Adopting partial economic analysis of resource costs incurred in the electricity sector alone, the MMA report claims that the economic costs are similar whether there is a 'soft start' or whether stronger 'early action' is taken. It finds the 'soft start' is about $4 billion more expensive. The 'soft start' involves emission permit prices of $15/tCO$_2$-e in 2010, $35 by 2020 and $75 by 2030. The 'early action' scenario requires permit prices of $23/tCO$_2$-e I 2010, $60 by 2020 and $70 by 2030. The electricity price outcomes are similar for both scenarios post 2030.

Access Economics has used its economy-wide Regional General Equilibrium Model to test the claims, adopting MMA's model results of permit price trajectories and increases in electricity prices to 2030, and with their findings contained in the report, "*The economic impacts resulting from alternative electricity and carbon price trajectories"*.

Key findings of the Access Economics analysis are:

- The carbon and electricity price impacts from a CPRS have wider flow on effects throughout the economy that are not captured in electricity market modelling.
- Depending on the discount rate applied, the economic costs projected under the 'early action' scenario are projected 41-45 per cent higher than the 'soft start' scenario over the period 2010-2030. The commensurate increase in cumulative emissions over the period is estimated to be 15 per cent.
- The economic cost of emissions abatement per tonne of CO2e is 22-25 per cent higher under the 'early action' scenario compared with the 'soft start' over the period 2010- 2030 (depending on the discount rate chosen).

"Access Economics has found that Australian GDP is a cumulative $200 billion lower under the 'early action' scenario to 2030, not $4 billion higher as suggested by MMA. In terms of the economic costs for every tonne of emission abatement, the 'early action' scenario imposes on Australia 22-25% higher costs than the 'soft start' scenario", Mr Hitchens said.

The Government's report of Treasury modelling, *Australia's Low Pollution Future*, also claims that there are advantages to Australia acting early if emission pricing expands gradually across the world.

"The key to the claim is in the word 'if'. You don't need a model to tell you that the required structural adjustment of the economy will cost less, the slower and more coordinated it is with what the rest of the world is doing. While they intended to help inform the community, unfortunately, none of the scenarios revealed in the Treasury report involves the more realistic partial and uncoordinated global responses to emission reduction likely to emerge for Copenhagen", Mr Hitchens said.

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12 November 2008

The economic impacts resulting from alternative electricity and carbon price trajectories

Report by Access Economics Pty Limited for

Australian Industry Greenhouse Network

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KEY FINDINGS

A recent report released by the Climate Institute, based on electricity market analysis by McLennan Magasanik Associates (MMA), concluded that the decision to adopt a stringent 'early action' carbon price trajectory, as part of the CPRS, may not lead to adverse economic impacts over and above those which could eventuate with a 'soft start'. Specifically, the report found that:

> *"…resource costs for the soft start and early action scenarios are similar. This implies that the economic costs are similar whether there is a soft start or whether early action is taken. (The soft start scenario is around $4 billion more expensive than the early action scenario.)"*[1]

The purpose of this report is to analyse the effects of the 'early action' and 'soft start' scenarios reported by MMA, at the economy wide level using a general equilibrium modelling framework.

Key findings of the Access Economics analysis include:

- The carbon and electricity price impacts from a CPRS have wider flow on effects throughout the economy that are not captured in electricity market modelling.
- Depending on the discount rate applied, the economic costs projected under the 'early action' scenario are projected 41-45 per cent higher than the 'soft start' scenario over the period 2010-2030. The commensurate increase in cumulative emissions over the period is estimated to be 15 per cent.
  - In other words, the projected economic costs of 'early action' compared with a 'soft start' rise considerably higher than the projected increase in emission abatement over the period.
- The economic cost of emissions abatement per tonne of CO_2e is 22-25 per cent higher under the 'early action' scenario compared with the 'soft start' over the period 2010-2030 (depending on the discount rate chosen).
  - In other words, the general equilibrium modelling results based on MMA assumptions project that the economic costs of 'early action' are considerably higher per tonne of emissions abated than the 'soft start' scenario.

