

EMAIL
admin@kinesis.org

OFFICE
02 8005 4290
FACSIMILE
02 9280 0953

MAIL
PO BOX 411 DARLINGHURST
NSW 1300 SYDNEY AUSTRALIA

kinesis

PROGRAM	<i>ACT DECCEW – Weathering the Change: Action Plan 2</i>	
PROJECT	<i>Action Plan 2: Primer</i>	
PREPARED FOR	Tanya Barden	ACT DECCEW
VERSION	FINAL	
AUTHORS	<i>Bruce Taper, Director Claire Hashman, Regulatory and Governance Specialist David Holden, Climate Strategist – Urban Planning Matthew Sander, Policy Analyst</i>	<i>8th December 2009</i>

Contents

- Introduction 3**
- 1. Findings from Action Plan 1 Review 4**
- 2. Methodology 5**
- 3. ACT Future Scenario Results 9**
 - 3a. Conservative Scenario 9
 - 3b. Progressive Scenario 11
- 4. ACT Future Scenario Analysis Summary 14**
 - 4a. Energy Efficiency 15
 - 4b. Fuel Switching 18
 - 4c. Renewable Energy 20
 - 4d. Waste to Energy 24
 - 4e. Travel/Transport 26
 - 4f. Employee Density 29
 - 4g. Street lighting 31
 - 4h. Bio-sequestration 33
- Appendix 1: Assumptions Behind The Modelling..... 35**
- Appendix 2: Annual Emissions Reduction Data..... 39**

Introduction

The following Primer quantifies the extent to which technological and policy interventions could reduce ACT emissions. Its purpose is to inform the appropriate interim targets to be established as part of the ACT Government's commitment to zero net emissions by 2060.

The Primer is preliminary in its findings and does not seek to describe, quantify or cost actual policy mechanisms. It provides a hierarchy for interventions that could be implemented within the ACT and gives an indication of their potential contribution to emissions reduction. It is informed by a detailed review of *Weathering the Change: Action Plan 1* and consultation with key ACT DECCEW staff.

Two scenarios, a *conservative* and *progressive*, were described and modelled to 2020. The reduction potential of each scenario was quantified using the ACT Greenhouse Reduction Modelling Tool, which was developed by Kinesis. The tool contains an accurate representation of the ACT's current emissions profile, including commercial, residential and transport emissions, consistent with the ACT Greenhouse Gas Inventory 2006 (ACT GGI) compiled by pitt&sherry.

The assumptions behind each scenario were determined at a workshop with key ACT DECCEW staff, working in collaboration with Kinesis.

The conservative scenario is based on a small deviation from current business as usual projections. The progressive scenario shows the level of ambition required to achieve the Legislative Assembly's recommended target of a 40% reduction on 1990 levels by 2020. In the progressive scenario, Greenpower was used to make up the shortfall needed to reach the 40% target.

Key findings from the scenarios are:

- Under the conservative scenario, ACT emissions will grow by 28% from 1990 levels by 2020.
- Under the progressive scenario, ACT emissions will fall by 40% from 1990 levels by 2020.
- Trigenation, lighting and Greenpower provide the most significant emissions reduction opportunities.

Also included in the Primer is a description of possible policy actions that could give effect to the modelled interventions. The Primer does not model specific emission reductions attributable to each proposed policy action.

This Primer provides the basis for a platform capable of delivering a best practice response to the climate problem. As a policy tool it encompasses the attributes agreed to within the UN Bali Agreement¹ and established by the Prime Minister in ratifying the Kyoto Agreement in 2007, for developed nations to adopt:

“Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives...”

This is the standard the ACT Government should seek to achieve as it moves to design and implement *Weathering the Change: Action Plan 2*.

¹ http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_act_p.pdf

1. Findings from Action Plan 1 Review

Kinesis undertook a review of the 43 Actions which make up the ACT Government's *Weathering the Change: Action Plan 1* which emphasised the need for the ACT to implement climate change policies which meet the standard of the Bali agreement, being measurable, reportable and verifiable greenhouse reduction initiatives. Kinesis recommended that Action Plan 2 be developed with regard to these key issues and, where possible, learn from Action Plan 1 Review findings.

The key findings of the Action Plan 1 Review were:

- 13 of the 43 Actions were capable of having their emissions reduction quantified;
- Emissions data for these 13 Actions was difficult to source, with 7 of the 13 Actions being quantifiable based on provided or estimated data;
- The remaining 31 Actions were not created to achieve measurable emissions abatement. Rather, they contributed to outcomes such as climate change education, research or adaptation.

The Review recommended that abatement actions included in Action Plan 2 be selected on the basis of their capacity to measurably reduce ACT emissions. It also suggested that Actions with defined KPIs are easier to manage and assess on an ongoing basis. It was proposed that funding could be tied to measurable emissions reduction and administered through a central fund. This fund could ensure that the most effective programs continue to receive financial support and monitor the ACT's progress towards its emissions reduction targets.

It was acknowledged that a range of actions may be beneficial to the community and provide benefits beyond emissions reduction outcomes. However, it was suggested that any program's contributions to emissions reductions should be measured and reported. Access to information relating to the relationship of actions to real emissions reduction would enable decision makers to make more robust assessments of the ACT climate policy on an ongoing basis in real time.

2. Methodology

This Primer has been developed on the basis of two pieces of original work:

- the ACT Greenhouse Reduction Modelling Tool; and
- an ACT Emissions Reduction Scenario Workshop

ACT Greenhouse Reduction Modelling Tool

In order to demonstrate the emissions reductions that could be achieved within the ACT, Kinesis built a land-use based greenhouse gas model of the ACT. The ACT Greenhouse Reduction Modelling Tool quantifies the emissions reduction potential of a series of technological and policy based interventions.

A full description of all the assumptions which underpin this tool can be found in Appendix 1 of this document.

The tool contains an accurate representation of the ACT's current emissions profile, including commercial, residential and transport emissions. It does not, however, include industrial or agricultural emissions. These represent a small percentage of the ACT's total emissions.

ACT emissions were benchmarked against a 1990 baseline and referenced to 2006 data. 1990 was the Legislative Assembly's recommended base year. 2006 was the best available current data point at the time the modeling was undertaken. Kinesis will be updating the modeling, consistent with the ACT GGI 2007.

Current emissions are projected out to 2020 under a business as usual (BAU) scenario. The BAU projections are based on floor-space and employment growth projections sourced from the 2006 Census and locally available employment and land use data including:

- 2006 Population and Employment;
- 2006 Dwelling Profile and Net Dwelling Density;
- Commercial, retail, education, health and community floor space data sourced from the ACT PLA Territory Planning process (unpublished);
- 2031 Population and Employment Projections.

The BAU scenario incorporates greenhouse reductions attributable to the Federal Government's Renewable Energy Target (RET) but not the Carbon Pollution Reduction Scheme which is yet to be legislated.

The effect of various emissions reduction interventions can be measured against 1990 and 2006 emissions levels to determine their overall effectiveness. The interventions included in the tool are divided into the following categories:

1. Energy efficiency;
2. Fuel switching;
3. Renewable energy;
4. Waste to energy;
5. Travel/transport;
6. Employee density;
7. Street lighting; and
8. Bio-sequestration.

In addition to assessing emissions reduction potential, the tool provides a marginal abatement cost for each intervention. The marginal abatement cost is calculated on a per tonne basis, enabling a clear comparison of the relative cost and abatement potential of each separate intervention, as opposed to a discrete cost estimate used for assessing the impact of regulation or program implementation.

“Business as Usual” ACT Emission Projections

BAU greenhouse gas emission projections represent the predicted greenhouse gas emissions each year to 2020 based on current consumption levels. This is calculated in two steps:

1. Greenhouse gas emissions are calculated from electricity and gas consumption from residential and non-residential buildings, resident travel and residential and commercial waste for the most recent year where data is available. This was determined to be the year 2006. This is calculated as tonnes CO₂-e per square metre for residential dwellings (single, attached and multi-unit) and non-residential buildings, and tonnes CO₂-e for resident travel emissions;
2. This consumption is then multiplied by the projected number of dwellings, total floor area and population for each year to predict BAU greenhouse gas emissions to 2020.

BAU reflects current average electricity and gas consumption derived from:

- Energy Use in the Australian Residential Sector, 1986 – 2020, Australian Government; Department of the Environment, Water, Heritage and the Arts (DEHWA), 2008.

As well as estimated resident travel based on:

- ABS Survey of Motor Vehicle;
- Transport Data Centre (2006) The Development of a Sydney VKT Regression Model.

The BAU projection is a reflection of current consumption patterns and does not attempt to recognise changes in consumption or emissions from changing technologies, such as more efficient lighting and appliances, changing consumption behaviour or energy pricing. The BAU projections, however, recognise that the grid electricity will include 20% renewable energy by 2020 as per the Federal Government Renewable Energy Target (RET).

Marginal Abatement Cost Methodology

An estimate of the potential cost of each intervention has been included in this analysis. The cost estimate is based on the marginal abatement cost of each action, derived from an estimate of the cost of implementing the intervention. It takes into account the avoided cost of replacing an existing technology, such as a light or appliance, which would need to be replaced over time in normal circumstances.

Marginal abatement costs are expressed as the cost of every tonne of CO₂-e abated. In some cases reducing emissions results in a net saving rather than cost. This usually occurs when the intervention avoids the use of fuel or electricity, for example, through improved vehicle efficiency. When an intervention results in a pay back, rather than a cost, it is expressed with a negative symbol, indicating that it has a negative cost.

Estimates of the marginal abatement costs for each intervention have been derived from research conducted by McKinsey & Company² as well as original analysis by Kinesis. This research was conducted as part of a macro analysis of the cost of carbon abatement.

The figures provided are intended to be indicative of the relative costs of each intervention to enable the ACT Government to establish a hierarchy of priorities for implementation. Actual implementation project costs could vary both higher and lower from the quoted figures. Rather than providing an

² http://www.mckinsey.com/client-service/ccsi/pdf/Australian_Cost_Curve_for_GHG_Reduction.pdf

accurate estimate of the costs of implementation, the marginal abatement costs show which interventions are likely to be more affordable than the others.

ACT Emissions Reduction Scenario Workshop

A policy evaluation workshop was held between Kinesis and key ACT DECCEW staff on Tuesday, the 27th of October. Two scenarios, a *conservative* and *progressive* abatement reduction pipeline were described and modelled to 2020 using the ACT Greenhouse Reduction Modelling Tool.

The conservative scenario was modelled assuming only minimal policy deviations from what could be expected to be achieved by 2020 under BAU policy conditions.

The progressive scenario was modelled to meet the Legislative Assembly's interim target of a 40% reduction on 1990 levels by 2020.

Both scenarios were based on consultation and discussion between ACT DECCEW staff and Kinesis during the workshop process. In many respects, this workshop was an exercise in engagement, with Kinesis providing the framework within which ACT DECCEW staff could determine the assumptions used to create possible futures within each scenario.

Changes to the model since the scenario workshop

As requested by DECCEW, BAU data and assumptions, such as commercial floor space and transmission loss data, have been modified in the model since the Scenario Workshop.

Collaboration between consultants engaged by ACT DECCEW

Collaboration has been sought with other consultants engaged by ACT DECCEW to ensure the assumptions behind the modelling are, where appropriate and applicable, consistent. The following data sources are consistent between the different consultant projects:

- Commercial, retail, education, health and community floor space data sourced from the ACT PLA Territory Planning process (unpublished);
- Residential energy consumption data from Australian Greenhouse Office (2008) Energy Use in the Australian Residential Sector 1986-2020;
- NEMCO/AEMO ACT marginal transmission loss factors for the associated years.

Different data sources and/or assumptions were adopted where the analysis in this report required modelling to quantify emission reduction strategies. This included:

- Hot water assumptions: the analysis in this report assumes the BAU scenario does not incorporate the phasing out of electric storage hot water systems;
- Appliance & Lighting Energy Efficiency: unlike Heuris data projections, the BAU projections do not assume improvements in energy efficiency that may result from the Federal Government's Minimum Energy Performance Standards or increases in appliance energy consumption due to growth in appliance ownership levels, for example, trends towards multiple and larger televisions and increased IT energy consumption;
- Transport: the analysis in this report is based on an adaption of the NSW Transport Data Centre's VKT regression model with local ACT specific data, aligned with ABS Census.

Limitations of Modelling

The analysis incorporates a 1990 base figure that was not modelled in the tool but sourced from pitt&sherry's ACT GGI 2006. This figure has been aligned as best as possible to ensure the 1990 figure is comparable with the figures generated in the model, however, some inconsistencies may be present.

The model analyses the greenhouse gas emissions and potential abatement from residential, commercial and retail buildings, residential travel and waste. The model does not consider industrial

processes, agriculture or commercial transport thereby possibly eliminating some additional abatement opportunities.

The paper outlines policy options that could give effect to emission reductions modelled in this report but does not model specific emission reductions attributable to each proposed policy option. This is to be the subject of future work.

3. ACT Future Scenario Results

Three modelling outputs were produced to represent the results of the conservative and progressive scenarios:

1. Waterfall chart showing the contribution each individual intervention makes to the ACT’s total emissions reductions in 2020;
2. Time series chart showing the cumulative emissions reductions achieved by all interventions through time;
3. Marginal abatement cost curve which presents a cost hierarchy of the relative marginal abatement costs of each intervention.

A complete table showing the total modelled reductions for each year under the conservative and progressive scenarios can be found in Appendix 1 of this document.

3a. Conservative Scenario

Under the conservative scenario, ACT emissions will grow by 28% from 1990 levels by 2020. This represents a 12% (0.5Mt) reduction on 2020 BAU emissions (Figure 1). Trigeneration, lighting, Greenpower and the proposed solar farm achieve the most significant reductions.

Most of these interventions begin immediately and scale up to achieving their full reduction potential by 2020. However, some interventions, such as those delivered by the solar farm, do not produce emissions reductions until after 2012 (Figure 2).

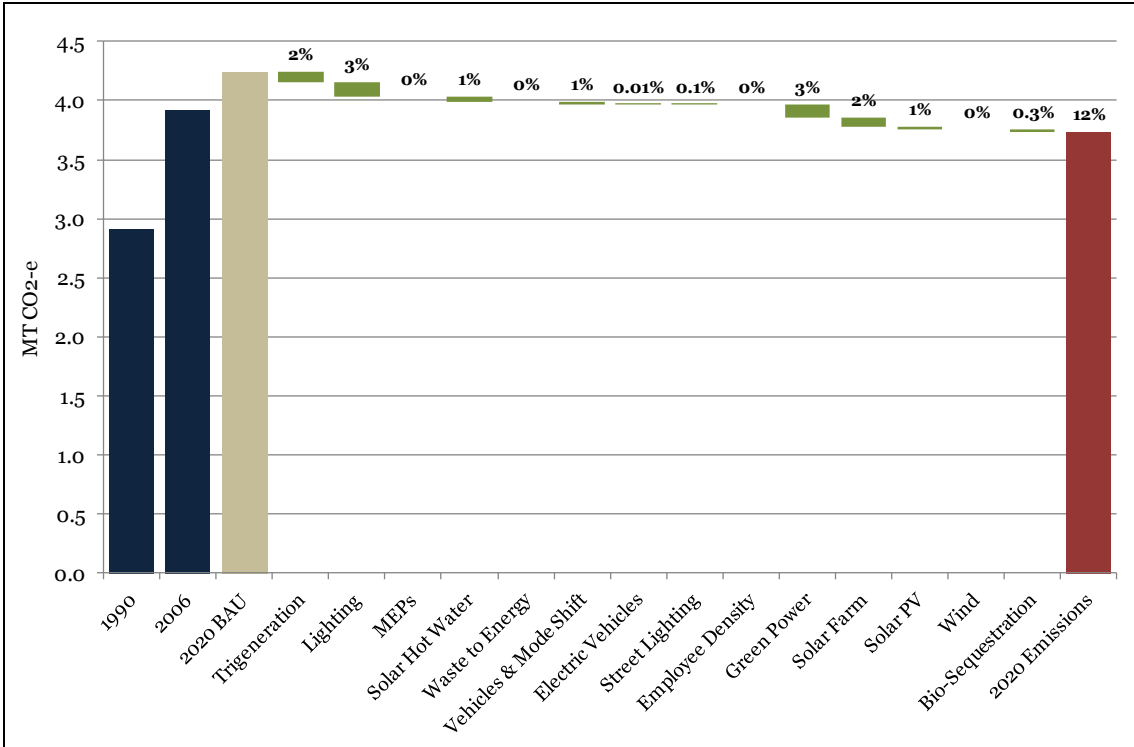


Figure 1. Emissions reduction interventions under a conservative scenario.

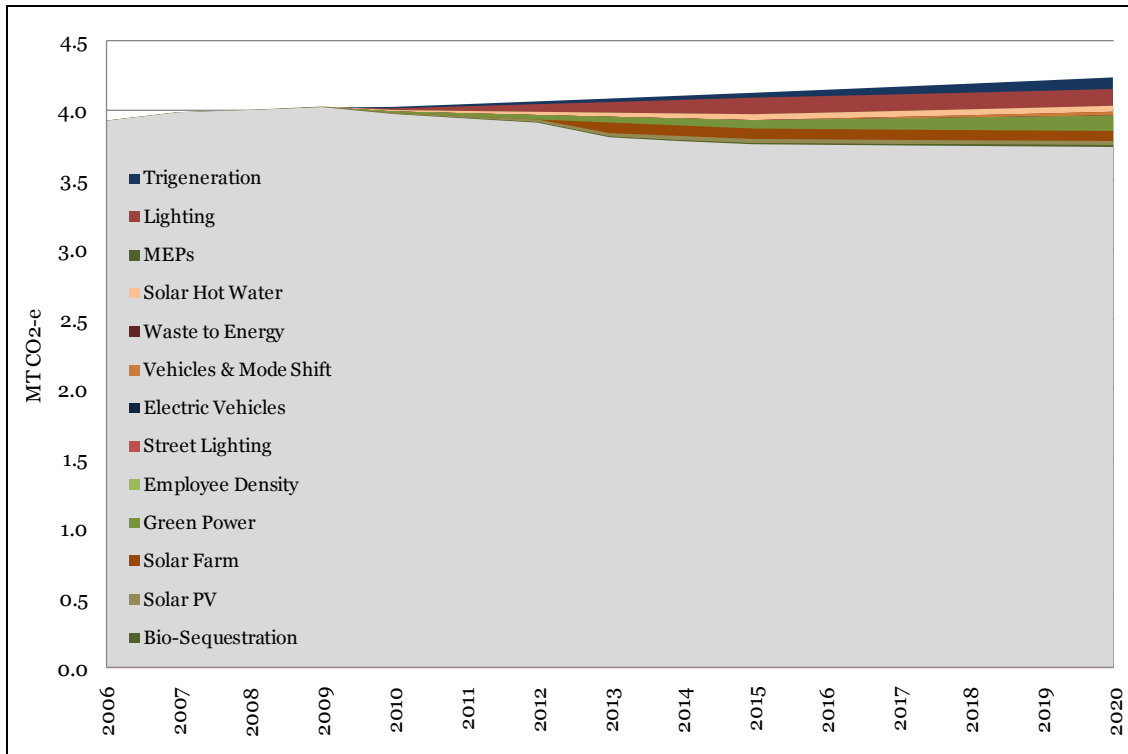


Figure 2. Cumulative emissions reductions under a conservative scenario.