[1] McLennan Magasanik Associates, 2008. A comparison of emission pathways and policy mixes to achieve major reductions in Australia's electricity sector greenhouse emissions, Report to the Climate Institute

1. INTRODUCTION

Access Economics was commissioned by the Australian Industry Greenhouse Network (AIGN) to undertake analysis of the economy wide impacts of alternative electricity and carbon price growth trajectories. These price trajectories were estimated by McLennan Magasanik Associates (MMA) for the Climate Institute[2].

A key conclusion drawn from the MMA modelling was that a 'soft start' to a carbon pollution reduction scheme (CPRS), as opposed to more significant early action in terms of emission abatement, may lead to worse economic and environmental outcomes in the long term:

> *"…resource costs for the soft start and early action scenarios are similar. This implies that the economic costs are similar whether there is a soft start or whether early action is taken. (The soft start scenario is around $4 billion more expensive than the early action scenario.)"*[3]

In the MMA report, this finding was qualified by uncertainty over the degree of cost reductions in new generating technologies that is likely or will occur, which appears to be a key driver of the MMA modelling results.

The modelling undertaken by MMA was restricted to the electricity sector only, with economy-wide impacts estimated by 'resource costs' associated with electricity generation. Resource costs were defined as the costs of labour, capital and fuel deployed in the electricity sector.

The objective of this report is to test the assertion that a 'soft start' would lead to worse economic outcomes than 'early action', by way of analysis of the electricity market results from the MMA modelling, in terms of their flow on effects into the wider economy by way of economy wide, general equilibrium modelling. This is based on an application of Access Economics' Regional General Equilibrium Model (AE-RGEM). See the Attachment for more detail on AE-RGEM.

1.1 THE MMA ANALYSIS

The three scenarios considered by MMA and assessed in this report include:

- A business-as-usual or 'no caps' scenario that does not incorporate a carbon price but does include existing government policies and measures to reduce emissions from the electricity sector such as the 2 per cent mandatory renewable energy target.[4]
- A 'soft start' scenario based on carbon prices of $15 t$CO_2$e in 2010, $35 t$CO_2$e in 2020 and $75/t CO_2e in 2030.
- An 'early action' scenario in which carbon prices are $23 t$CO_2$e in 2010, $60/t CO_2e in 2020 and $70/t CO_2e in 2030.

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[2] McLennan Magasanik Associates, 2008. A comparison of emission pathways and policy mixes to achieve major reductions in Australia's electricity sector greenhouse emissions, Report to the Climate Institute

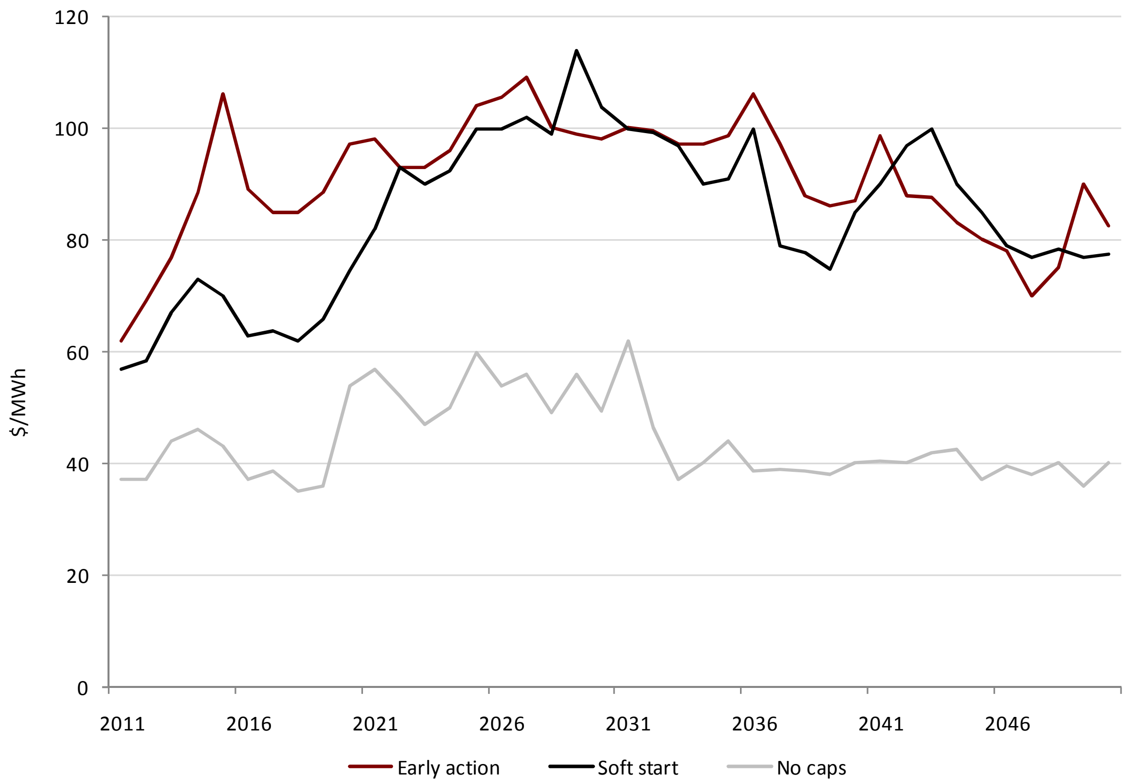
[3] McLennan Magasanik Associates, 2008. A comparison of emission pathways and policy mixes to achieve major reductions in Australia's electricity sector greenhouse emissions, Report to the Climate Institute