Street lighting and solar PV are the only interventions with a higher marginal abatement cost than a bulk Greenpower purchase.³ This indicates that there are a number of interventions the ACT could consider before making a bulk Greenpower purchase (Figure 3). The width of the bars in this chart reflects their relative abatement potential, while the height represents their marginal cost of abatement.

³ Data is not available to calculate a project specific marginal abatement cost of the solar farm.

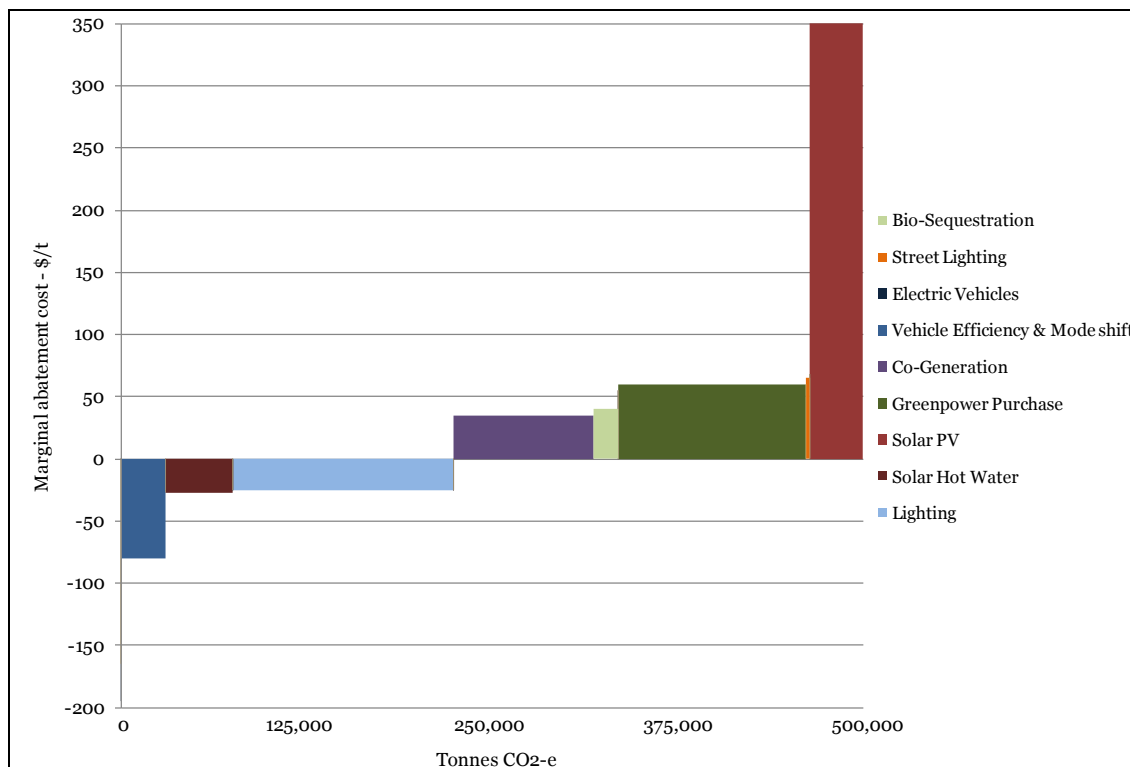


Figure 3. Marginal abatement cost of interventions under a conservative scenario.

3b. Progressive Scenario

The progressive scenario demonstrates a pathway for the ACT to reduce its greenhouse emissions by 40% from 1990 levels by 2020. The progressive scenario represents a 59% (2.3Mt) reduction on 2020 BAU emissions levels (Figure 4).

The progressive scenario was modelled using aggressive adoption assumptions for all interventions, except wind power which was not modelled. Once each intervention was modelled the Greenpower purchase was increased to ensure that the scenario resulted in a 40% reduction.

This was done with the intention of demonstrating the level of ambition required to meet a 40% reduction target. It does not represent a recommended level of Greenpower purchase for the ACT. The amount of Greenpower modelled in this scenario may not be available in 2020. However, if the ACT chooses to meet a 40% reduction target without Greenpower then these modelled reductions will need to be found elsewhere.

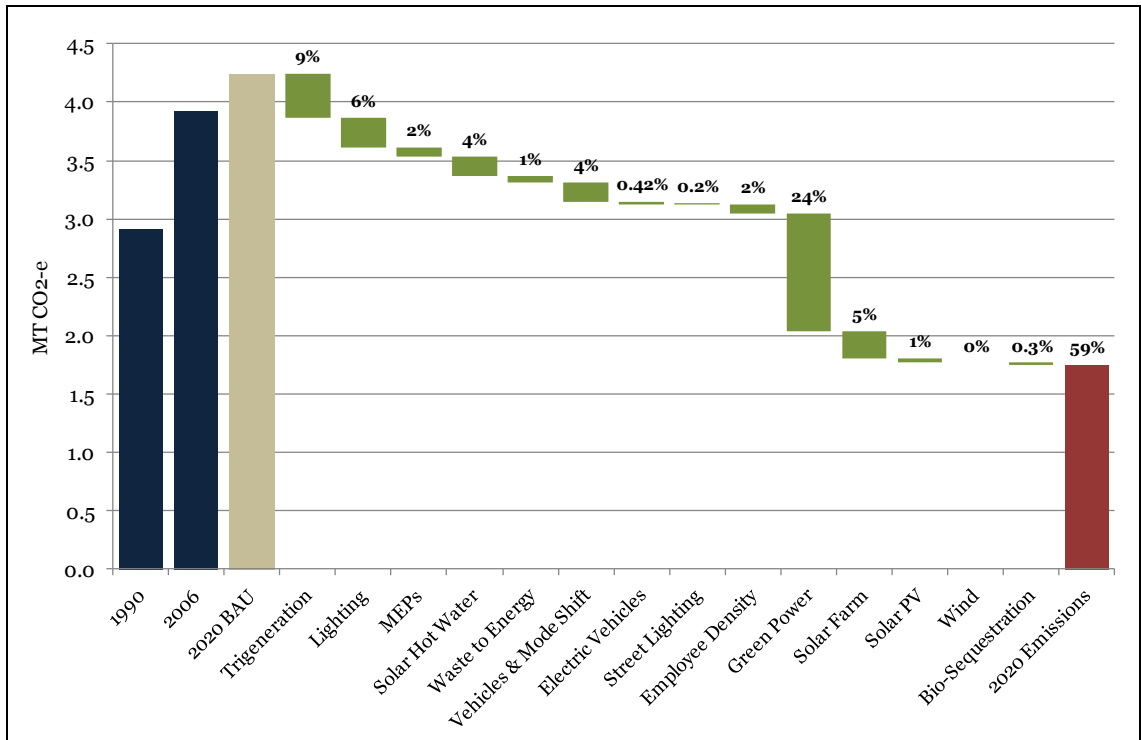


Figure 4. Emissions reduction interventions under a progressive scenario.

Like the conservative scenario, most interventions are modelled to begin taking effect from 2010. However, some such as the solar farm and vehicle efficiencies don't begin achieving significant reductions until after 2012 (Figure 5).

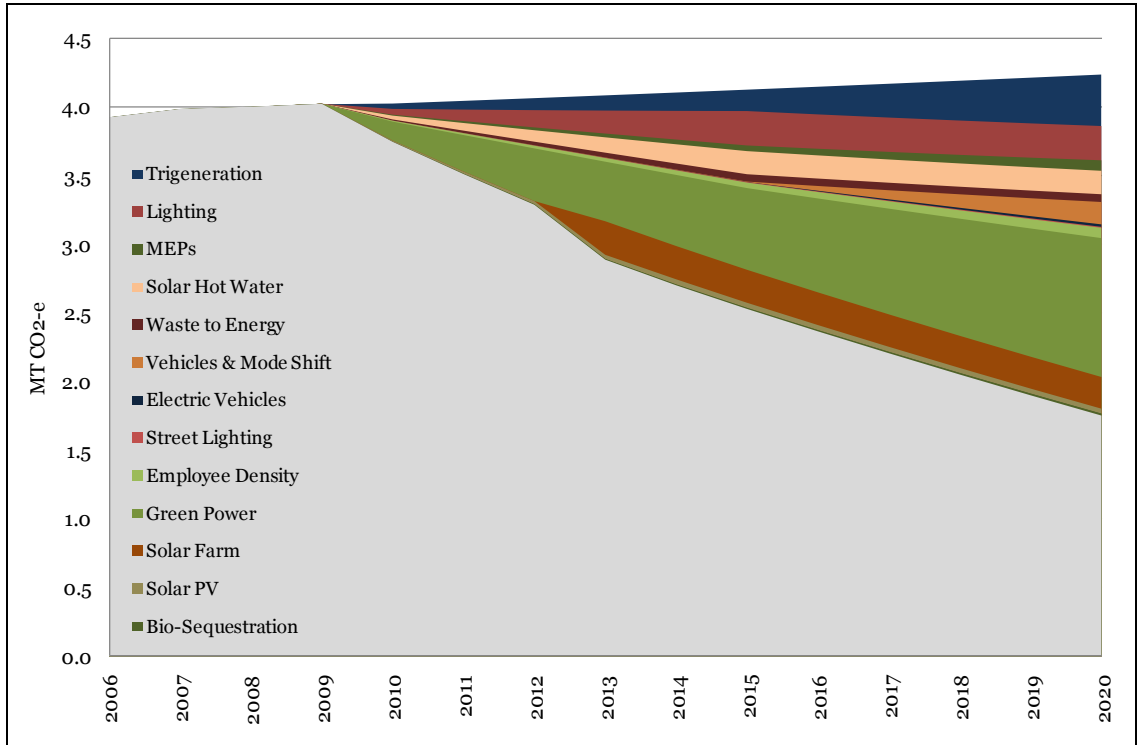


Figure 5. Cumulative emissions reductions under a progressive scenario.

The cost curve for the progressive scenario (Figure 6) includes a number of interventions, such as increased employee density, which result in a positive payback per tonne of CO₂-e abated but were not included in the conservative scenario.

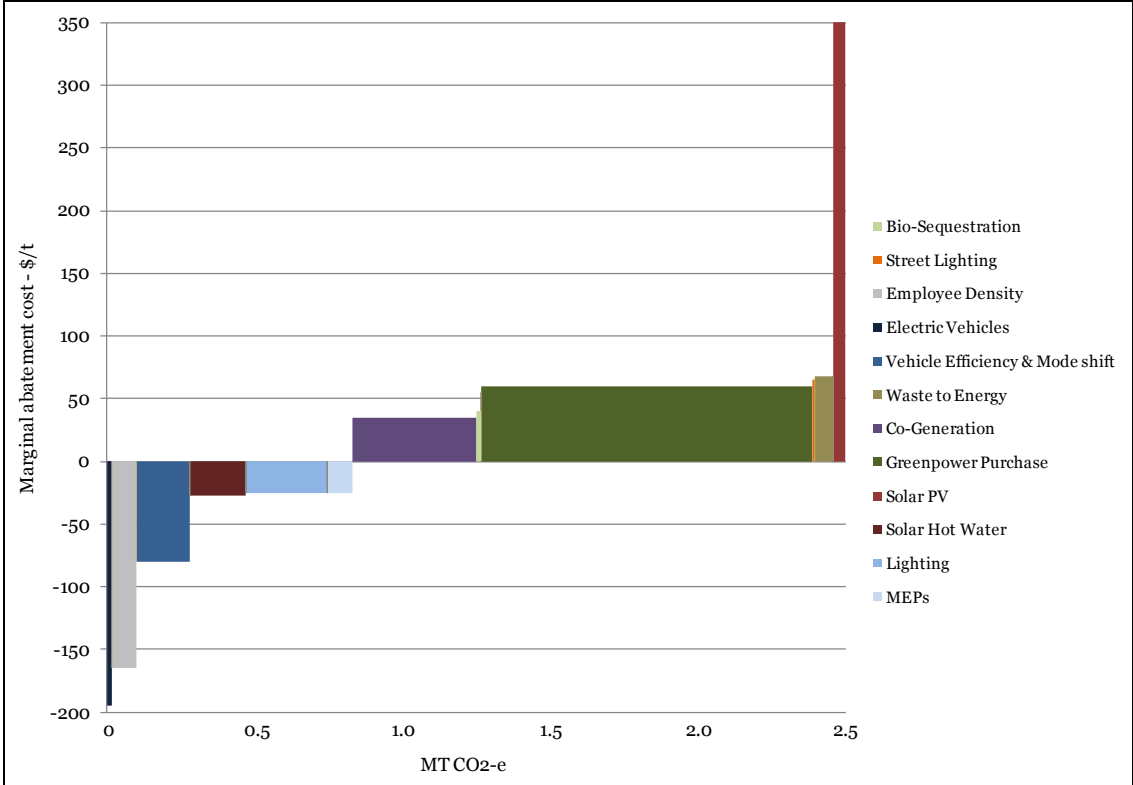


Figure 6. Marginal abatement cost of interventions under a progressive scenario.

4. ACT Future Scenario Analysis Summary

Table 1 summarises the results of the scenario analysis. Detailed explanation of each modelled intervention follows.

Strategy	Intervention	Conservative Scenario		Progressive Scenario	
		Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Energy Efficiency	MEPS	0	0.0%	76,483	1.8%
	Lighting	129,112	3.0%	249,697	5.9%
Fuel Switching	Trigeneration	81,716	1.9%	378,649	8.9%
Renewable Energy	Solar Hot Water	39,065	0.9%	170,664	4.0%
	Solar PV	31,068	0.7%	36,822	0.9%
	Solar Farm	71,605	1.7%	230,636	5.4%
	Wind	0	0.0%	0	0.0%
	Greenpower	109,606	2.6%	1,011,672	24%
Waste To Energy		0	0.0%	56,520	1.3%
Travel/ Transport	Vehicle Efficiency and Mode Shift	26,027	0.6%	162,888	3.8%
	Electric Vehicles	357	Less than 0.01%	17,882	0.4%
Employee Density		0	0.0%	75,077	1.8%
Street Lighting		2,136	0.1%	7,121	0.2%
Bio-sequestration		14,486	0.3%	14,486	0.3%

Table 1. Scenario Results Summary.

4a. Energy Efficiency

Background

Two interventions were examined to assess the potential for greenhouse emissions reduction through energy efficiency measures. These were: minimum energy performance standards (MEPS), which relate to increasing the efficiency of all ACT appliances, and improved lighting efficiency.

The Federal Government has introduced MEPS for some appliances in an effort to phase out inefficient appliances in Australia. MEPS does not cover all appliances, and many appliances have increased their overall energy consumption as they have become larger, more complex and more numerous within the household and commercial sector, despite being more efficient.

The modelling undertaken for this Primer analysed the effectiveness of improving the efficiency of all appliances across the ACT.

The Federal Government has mandated a phase out of incandescent lighting technology and placed minimum standards on fluorescent lamps; however, there are additional ways to achieve emissions reduction in lighting energy consumption in the ACT.

Lighting assumptions are derived by calculating the emissions reduction that can be achieved by improving the efficiency of all household and commercial lighting in the ACT. This may be through increases in efficiency or a reduction in the numbers of lights used. A separate estimate has been made to calculate the reductions that can be achieved by upgrading all street lights in the ACT.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
MEPS	0	0.0%	76,483	1.8%

Under the conservative scenario it was assumed that there were 0% improvements in efficiency in household appliances in 2020. This means that the ACT has implemented no initiatives to encourage energy efficiency by 2020.

Under the progressive scenario it was assumed that appliances in the ACT become 10% more efficient. It was considered that the ACT could impose additional incentives or standards to encourage energy efficiency beyond those which would be achieved under BAU scenario.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Lighting	129,112	3.0%	249,697	5.9%

Under the conservative scenario it was assumed that the consumption of energy of lighting was reduced by 25% in residential and 25% in non-residential buildings.

The progressive scenario assumed that consumption of energy of lighting was reduced by 50% in residential and 50% non-residential buildings.

Marginal Abatement Costs

The following marginal abatement costs have been assessed for each energy efficiency intervention:

- MEPS: \$-25 per tonne of CO₂-e abated;
- Lighting: \$-25 per tonne of CO₂-e abated.

Relevance to Action Plan 1

The following actions under *Weathering the Change: Action Plan 1* supported energy efficiency initiatives:

- Action 3 – Establish a \$1million Energy Efficiency Fund for ACT Government Agencies;
- Action 8 – Implement Energy Efficiency Improvements in Government Housing;
- Action 13 – Undertake Energy Efficient Street light Replacement;
- Action 19 – Pursue Energy Efficiency Energy Rating for All Buildings;
- Action 39 – Showcase Renewable and Energy Efficient Technologies.

Potential Policy Actions

Considerations

- How can the ACT capture energy efficiency improvements to deliver absolute emissions reductions?
- How can the ACT implement programs which are complimentary to Federal initiatives?

Policy Name: Energy Efficient Appliances Program

Description: The ACT could implement policies that compliment the Federal Government MEPS regulation to increase the efficiency of appliances in the ACT. This could involve the imposition of additional energy efficiency standards on appliances not covered by the Federal Government MEPS, or the provision of incentives and rebates for the best energy efficient appliances. Additional programs could include:

- a “cash for clunker” program in which rebates are made available for residents and commercial businesses to replace old appliances with more efficient models; or
- the establishment of government procurement protocols and community education programs which emphasise the importance of energy efficiency measures.

Policy Focus: Complimentary ACT appliance efficiency programs should be benchmarked to achieve emissions reductions that:

- go beyond the reductions that can be achieved by existing MEPS regulations; and/or
- target appliances, such as televisions, which are not covered by MEPS.

Responsibility: The implementation of MEPS is a Federal responsibility. The ACT could act as a catalyst, taking the lead by incentivising the implementation of more energy efficient appliances. Additionally the ACT Government could push for more stringent appliance standards under MEPS through the COAG process. The ACT could also take responsibility for improving appliance standards within the ACT by implementing complimentary measures or policies.

Commentary: A “cash for clunkers” style program would require consideration of safe and environmentally friendly ways in which to dispose of used appliances. This is particularly important for used refrigerators which can contain potent greenhouse gasses. A revenue source would also have to be considered. In NSW the Greenhouse Gas Abatement Scheme funded the “cash for clunkers” program.

Policy Name: ACT Lighting Retrofit Program

Description: The ACT could launch a lighting retrofit program to increase efficiency across the ACT community. The ACT could achieve significant emissions reductions by replacing all lights in ACT with the most efficient lights available.

The extent of the reductions achieved under this program would depend on the speed with which it is implemented. The sooner retrofits are completed, the faster demand on the grid can be alleviated. Lighting in ACT residences consumes approximately 8% of all electricity in the ACT. There are significant savings to be gained from replacement of light bulbs in ACT residences.