[4] The expanded (20%) RET was not incorporated into this analysis.

The 'soft start' and 'early action' scenarios are designed in the MMA scenarios to yield the same cumulative abatement over the period 2010 to 2050 from the electricity sector. However, the 'soft start' scenario, as the name suggests, implies a lower carbon price in earlier years with a higher carbon price in latter years compared with the 'early action' case.

Both the 'soft start' and 'early action' scenarios have a significant impact on electricity prices which are summarised in Figure 1. Of particular relevance is the large spike in electricity prices under the 'early action' scenario in 2015, and the relatively higher electricity prices in that scenario compared with the 'soft start' scenario over the period to 2028. In addition, it appears that electricity prices under the 'soft start' scenario only increase above the 'early action' scenario from 2028 onwards (with a spike in 2029).

FIGURE 1: ELECTRICITY PRICE SHOCKS EMPLOYED IN AE-RGEM MODELLING, FROM MMA MODELLING OF A CPRS, 2010-2050



Source: MMA

1.2 ACCESS ECONOMICS MODELLING ASSUMPTIONS

In order to model the economy-wide effects of the 'soft start' and 'early action' scenarios, the following assumptions were made in the general equilibrium model:

- Electricity price increases under each scenario as shown in Figure 1 were imposed in order to be completely consistent with the MMA analysis;
- The emission abatement from electricity generation as derived by MMA was also assumed under each scenario;
- The carbon prices assumed by MMA under each scenario were allowed to prevail outside the electricity sector, driving abatement in, for example, the transport sector;

- Emission-intensive trade-exposed (EITE) sectors in the model were shielded from carbon prices under each scenario in the same manner defined by the recently released CPRS Green Paper; and
- No assumptions about improved autonomous energy efficiency (linked to carbon prices) are made in either scenario.

2. MODELLING RESULTS

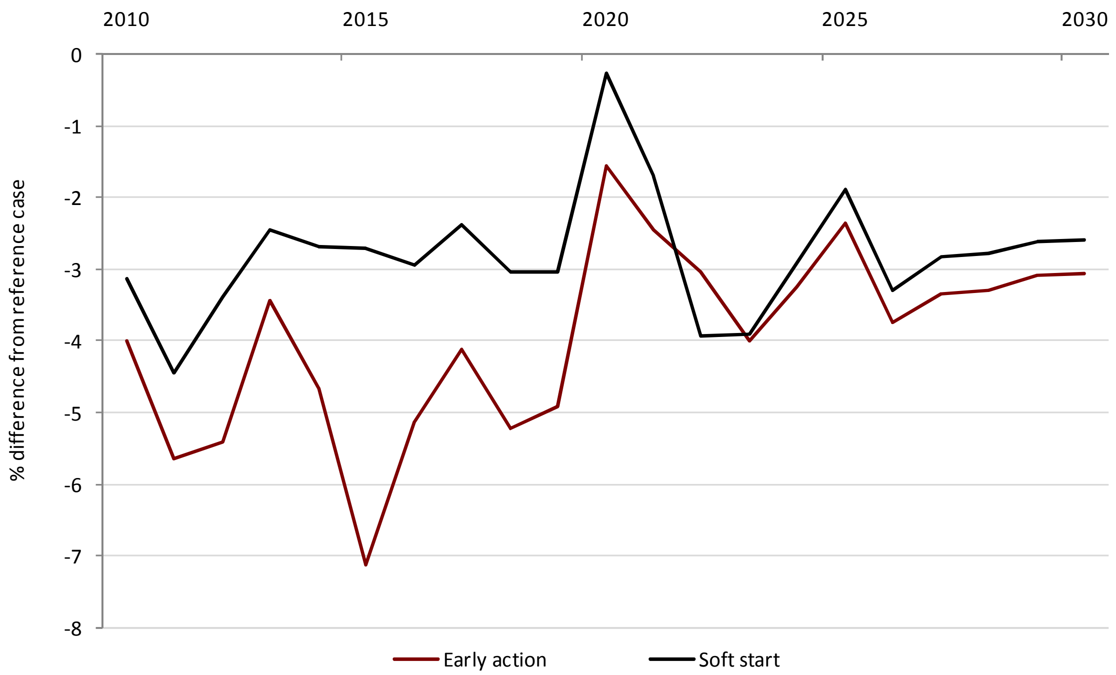
Based on the above modelling of electricity prices, GDP impacts were modelled through AE-RGEM (Figure 2). The pronounced electricity price rises of the 'early action' scenario relative to the 'no caps' case, shown in Figure 1, impact early in the projection period, leading to higher economic impacts in the early part of the period.

Electricity prices in the two scenarios converge towards the end of the projection period, leading to a convergence of GDP impacts over the same period, although with GDP consistently tracking lower in the 'early action' scenario. The GDP impacts reflect the flow on effects of the electricity price shocks through the economy plus the effects of the carbon price on other parts of the economy.

The increase in the cost of using energy reduces the economic output of energy users. This affects the level of both employment (labour) and investment (the capital stock) in the economy. The impact of the carbon price will fall more heavily on capital than labour, as capital combines with energy in the production process – therefore capital intensive production is affected worse than labour intensive production.

Real wages fall considerably, which mitigates some of the falls in employment and also the increases in energy prices. Exports fall because Australia's costs of production increase for commodities for which Australia is effectively a price taker (despite EITE shielding). Reduced real wages, employment and higher prices for many commodities cause real consumption to fall.

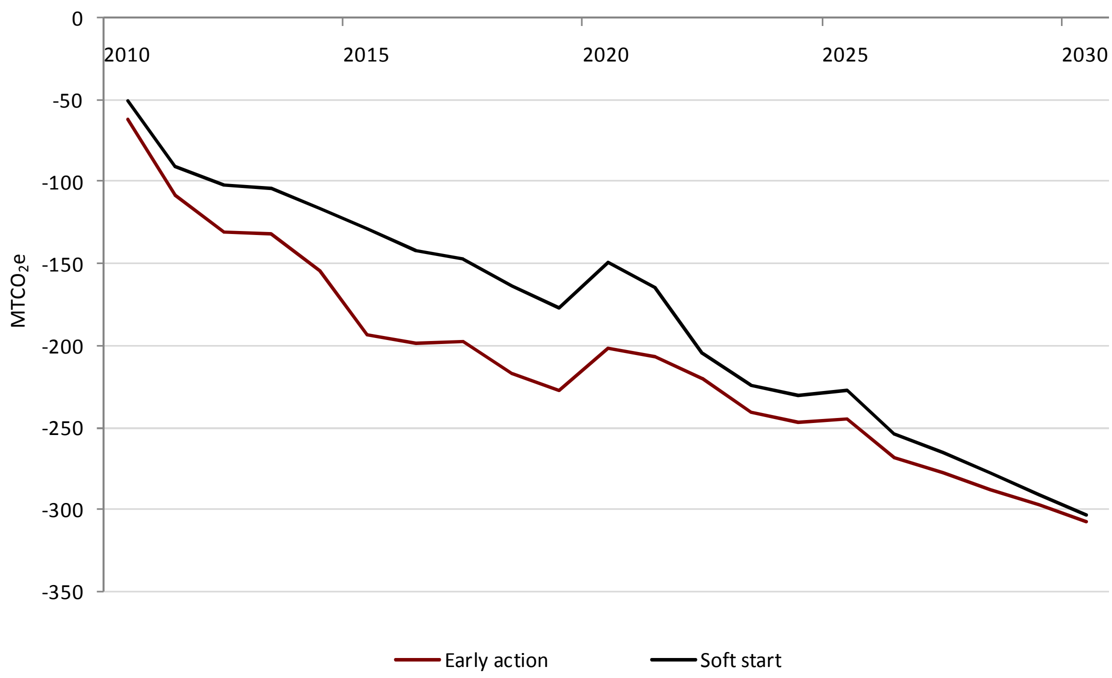
FIGURE 2: GDP IMPACTS OF A CPRS WITH 'EARLY ACTION' VERSUS 'SOFT START' ELECTRICITY AND CARBON PRICE TRAJECTORIES, PERCENTAGE DIFFERENCE FROM REFERENCE CASE, 2010-2030, AUSTRALIA