Policy Focus: The ACT Lighting Retrofit Program could include the following:

1. Staged levels of retrofitting could be undertaken to ensure that the light replacement is targeted to achieve the biggest emissions reduction as quickly as possible. For example: ACT Government office buildings, commercial buildings, ACT low income housing and ACT housing;
2. The ACT Government could bulk purchase LEDs to lower the costs of the program;
3. Residential lighting retrofit could occur in line with the street light replacement program, making the ACT more energy efficient one street at a time.

Responsibility: Retrofitting ACT lighting is primarily the responsibility of the ACT Government which could coordinate the import and distribution of lights to ensure that they are installed across the ACT.

Commentary: The program could also provide an educational component to residents who would see visible action through the differences in the consumption of their home's electricity.

Policy Name: ACT Energy Efficient IT Program

Description: IT hardware consumes an increasingly large proportion of electricity worldwide. Despite IT components becoming more efficient overall, they are also becoming more complex and requiring more power to operate. In addition, more and more aspects of business are reliant on electronic management, increasing the quantity and types of technologies which may be present in each business.

The ACT could develop a program in anticipation of increasing IT energy consumption. It could educate government and private enterprise by showcasing low emissions IT strategies and set a benchmark for the business community.

Policy Focus: The ACT Energy Efficiency IT Program could incorporate the following aspects:

- ACT Government could undertake an audit of all ACT government IT hardware. This would inform the benchmark which could be met by each department;
- An audit should include the amount of energy consumed in cooling servers and equipment;
- All government procurement could have efficiency requirements;
- Procurement could establish expectations with external consultants in contracts regarding the ratio of communications which must utilise Skype or teleconferencing to reduce transport emissions;
- The ACT Government initiatives could later be used to demonstrate IT emissions reduction strategies to the ACT business community.

Responsibility: It would be the responsibility of the ACT Government to implement an Energy Efficient IT Program.

Commentary: Savings could result from emissions reduction achieved through IT use and/or efficiency.

4b. Fuel Switching

Background

The contribution of trigeneration to reduce ACT's greenhouse gas emissions was examined. In optimised conditions trigeneration produces 35% of the emissions per MJ compared to black coal. Assumptions were derived by considering whether trigeneration could be installed in different types of buildings, the extent of likely penetration and whether trigeneration would be likely to be used for hot water, heating or cooling.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Trigeneration	81,716	1.9%	378,649	8.9%

The assumptions under the conservative scenario for trigeneration penetration are as follows:

- Commercial buildings - 15% penetration: with hot water, heating and cooling;
- Retail buildings - 0% penetration: no hot water, heating or cooling.

The assumptions under the progressive scenario for trigeneration penetration are as follows:

- Commercial buildings - 50% penetration: with hot water, heating and cooling;
- Retail buildings - 20% penetration: with hot water, heating and cooling.

Marginal Abatement Costs

- Trigeneration: \$35 per tonne of CO₂-e abated.

Relevance to Action Plan 1

There are no actions under *Weathering the Change: Action Plan 1* which promote targeted fuel switching.

Potential Policy Actions

Considerations

- Given the potential, why has trigeneration not yet been implemented in the ACT?

Policy Name: Decentralised Energy Master Plan

Description: Transforming the ACT to a low carbon economy will require considerable planning, preparation and investment. Trigeneration is well suited to the ACT climate and can make large contributions to this transformation; however, there are some barriers to its implementation. These include the potentially high costs of initial capital outlay and a lack of education in the community and business sectors about the benefits trigeneration can provide.

The ACT Government could provide support to the implementation of trigeneration in the ACT by developing a Decentralised Energy Master Plan.

Policy Focus: Decentralised Energy Master Plan could include the following:

1. Investigation of ACT trigeneration capacity and distribution system. This would include an examination of the availability of gas across the ACT;
2. Large building implementation of trigeneration. The replacement of standard and inefficient HVAC systems should be identified and incentivised;
3. Community education programs could be created to promote the desirability of buildings, both large and small, with access to trigeneration;
4. The Plan could increase NABERS building standards to require trigeneration;
5. Collaboration with ACTEW AGL to fund a retrofit scheme should be explored.

Responsibility: The implementation of trigeneration in the ACT would be the responsibility of the Territory. However collaboration with private enterprise may facilitate implementation.

Commentary: Trigeneration has been demonstrated in other cities worldwide as a low carbon energy solution. The ACT climate and the large amounts of government controlled floor space make trigeneration an ideal option for the ACT. Trigeneration could be showcased in government buildings and hospitals to facilitate community awareness and understanding of the technology.

The Decentralised Energy Master Plan should not be assessed on greenhouse gas benefits alone. Significant fuel switching may promote infrastructure savings or defer the need to upgrade the existing electricity distribution network.

4c. Renewable Energy

Background

Five actions that could reduce greenhouse emissions through increasing the ACT's renewable energy supply are: solar hot water (which was divided into different housing types), solar photovoltaic, the ACT solar farm, wind and Greenpower purchase.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Solar Hot Water	39,065	0.9%	170,664	4.0%

The assumptions under the conservative scenario for solar hot water penetration were as follows:

- Single dwellings – 20% penetration;
- Attached dwellings – 20% penetration;
- Multi-dwellings – 0% penetration;
- Commercial buildings – 0% penetration;
- Retail buildings – 0% penetration.

The assumptions under the progressive scenario for solar hot water penetration were as follows:

- Single dwellings – 75% penetration;
- Attached dwellings – 75% penetration;
- Multi-dwellings – 10% penetration;
- Commercial buildings – 10% penetration;
- Retail buildings – 10% penetration.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Solar PV	31,068	0.7%	36,822	0.9%

Under the conservative scenario the installation of 27 MW of solar photovoltaic energy was modelled. This was calculated to produce a total of 37,314MWh of electricity per year.

Under the progressive scenario the installation 32 MW of solar photovoltaic energy was modelled. This was calculated to produce a total of 44,224MWh of electricity per year.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Solar Farm	71,605	1.7%	230,636	5.4%

Under the conservative scenario the ACT Solar farm, to be completed by 2012, was modelled with a total capacity of 62MW, this is expected to produce 86,000MWh of electricity per year.

Under the progressive scenario the ACT Solar farm, to be completed by 2012, was modelled with a total capacity of 200MW, this is expected to produce 277,000MWh of electricity per year.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Wind	0	0.0%	0	0.0%

Wind was not modelled under either the conservative or progressive scenario.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Greenpower	109,606	2.6%	1,011,672	24%

Under the conservative scenario Greenpower purchase was assumed to constitute 5% of remaining non-renewable electricity.

Under the progressive scenario Greenpower purchase was calculated to enable the ACT to meet a 40% emissions reduction from 1990 levels by 2020. This amount constituted 65% of remaining non-renewable electricity.

Marginal Abatement Costs

The following marginal abatement costs have been assessed for each renewable energy intervention:

- Solar hot water: \$-27 per tonne of CO₂-e abated;
- Solar PV: \$350 per tonne of CO₂-e abated;
- Wind: \$55 per tonne of CO₂ abated (Note: wind was not included in either scenario.);
- Greenpower: \$60 per tonne of CO₂-e abated.

The abatement cost for solar PV is based on research undertaken by Kinesis and factors the capital cost for installing a solar PV system.

Information provided to Kinesis by ACT DECCEW staff indicates that the cost of purchasing electricity from solar PV through the feed in tariff has an abatement cost of approximately \$500 per tonne.

Relevance to Action Plan 1

The following actions under *Weathering the Change: Action Plan 1* supported renewable energy:

- Action 5 - Legislate for Green Power to be offered to all new electricity customers;
- Action 9 - Provide a solar hot water rebate;
- Action 18 - Introduce a feed-in tariff for renewable micro generation;
- Action 20 - Investigate mandatory solar hot water for new houses;
- Action 39 - Showcase renewable and energy efficient technologies.

Potential Policy Actions

Considerations

- The transition to a greener grid should be performance based.

Policy Name: Low Carbon Energy Fund

Description: The ACT Government has implemented a mechanism to finance renewable energy projects through its gross feed in tariff. This tariff allows the energy utility to apply a small recovery rate, currently 0.12c per kWh, to all electricity purchased in the ACT and uses this to purchase renewable electricity from households with solar panels or small scale wind turbines at a premium rate (currently 50.05 cents per kWh hour).

Although the feed in tariff is an effective mechanism for encouraging renewable energy generation technologies it only supports solar PV and small scale wind which typically have high marginal costs of abatement.

To support a greater suite of renewable energy technologies, and additional low carbon technologies such as trigeneration, the ACT Government could consider modifying the feed in tariff so that the current recovery rate is used to support a wider range of electricity generation technologies. The proposed low carbon energy fund could support projects on a greenhouse performance basis; assessed solely on their emissions reduction potential.

The proposed low carbon energy fund would pay a variable rate for all electricity depending on its carbon intensity. Under this revised scheme renewable electricity would continue to be purchased at the current premium rate. A lower premium rate could be paid for technologies with higher greenhouse intensity per MWh of electricity than renewable, but lower intensity than coal; such as gas co-generation.

The fund could also be used to provide a source of revenue for households that install solar hot water systems. Under the scheme a payment would be made from the low carbon energy fund based on electricity avoided. The payment would be the same for electricity produced by renewable technologies.

Figure 7 illustrates how the variable electricity rate could apply to different electricity generation technologies.

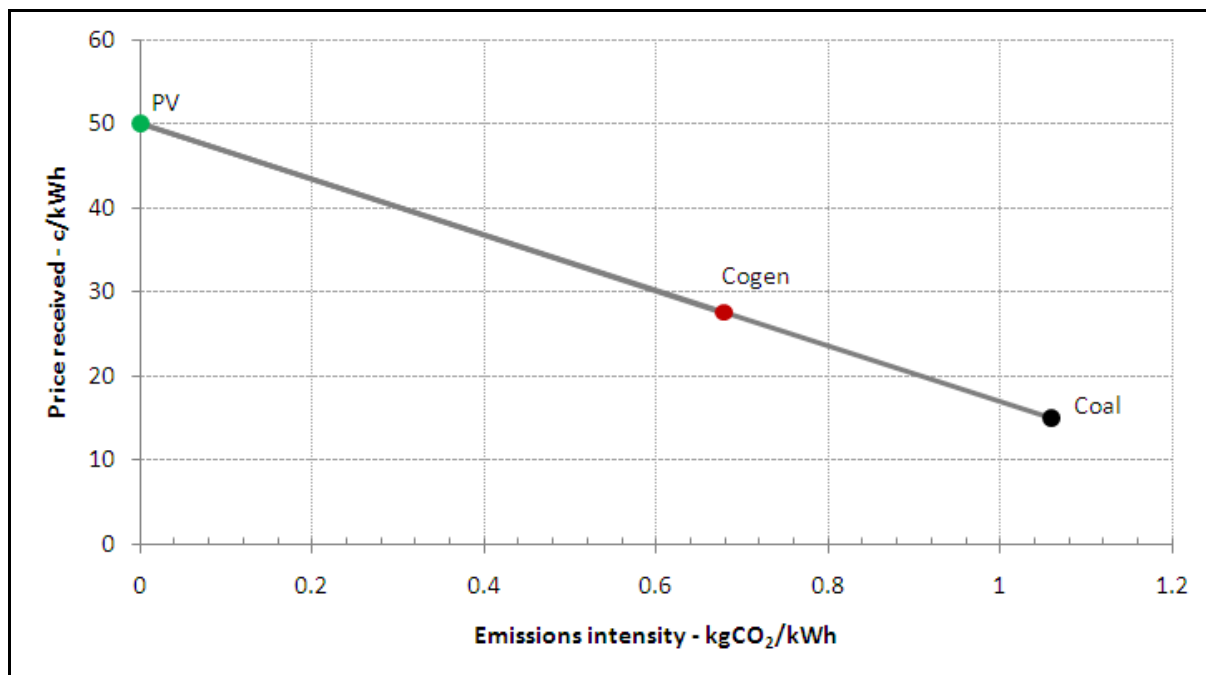


Figure 7. Potential variable rate of payment for electricity based on greenhouse intensity.

Policy Focus: The KPI for the low carbon energy fund would be greenhouse intensity per MWh of electricity. Electricity generation technologies with lower greenhouse intensity would receive a greater premium from the low carbon energy fund.

Responsibility: Although the Federal Government is supporting renewable energy growth through its Renewable Energy Target (RET) the ACT Government is also responsible for energy policy within the ACT. This is especially the case in the absence of a national energy policy.

Commentary: In addition to the recovery rate which is used by the energy utility to fund the gross feed in tariff, the ACT Government also has a number of direct funds under Action Plan 1 that support renewable energy, solar water heaters and energy efficiency measures. Most of this funding has been used to support pilot or demonstration projects. Some of these funding initiatives have encountered administrative difficulties and not all funding has been able to be spent. Kinesis has estimated that the combined budget for these initiatives is approximately \$24,024,000 over ten years.

It is proposed that the ACT Government could roll all of this funding into the low carbon energy fund in order to cut down on administrative costs, improve efficiency and ensure a greater number of total projects are funded. Supplementing the low carbon energy fund with direct Government funding would reduce the rate in which the recovery rate would need to be increased to fund additional electricity generation.

4d. Waste to Energy

Background

The ACT is currently investigating the conversion of waste to energy as part of a revised waste strategy. For the purpose of this Primer, waste to energy is a process whereby the waste stream is digested to create methane. This methane can then be captured and burned as a form of clean energy to generate electricity. Waste to energy plants prevent the release of methane gas from landfills and can displace more carbon intensive forms of electricity.

Waste to energy programs were not included as an action in *Weathering the Change: Action Plan 1*. However, the ACT is currently investigating a number of waste to energy projects and has commissioned a study into the possibility of using waste to energy technology on all ACT landfill sites.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Waste to Energy	0	0.0%	56,520	1.3%

The conservative scenario did not model any waste to energy conversion. It therefore had no effect on ACT emissions.

The progressive scenario modelled the effect of converting 30% of the ACT's waste stream to energy by 2020.

Marginal Abatement Cost

- Waste to energy: \$65-\$70 per tonne of CO₂-e.

Relevance to Action Plan 1

There are no actions under *Weathering the Change: Action Plan 1* that support waste to energy technology.

Potential Policy Actions

Considerations

- What is the effect and likely timeframe of converting waste to energy?

Policy Name: Waste to Energy Strategy

Description: Waste to energy, or alternative waste technology, is a proven technology that has already been implemented at a number of landfills internationally and across Australia. The ACT Government is currently investigating measures to implement such technology in ACT landfills.

Waste to energy plants have a high initial capital cost. Due to this high cost, the ACT Government could investigate seeking private capital to fund the construction and maintenance of waste to energy technology facilities on ACT landfill sites. As the ACT currently owns its landfill sites this could involve a public/private partnership. The ACT Government could lease space at its landfills to a private waste to energy technology provider and allow the private operator to levy a charge on all waste that is delivered to its plant.

Policy Focus: The ACT Government could establish the following KPI's for any waste to energy strategy:

1. Percentage of waste stream diverted through the waste to energy facility; or
2. A greenhouse reduction benchmark, mandating a specific emissions reduction target for ACT waste services.

Responsibility: Managing waste and landfill is an ACT Government responsibility.

Commentary: To encourage a waste to energy strategy, the ACT Government may need to provide a funding or subsidiary incentive to any potential private facility operators to assist in lowering the capital expenditure needed to construct the facility. This might be funded by an increased collection levy on ACT businesses and residents, or come from the consolidated low carbon energy fund which has been proposed as part of the renewable energy intervention.

4e. Travel/Transport

Background

Three actions were modelled to reduce greenhouse emissions from within the ACT transport sector. These were improved vehicle fleet efficiency, increased electric vehicle use and changes to mode shift.

Due to urban form and land use patterns, the ACT has a high reliance on private vehicle fleets. The response modelled for the ACT is therefore targeted at improving the vehicle efficiency of private vehicles, and by encouraging increased penetration of electric vehicles.

Improved vehicle efficiency was derived by calculating the emissions reduction that can be achieved by improving the efficiency of all vehicles within the ACT. A separate estimate has been made calculating the reductions that can be achieved if a certain percentage of the ACT fleet was switched to fully electric vehicles charged using electricity sourced over the grid, or using 100% renewable energy.

An estimate has also been made of the effectiveness of changing the pattern of new land development from the current average split between infill and greenfield. This calculation measures the average vehicle kilometres travelled by residents in current ACT greenfield compared to infill developments. It then calculates the emissions that would occur if new development patterns were based on a greater percentage of infill development than is currently occurring.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Vehicle Efficiency and Mode Shift	26,027	0.6%	162,888	3.8%

Under the conservative scenario, the ACT vehicle fleet was assumed to be 5% more fuel efficient than the current average by 2020. It was also assumed that 40% of new developments will be infill and 60% greenfield in 2020.

Under the progressive scenario, the ACT vehicle fleet was assumed to be 30% more fuel efficient by 2020. It was also assumed that 80% of new developments will be infill and 20% greenfield in 2020.

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Electric Vehicles	357	Less than 0.01%	17,882	0.4%

Under the conservative scenario less than 0.1% of the vehicle fleet was assumed to be fully electric by 2020. These vehicles were assumed to be charged over the grid.

Under the progressive scenario 5% of the vehicle fleet was assumed to be fully electric by 2020. These vehicles were charged using renewable electricity.

Marginal Abatement Cost

- Vehicle efficiency: \$-80 per tonne of CO₂-e;
- Electric vehicles: \$-200 per tonne of CO₂-e.

Relevance to Action Plan 1

The following actions under *Weathering the Change: Action Plan 1* support emissions reduction actions within the transport sector:

- Action 4 - Develop and implement a Park-and-Ride strategy;
- Action 7 - Offer stamp duty concessions for low emissions vehicles;
- Action 12 - Undertake ACTION CNG bus fleet replacement;
- Action 14 - Introduce free bus travel for bicycle riders;
- Action 15 - Implement public transport improvements;
- Action 16 - Develop network and service plans for buses;
- Action 17 - Investigate travelling to work options;
- Action 21 - Develop integrated land use and transport planning;
- Action 42 - Develop fuel sale data legislation for emissions monitoring.

Potential Policy Actions

Considerations

- What can the ACT Territory Plan contribute to emissions reduction?

Policy Name: Electric Vehicle Ready

Description: Achieving progressive take up of electric vehicles within the ACT will require considerable planning and preparation. New infrastructure, including re-charge stations and battery swap systems must be built and measures must be taken to ensure that the electricity grid can support increased demand. Eliminating the infrastructure barriers to electric vehicles will encourage vehicle manufacturers to target the ACT as a potential market by making it easier for companies which propose to establish battery charging and swap station networks within the ACT.

The Electric Vehicle Ready policy could outline a strategy in a master plan for overcoming these infrastructure barriers. It would plan for the growth and funding of necessary infrastructure and identify regulatory measures needed to encourage increased electric vehicle penetration. In short, it would send a positive signal to manufacturers of electric vehicles that the ACT is electric vehicle ready.