Source: Access Economics modelling

Figure 3 shows the emissions abatement trajectories associated with the electricity and carbon price shocks through the economy. Abatement is achieved in the electricity sector and in other sectors of the economy. The 'early action' scenario leads to greater abatement early in the projection period, with convergence between the scenarios in the latter years.

FIGURE 3: EMISSIONS ABATEMENT RESULTING FROM A CPRS WITH 'EARLY ACTION' VERSUS 'SOFT START' ELECTRICITY AND CARBON PRICE TRAJECTORIES, MT DIFFERENCE FROM REFERENCE CASE, 2010-2030, AUSTRALIA



Source: Access Economics modelling

Table 1 shows the macroeconomic impacts of the two scenarios by 2030. In the 'early action' scenario, Australian GDP is 0.5 percentage points below that of the 'soft start' scenario, even though the carbon price is lower in the 'early action' scenario by 2030. This is because of the dynamic impacts on investment and employment, which are much higher under the 'early action' scenario in early years, leading to a lower production base by 2030 compared with the 'soft start' scenario. In that same year, emissions from the economy are 3.9 MT higher in the 'soft start' scenario compared with 'early action'.

TABLE 1: COMPARISON OF MACROECONOMIC IMPACTS OF AN 'EARLY ACTION' VERSUS 'SOFT START' ELECTRICITY AND CARBON PRICE TRAJECTORY (% DIFFERENCE FROM REFERENCE CASE UNLESS STATED, 2030), AUSTRALIA

Indicator	Early action (1)	Soft start (2)	Difference (2) minus (1)
GDP	-3.1	-2.6	0.5
GNP	-3.7	-3.2	0.5
Returns to capital	-2.8	-2.6	0.2
Exports	-4.5	-4.3	0.2
Imports	-7.5	-7.2	0.3
Emissions (MT)	-307.6	-303.7	3.9
Carbon price ($/t CO_2e)	69.0	73.5	4.5

Source: Access Economics modelling

The differences in economic impacts between the 'early action' and 'soft start' electricity price scenarios are most obvious when accumulated over the entire period. By committing to an 'early action' trajectory, the NPV of GDP impacts is increased by 45.3 per cent relative to a 'soft start', for an increase in total (accumulated over all years 2010-2030) emissions abatement of 15.9 per cent over the 'soft start' using a 7% real discount rate (Table 2). That is, a threefold increment in proportional impacts. By varying the discount rate over the range 3-7 per cent, the negative GDP increments of the 'early action' relative to 'soft start' range from 41.4 per cent to 45.3 per cent.

This finding is largely consistent with the electricity price paths shown in Figure 1. Considerably higher electricity prices under the 'early action' scenario are consistent with higher economic costs in the early years of the simulation. This, combined with, almost, convergence in electricity prices (except for the spike in 2029) would be consistent with the 'early action' scenario generating much higher economic costs than the 'soft start' scenario.

TABLE 2: AUSTRALIAN GDP AND TOTAL EMISSIONS ABATEMENT IMPACTS (RELATIVE TO REFERENCE CASE) OF THE 'EARLY ACTION' AND 'SOFT START' SCENARIOS UNDER DIFFERENT DISCOUNT RATES

Indicator	Early action	Soft start	Early action relative to soft start
	($ million)	($ million)	%
NPV 2010-2030 @ 7% real	-585,660	-403,105	45.3
NPV 2010-2030 @ 5% real	-690,522	-481,338	43.5
NPV 2010-2030 @ 3% real	-826,971	-584,856	41.4
Total emissions abatement 2010-2030 (MT CO_2e)	-4,421	-3,813	15.9

Source: Access Economics modelling

In terms of the economic cost of emissions abatement in each scenario, defined as the NPV of GDP lost per tonne of CO_2e abated over 2010-2030, committing to an 'early action' trajectory will lead to an increase in the cost of abatement of 22-25 per cent relative to a 'soft start' for a range of discount rates of 3-7 per cent (Table 3).

TABLE 3: GDP COSTS PER TONNE OF EMISSIONS ABATED (RELATIVE TO REFERENCE CASE) OF THE 'EARLY ACTION' AND 'SOFT START' SCENARIOS UNDER DIFFERENT DISCOUNT RATES

Indicator	Early action	Soft start	Early action relative to soft start %
	(\$/t CO_2e)	(\$/t CO_2e)	%
NPV of GDP per tCO_2e 2010-2030 @ 7% real	132.48	105.73	25.3
NPV of GDP per tCO_2e 2010-2030 @ 5% real	156.20	126.25	23.7
NPV of GDP per tCO_2e 2010-2030 @ 3% real	187.07	153.40	22.0

Source: Access Economics modelling

3. REFERENCES

McLennan Magasanik Associates, 2008. *A comparison of emission pathways and policy mixes to achieve major reductions in Australia's electricity sector greenhouse emissions*, Report to the Climate Institute.

ATTACHMENT 1: SOME DETAIL ABOUT AE-RGEM

AE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP (or GSP at the State level), employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various *components* of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works. Figure 4 shows the key components of the model for an individual region (say, Queensland). The components include a representative household, producers, investors and international (or linkages with the other regions in the model, including other Australian States and foreign regions). Below is a description of each component of the model and key linkages between components. Some additional, somewhat technical, detail is also provided.

AE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a Cobb-Douglas utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so choose between domestic, imported and interstate intermediate inputs via a CRESH production function.

- The model contains a more detailed treatment of the electricity sector that is based on the 'technology bundle' approach for general equilibrium modelling developed by ABARE (1996).[5]

- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply (assumed to be 0.2).
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).
- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But in relative terms imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.
- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region's emissions fall below or exceed their quota.