The electric vehicle master plan would also coordinate action between various stakeholders including the Federal Government, vehicle manufacturers, private businesses and the public to ensure an efficient and targeted response.

Policy Focus: The electric vehicle master plan should achieve clarity in the following performance areas:

1. Grid demand management. To ensure the grid can support increased demand and that there is potential for future “greening” of the grid to deliver further emissions reduction benefits to the transport sector;
2. Electric charging infrastructure. Establishing the necessary charging infrastructure in homes and in public and commercial locations;
3. Battery swap infrastructure. Creating battery swap stations in key locations where battery re-charging is impractical;
4. Standards compliance. To ensure that electric vehicles can comply with all re-charge and battery swap infrastructure;
5. Funding and revenue measures. To determine how necessary infrastructure will be funded between Territory and Federal Government, private business and public charges.

Responsibility: Private vehicle transportation regulation and infrastructure is primarily the responsibility of state and territory governments. The ACT Government would be the primary stakeholder in delivery of the electric vehicle master plan.

Commentary: The electric vehicle master plan should be developed in coordination with the ACT Government's plans for greening the electricity grid. Due to the limited number of electric vehicles available today new vehicles becoming available are likely to be in high demand. Establishing a low carbon electricity grid that can supply the necessary electricity to support electric vehicles will make the ACT an attractive market. This will be increased substantially if there is a comprehensive strategy for delivering the necessary charging and battery swap infrastructure.

Policy: Vehicle Registration Discount

Description: Due to the ACT's high reliance on private vehicles, measures to encourage the purchase of more fuel efficient vehicles would help reduce transport sector emissions.

The ACT Government has already implemented a variable stamp duty charge that rewards the purchase of more efficient vehicles. However, this charge is only applied once upon vehicle purchase and represents only a small percentage of the total cost of a new vehicle. It is proposed that the ACT Government could send a stronger signal to the market by implementing a variable vehicle registration cost that would reward owners of more fuel efficient vehicles.

This variable rate could be applied every year and could vary depending on the number of vehicle kilometres travelled each year. Vehicle owners could register their odometer during the registration process and have their registration costs assessed based on their kilometres travelled during the year. This would help encourage alternative transport uptake such as bus and bicycle use.

Revenue raised through this mechanism could be hypothecated to support investment in electric vehicle infrastructure.

Policy Focus: The vehicle registration discount could be tailored to achieve positive outcomes in the following areas:

1. Optimised penetration rate of fuel efficient vehicles;
2. Reduced private transport vehicle kilometres travelled;
3. Reduced greenhouse emissions across the private transport fleet.

Responsibility: Private vehicle registration is an ACT Government responsibility.

Commentary: Applying the variable charge based on vehicle kilometres travelled could be administratively difficult as the ACT does not have mandatory inspections as part of the registration process. However, the development of an "opt in" digital system (with random audits and penalties for false statements) could be one means of overcoming this. This system could also support motorists seeking to reduce insurance costs by demonstrating of limited vehicle use.

4f. Employee Density

Background

Increasing commercial employee density can reduce commercial per capita greenhouse emissions by avoiding future additional floor space growth, and energy required for lighting, heating, cooling and ventilation.

The abatement potential of reducing the average floor area required for each commercial employee within the ACT was modelled.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Employee Density	0	0.0%	75,077	1.8%

The conservative scenario did not model any change to BAU employee density rates by 2020.

The progressive scenario examined the effect of decreasing the floor space per employee within the ACT by 10%.

Marginal Abatement Cost

- Employee density: \$-165 per tonne of CO₂-e.

Relevance to Action Plan 1

There are no actions under *Weathering the Change: Action Plan 1* which support increased employee density.

Potential Policy Actions

Considerations

- Is increased employee density a legitimate response the climate problem?

Policy Name: ACT Government Employee Density Target

Description: Approximately 50% of the ACT's commercial floor space is leased and operated by the ACT or Federal Government. Both the ACT and Federal Governments can show leadership by implementing a strategy to reduce employee density within the ACT commercial sector.

Because they operate such a significant percentage of total ACT floor space, it may be possible for the ACT and Federal Government to achieve the modelled mitigation potential of increased floor space density without needing to leverage any reductions within the private commercial sector.

In the 2006-07 Budget, the ACT Government announced an initiative to consolidate and rationalise government office accommodation tenancies for leased and owned premises. A key target of this

strategy was to incrementally reduce utilisation rates across the ACT Public Sector from 21.6m² per person to 18.3m² per person with a longer-term target of 15m² per person.⁴

Meeting this target, and quantifying the mitigation outcome, could be the first steps towards more comprehensive action across the ACT commercial sector.

Policy Focus: The ACT Government should set a KPI for its employee density target based on achieving a quantified emissions reduction outcome.

Responsibility: Although the ACT Government has responsibility over its own leased buildings, it would need to work with the Federal Government, commercial sector and employee unions in order to leverage reductions through reduced employee density across the ACT.

Commentary: Reduced employee density can be a contentious issue as there are workplace health and safety considerations. Coordination with employee unions may be necessary if implementing any comprehensive ACT wide strategy.

⁴ <http://www.audit.act.gov.au/auditreports/reports2009/Report%206-2009%20-%20Govt%20Accommodation%20V2.pdf>

4g. Street lighting

Background

The emissions reduction potential of street lighting has been estimated separately to household and commercial lighting. New street-lighting technologies such as LED lights are becoming available at increasingly lower costs. The ACT Government is already implementing projects to replace existing street lights with energy efficient alternatives.

For the street lighting intervention, an estimate was made of the abatement potential of improving the efficiency of all ACT street lights.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Street lighting	2,136	0.1%	7,121	0.2%

The conservative scenario models the effect of improving the efficiency of street lighting across the ACT by 15%.

The progressive scenario models the effect of improving the efficiency of street lighting across the ACT by 50%.

Marginal Abatement Cost

- Street lighting: \$65 per tonne of CO₂-e.

Relevance to Action Plan 1

The following action under *Weathering the Change: Action Plan 1* support increase street light efficiency:

- Action 13 - Undertake energy efficient street light replacement.

Potential Policy Actions

Considerations

- When is it appropriate to demonstrate a step-change to the market?

Policy Name: Green Street Retrofit

Description: The ACT is currently undertaking a bulk street lighting retrofit across some suburbs within this ACT. However, this program has so far only replaced a partial percentage of the ACT's total streetlights and is not tied to a specific outcome of emissions reduction benchmark.

To leverage the emissions reduction potential of improved street lighting efficiency to the extent modelled in this Primer, the ACT could consider an expanded street light retrofit program that builds on and extends this existing action.

Policy Focus: The Green Street Retrofit could be structured around the following two KPI's:

1. An emissions reduction benchmark, designed to ensure that the initiative achieves a quantified emissions reduction outcome; and
2. A marginal abatement cost outcome that includes reduced maintenance costs due to longer lamp life, to ensure that retrofits are undertaken where they can achieve a marginal abatement cost below a specified target.

Responsibility: Street lighting within the ACT is an ACT Government responsibility.

Commentary: Implementing a bulk street lighting changeover across the ACT could also allow the ACT Government to coordinate multiple mitigation interventions. For example, the street light retrofits could also include a bulk household lighting retrofit with both programs implemented at the same time.

4h. Bio-sequestration

Background

The ACT Government has already implemented a number of tree planting projects including an aspirational target to plant an additional one million trees within the ACT. The emissions reduction potential of this scheme has been modelled in this Primer.

It should also be noted that this program has additional benefits that extend beyond bio-sequestration. These benefits include improved visual amenity, shading, reduced urban heat island effect, storm water management and increased bio-diversity. These benefits are primarily the main driver behind urban tree planting policies.

The emissions abatement potential of the ACT's existing forest stock was not considered in this analysis.

Effectiveness

Intervention	Conservative Scenario		Progressive Scenario	
	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels	Tonnes CO ₂ -e Reduction	% Reduction on 2020 BAU emissions levels
Bio-sequestration	14,486	0.3%	14,486	0.3%

Under the conservative scenario, the abatement potential of the ACT's existing aspiration to plant one million trees was modelled.

For the progressive scenario, no additional bio-sequestration was modelled beyond the one million tree aspiration.

Marginal Abatement Cost

- Bio-sequestration: \$40 per tonne of CO₂-e.

Relevance to Action Plan 1

The following actions under *Weathering the Change: Action Plan 1* support tree planting or tree replacement schemes:

- Action 23 - Increase the New Home Owner's Entitlement to Trees and Shrubs;
- Action 25 - Pursue an Urban Forest Replacement Program;
- Action 36 - Plant One Million Trees;
- Action 43 - Undertake a Carbon Sequestration Audit.

Existing Policy Action

Considerations

- What value do we place on the carbon sequestration of our tree planting schemes?

Policy Name: Plant One Million New Trees

Description: This policy is Action 36 of the ACT's Action Plan 1 and is an aspirational target. The program aims to plant one million trees over a ten year period beginning in 2007. According to departmental advice provided to Kinesis, \$10.341 million in funding is available for the period of

2007-08 through to 2011-12. This funding will cover the planting and maintenance of 793,500 trees. Additional funding will be sought to after this period to complete the program.

While the ACT is undertaking significant tree planting initiatives any carbon sequestration benefits should be included as part of a comprehensive emissions reduction strategy and ensure that all mitigation activities are accounted for.

Responsibility: Tree planting and tree maintenance schemes are the responsibility of the ACT Government.

Commentary: In this Action Plan 2 Primer no new tree planting strategies have been quantified, only existing policy has been assessed.

Appendix 1: Assumptions Behind The Modelling

4a. Energy Efficiency

- Consumption for lighting and appliances is taken from Energy Use Residential 1986-2020 and the Building Code of Australia "BCA Electricity data units" respectively.
- Lighting and appliance electricity and gas consumption is projected with dwelling and non-residential floor space growth
- The reductions in lighting and appliances simply apply a % reduction of total energy consumption for each.

The marginal abatement cost for improved efficiency has been derived from research conducted by McKinsey & Company.

4b. Fuel Switching

Trigeneration:

- Electricity and gas demands for thermal end-uses (i.e. hot water consumption and space heating & cooling loads) for residential and non-residential buildings were derived from information tabulated in "Energy Use in the Australian Residential Sector 1986-2020" and the annual energy consumption allowances specified by the Building Code of Australia in BCA Section J respectively.
- For residential development, the electrical and gas energy demands were converted into end-use thermal loads by taking into account the standing losses and heating efficiencies of conventional water heaters and, for space cooling and heating, the representative efficiencies (COP/EER) of electric heat pumps and of direct electric resistance and gas combustion heaters.
- For non-residential development, the conversion from primary (gas and electricity) energy consumption to thermal demand was made on the basis of representative energy conversion efficiencies for commercial hot water boilers, electric chillers and packaged air conditioning systems.
- The trigeneration plant was sized to supply these annual loads taking into account heat distribution losses as well as the efficiency of conventional single- and double-effect heat-driven cooling plant. In addition, approximately 70% of the heat generated by the cogen prime-mover was considered unrecoverable.

The marginal abatement cost for trigeneration has been derived from research conducted by McKinsey & Company and analysis by Kinesis for local governments across NSW.

4c. Renewable Energy

All renewable energy is assumed to off-set grid electricity and gas. Grid electricity is assumed to incorporate the Federal Government 20% renewable energy target (RET) by 2020.

Solar hot water:

- Consumption for electricity and gas hot water consumption is taken from Energy Use Residential 1986-2020 and the Building Code of Australia "BCA Electricity data units".
- The model assumes a solar contribution of 65%, i.e. that solar can contribute 65% of the hot water energy demand.
- Solar hot water systems, when implemented, offset hot water electricity and gas energy consumption equally.

Solar PV:

- The model assumes the energy generation from Solar PV in the ACT is 1.382 MWh/year per kW peak. This assumes the use of mono-crystalline PV technology. Thin-film PV technology assumes half the yearly energy generation per kW peak.
- The emissions savings from both residential solar PV and the solar farm apply to total ACT electricity consumption.
- The solar farm assumes the nominated MW peak of PV is implemented in 2013.
- Residential solar PV assumes that in 2009 there is 1,560 kW peak of PV, increasing to 62,000 kW peak by 2014, as per the feed in tariff projections provided to Kinesis by ACT DECCEW.

Wind:

- Wind energy is calculated using a Weibull Annual Energy Calculation equation with a shape factor of 2 and a wind speed within the ACT of 7 metres/second (m/s).
- Wind turbines modelled are Vestas V80-2MW systems, rated at 16 m/s with a cut in/out rate of 4m/s and 25m/s respectively.
- A de-rated annual energy production factor of 20% is included to account for yearly maintenance and turbulent wind.

Greenpower:

- Greenpower calculations apply only the remaining kWh of electricity after the energy savings from efficiency and renewable energy interventions listed above have been modelled.

The marginal abatement cost for improved renewable energy has been derived from research conducted by McKinsey & Company. Analysis of solar PV is based on data provided to Kinesis for the cost of funding the premium surcharge for solar PV through the feed in tariff. Greenpower costs are based on the capped price of renewable energy credits.

4d. Waste to Energy

- Waste consumption data for domestic and commercial/retail buildings is from Pre-Feasibility Assessment of Thermal Conversion Technologies for ACT (URS, 2009).
- The model assumes:
 - 90% of waste sent to AWT is used in the plant
 - 10 kWh/t waste diverted to AWT
- 50% of all waste is diverted to AWT by 2015

The marginal abatement cost for waste to energy emission reductions has been derived from research conducted by McKinsey & Company.

4e. Travel/Transport

- Transport emissions were modelled using an extrapolation of Sydney's Household Travel Survey and the ABS Survey of Motor Vehicle use.
- The model assumes approximately 13.2 vehicle kilometres travelled per driver per day and that 95% of travel emissions are from private vehicle use with the remaining 5% from public transport use.
- The model projects travel emissions to 2020 with population growth.

Vehicle Efficiency:

- The model calculates the emission savings from vehicle efficiency.
- The model assumes an increase in efficiency from 0.315 kg CO₂-e per kilometres in 2009 to 0.221 kg CO₂-e per kilometre by 2020.
- The model applies this saving to the percent of vehicles nominated by the user.

Mode shift from new development:

- Using current levels of vehicle ownership from the ABS Census, the model calculates the impact of new development in infill and greenfield locations.
- The mode shift and subsequent emission savings modelled in the tool applies to residents of new development only.

Electric Vehicles:

- As an alternative to improved vehicle efficiency, electric vehicles have the potential to further reduce emissions from travel. The model calculates the effect of replacing some of the existing private vehicle fleet with pure electric vehicles (non-hybrid) using energy derived from the existing electricity grid.
- Trip efficiency for the electric vehicles was assumed to be 100 Wh per km.
- This estimate takes into account battery charge/discharge efficiency and is consistent with the efficiency reported by Mitsubishi for their iMiEV pure electric vehicle.⁵
- The model also calculates the additional savings from supplying this electric vehicle fleet with renewable energy.

The marginal abatement costs for travel/transport emission reductions have been derived from research conducted by McKinsey & Company.

4f. Employee Density

- Increased employee density results in less energy required per employee.
- The model assumes an average employee within the ACT requires approximately 21.6 metres squared of floor space. This figure has been estimated from the Territory and Municipal Services 2007-08 Annual Report.⁶
- The model assumes that an increase in employee density will lead to a reduction in commercial floor space and a subsequent reduction in energy demand, on a one-to-one basis.

The marginal abatement cost for increased employee density was calculated based on Kinesis research. This cost assesses reduced energy use from increased density.

4g. Street lighting

- The model assumes street lighting accounts for approximately 47 kWh per resident per day.
- This was determined from Planet Footprint data street lighting energy from local councils around NSW.
- The reductions in street lighting simply apply a percent reduction of total street lighting energy consumption.

The marginal abatement cost for improved lighting efficiency has been derived from Kinesis analysis of local government street lighting efficiency improvements in Sydney.

4h. Bio-sequestration

The bio-sequestration potential of tree planting schemes has been assessed on a per tree basis using data from the forestry offset provider greenfleet. This data shows that an average Australian native tree can sequester 268 kilograms of carbon dioxide over an average lifecycle of 18.5 years. Using these assumptions Kinesis calculated an average yearly sequestration rate of 14.5 kilograms per tree.

⁵ http://www.mitsubishi-motors.com/corporate/about_us/technology/review/e/pdf/2008/20e_11.pdf

⁶

http://www.tams.act.gov.au/__data/assets/pdf_file/0007/131695/A.9_Analysis_of_Agency_Performance.pdf

The marginal abatement cost for bio-sequestration has been derived from research conducted by McKinsey & Company.

In addition, a marginal abatement cost was calculated for the ACT tree planting program derived from existing budget data for ACT tree planting schemes which was provided to Kinesis during our review of Action Plan 1. Our analysis of this data showed that the ACT's existing tree planting schemes has a marginal abatement cost of \$1900. This far exceeds the abatement cost estimated by McKinsey and Company and given by third party offset providers such as Greenfleet and reflects the full program cost of the schemes including administrative and program management costs.

Appendix 2: Annual Emissions Reduction Data

Mega-tonnes/year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BAU Emissions:	3.92	3.98	4.00	4.02	4.03	4.05	4.07	4.09	4.11	4.13	4.15	4.17	4.20	4.22	4.24
Savings from conservative scenario interventions:															
Trigeneration	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08
Lighting	0.00	0.00	0.00	0.00	0.02	0.04	0.06	0.08	0.11	0.13	0.13	0.13	0.13	0.13	0.13
MEPs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solar Hot Water	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Waste to Energy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles & Mode Shift	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03
Electric Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Street Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Employee Density	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green Power	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11
Solar Farm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
Solar PV	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bio-Sequestration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 2: Total Emissions and Emission Reductions (MT of CO₂-e) for each intervention under the Conservative Scenario

Mega-tonnes/year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BAU Emissions:	3.92	3.98	4.00	4.02	4.03	4.05	4.07	4.09	4.11	4.13	4.15	4.17	4.20	4.22	4.24
Savings from progressive scenario interventions:															
Trigeneration	0.00	0.00	0.00	0.00	0.04	0.07	0.09	0.11	0.14	0.16	0.20	0.25	0.29	0.34	0.38
Lighting	0.00	0.00	0.00	0.00	0.04	0.08	0.13	0.17	0.21	0.25	0.25	0.25	0.25	0.25	0.25
MEPs	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.06	0.07	0.08
Solar Hot Water	0.00	0.00	0.00	0.00	0.03	0.06	0.08	0.11	0.14	0.17	0.17	0.17	0.17	0.17	0.17
Waste to Energy	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.05	0.06	0.06	0.06
Vehicles & Mode Shift	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.10	0.13	0.16
Electric Vehicles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02
Street Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Employee Density	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.08
Green Power	0.00	0.00	0.00	0.00	0.14	0.27	0.38	0.43	0.52	0.60	0.68	0.77	0.85	0.93	1.01
Solar Farm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.24	0.24	0.24	0.24	0.23	0.23	0.23
Solar PV	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bio-Sequestration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 3: Total Emissions and Emission Reductions (MT of CO₂-e) for each intervention under the Progressive Scenario