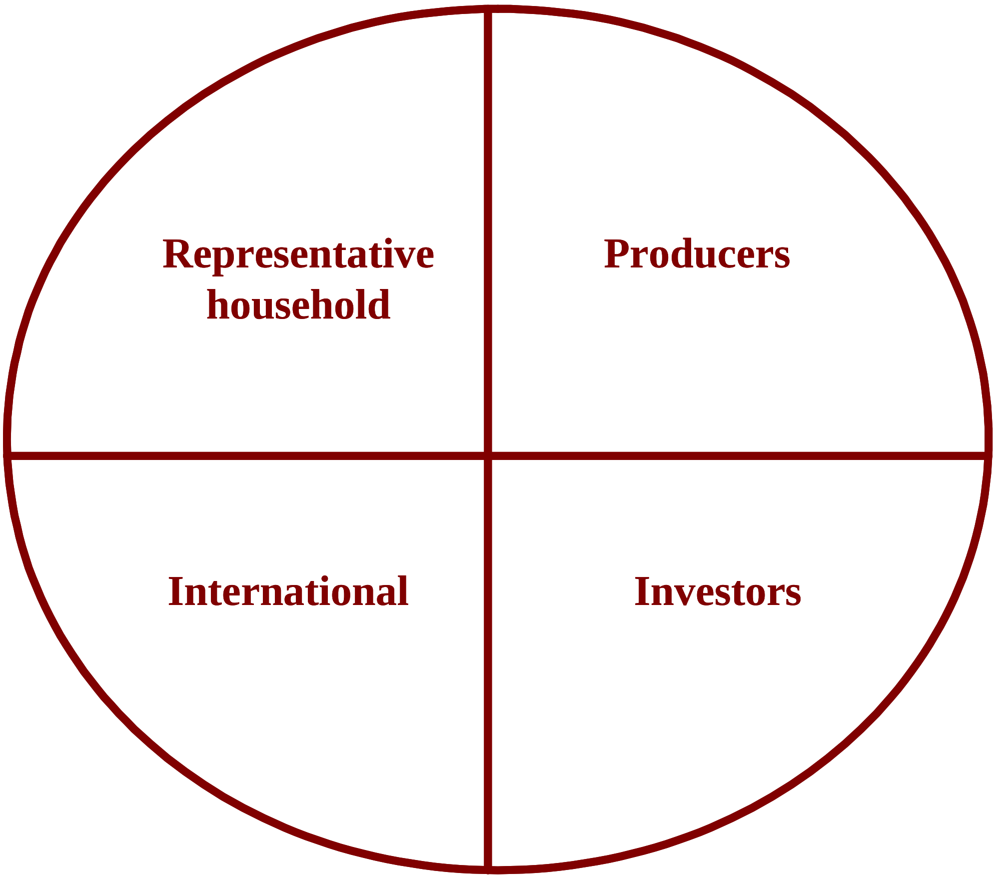
THE REPRESENTATIVE HOUSEHOLD

Each region in the model has a so-called *representative household* that receives and spends all income. The *representative household* allocates income across three different *expenditure* areas: private household consumption; government consumption; and savings.

Going clockwise around Figure 4, the representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as *inputs into production* along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

[5] Australian Bureau of Agricultural and Resource Economics (ABARE), 1996, *MEGABARE: Interim Documentation*, Canberra.

FIGURE 4: KEY COMPONENTS OF AE-RGEM



The *representative household's* relationship with investors is through the supply of investable funds – savings. The relationship between the *representative household* and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

Some detail

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE expenditure function. Private household consumption on composite goods from different sources is determined is determined by a CRESH utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- All savings generated in each region is used to purchase bonds whose price movements reflect movements in the price of generating capital.

PRODUCERS

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. First they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.

Some detail

- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. The exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply is (assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as AE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

INVESTORS

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

Some detail

- Once aggregate investment is determined in each region, the regional investor is constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

INTERNATIONAL

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions must be met such as global exports and global imports are the same and that global debt repayments equals global debt receipts each year.

FEATURES SPECIFIC FOR CLIMATE POLICY ANALYSIS

AE-RGEM has been developed principally for analysing climate change response policy. The industry detail allows for comprehensive accounting for greenhouse gas emissions at the State and Territory levels. These data are calibrated to the latest greenhouse gas inventory numbers across States published by the Australian Greenhouse Office.

Apart from emission accounting, AE-RGEM has been developed to allow for energy substitution possibilities in response to emissions pricing. The energy-factor bundle is a constant elasticity of substitution (CES) combination of the primary factor bundle and the energy bundle, and is combined in fixed proportions with the intermediate input bundle. Depending on the value of the substitution elasticities at the various production nodes for an industry sector, substitution is possible between the four energy inputs and then between the energy and primary factor bundles.

The production structure for electricity generation is based on a ‘technology bundle’ approach developed by ABARE (2006), and modified in AE-RGEM. The model accounts for six generation technologies: brown coal, thermal coal, gas, oil, hydro, nuclear (not in Australia) and other renewables. Electricity generators choose their pattern of technologies by minimising costs in response to changes in relative prices using a CES production function. Trade in electricity across the National Electricity Market is also modelled.

This treatment of electricity is an attempt to bridge the gap between the general equilibrium modelling framework and ‘bottom-up’ electricity models. ‘Bottom-up’ models are engineering-based, linear programming models that take energy/electricity demand as given and determine the least-cost technology mix to satisfy a given level of demand. While these ‘supply side’ models are not suited to estimating the economy-wide impacts of imposing a carbon price they are often used to inform general equilibrium models of the responses to emissions pricing in the electricity sector. In the case of the results reported here the electricity sector in the model was enhanced to reflect specific assumptions supplied by International Power. In particular, the cost of generation from renewable sources was increased to reflect the costs of provision of network backup and enhancement.