

# **CARBON FUTURES: REDUCING EMISSIONS FOR THE AUCKLAND REGION**

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## **Abstract**

Over the last three years, the ARC has led a consortium of councils and key stakeholders to develop integrated regional policy responses to address energy and climate change issues, that would map the way forward by determining how the Auckland region will adapt, manage and respond to risks associated with climate variability and the pressures faced due to rising greenhouse gas (GHG) emissions. As part of the Regional Response to Climate Change (RRCC) work, two significant projects have been developed:

1. Carbon Now – A performance and systems-based framework for measuring GHG emissions, preparing reduction targets, monitoring and reporting against targets.
2. Carbon Futures – A back-casting and visioning study which projected estimated 2006 baseline emissions through to 2040 and then developed a suite of mitigation initiatives to achieve a range of reduction targets.

The first stage of the Carbon Futures project involved a detailed estimate of the current emissions for the region, based on data supplied through the International Council for Local Environmental Initiatives' *Communities for Climate Protection* programme and other sources. Data was supplied by each of the seven Councils within the Auckland Region and an aggregated regional emissions profile was developed using 2006 data.

This 2006 emissions profile was then projected out to 2040 based on a range of assumptions linked to each individual sector.

The final stage of the project involved developing a suite of options for reducing emissions across the region and assigning responsibilities for various options to relevant authorities and sectors.

The study provided a very interesting 'reality check' for decision makers in the region - putting the ever-increasing 'business as usual' emissions projections well and truly into perspective and outlining a range of available options to address these.

## 1.0 INTRODUCTION

Internationally, over the last 10 years, major cities have been developing plans and strategies to combat their rising Greenhouse Gas (GHG) emissions. Vision statements have become prevalent with Vancouver aiming to be “The world’s greenest city by 2020”, London; “The cleanest & greenest city in the world”, and Sydney; “Green by example and green by reputation”.

The plans developed generally include recommendations and goals for reducing emissions across all sectors. While there are questions over the effectiveness of these plans to date, it is important to realise that many of the objectives are long term and require large shifts in behaviour, significant policy changes, large investment and in nearly all cases, political will.

The development and endorsement of the Auckland Sustainability Framework (ASF) in 2007, and the regional vision statement (entitled the ‘One Plan’) established a framework for managing the sustainability of the Auckland Region for the next 100 years. Climate Change, and in particular reducing carbon emissions and the region’s ecological footprint are key considerations within these documents.

In 2009, Auckland Regional Council (ARC) engaged AECOM to undertake a study into possible mitigation options for Greenhouse Gas (GHG) emissions across the Auckland Region. This project was entitled ‘Carbon Futures’ and was complementary to a second project running concurrently entitled ‘Carbon Now’. ‘Carbon Now’ focussed on developing a robust inventory of current emissions for the Region.

The objectives of the Carbon Futures project were divided into two Stages, as follows:

### **Stage 1 – Preliminary Data Review and Business-As-Usual Projections:**

- Develop an approximate estimate of current emissions for the Auckland Region based on Communities for Climate Protection (CCP) data held by ICLEI (International Council for Local Environmental Initiatives) and other sources. CCP data was available for 2001 only, and was held for ARC and each of the Territorial Authorities (TAs) within the Auckland Region. The first task was to project a 2001 regional emissions estimate to 2006 (census year) in order to get a current emissions estimate.
- Develop Business-As-Usual (BAU) projections to 2040.

### **Stage 2 – Development of Mitigation Options**

- Undertake a Best Practice Review looking at case studies, strategies and initiatives developed in other cities / countries.
- Develop a range of emission abatement options in conjunction with key stakeholders in a robust, collaborative manner, to improve the chances of uptake of the final recommendations.
- Evaluate these via a series of workshops and generate a prioritised list of options along with approximate implementation costs, GHG reduction benefits and other co-benefits.

## 2.0 STAGE 1 – PRELIMINARY DATA REVIEW AND BAU PROJECTIONS

### 2.1 Data Gathering

The first stage of the project involved gathering of emissions data for the Auckland region, and compiling an aggregated estimate of emissions.

The majority of 2001 emissions data was obtained through the CCP programme held by ICLEI. This data was approximate only but served as a useful starting point to understand baseline emissions for the region.

CCP data is divided in two sectors:

- Corporate (emissions from Council operations – buildings, vehicles, plant etc)
- Community (emissions from the entire Council jurisdiction)

Under each sector, emissions are recorded in a number of categories as per Table 1. At a macro level, these categories are consistent with those developed by the Intergovernmental Panel on Climate Change (IPCC) and are informed by IPCC 2006 Guidelines (IPCC, 2006), and the GHG Protocol Initiative Corporate Standard (WRI, 2004).

The IPCC categories are as follows:

- Stationary Combustion
- Mobile Combustion
- Fugitive and other Energy Emissions
- Industrial Processes and Product Use
- Agriculture, Forestry and Other Land Use
- Waste

At Council level, ICLEI encourages reporting in the following categories, which then relate back to the IPCC Categories above.

**Table 1 - CCP-NZ Categories**

CCP Corporate Categories	CCP Community Categories
Buildings and Facilities	Residential
Street Lights Stationary Combustion and Traffic Signals	Commercial
Water/Sewer (energy only)	Industrial
Vehicle Fleet	Transportation
Employee Commute	Agricultural
Waste	Waste
Other	Other

The majority of data analysis and comparison during this project was focussed on emissions from the **Community** sector, as these are obviously orders of magnitude larger than the **Corporate** sector emissions.

It is noted also that only energy and waste data was available through CCP for Councils. Agricultural emissions and forest sink data was obtained from other sources as detailed below.

## **2.2 Review of Community Emissions Data for 2001**

### **2.2.1 Energy Sector: Residential, Commercial, Industrial, Transport**

ARC Community CO<sub>2</sub> emissions were determined by CCP-NZ using proxy data for 2001 to be 9.1 million tonnes of CO<sub>2</sub> in the Residential, Commercial, Industrial and Transport sectors. This data was entered into the CCP-NZ software by ARC staff, but was provided by CCP-NZ, based on Energy Efficiency and Conservation Authority (EECA) and Ministry for Economic Development (MED) sources.

Community emissions data was provided by CCP-NZ for the seven Territorial Authorities (TAs) of cities and districts within the Auckland Region; (i.e. Auckland city, Manukau City, North Shore City, Waitakere City, Rodney District, Papakura District and Franklin District). Franklin District is partly in Auckland Region and partly in the Waikato Region and this was proportioned accordingly.

The sum of the Community CO<sub>2</sub> emissions in 2001 for the seven TA's comprising the Auckland Region, mostly as derived from CCP-NZ proxy data, was estimated as 7.7 million tonnes of CO<sub>2</sub>. This is a significantly lower estimate of the greenhouse footprint of the Auckland Region. To improve our understanding of this difference a comparison was undertaken of the corresponding energy consumption data (based on GJ of energy use per head of population) by sector and by fuel.

In addition, for further comparison, the corresponding national energy consumption data in terms of GJ of energy use per head of population, analysed by sector and fuel type, was compared. This national data was derived from MED Energy Data File (MED, 2007).

Theoretically the total emissions for the Auckland Region and the Territorial Authorities should be the same using either approach because they come from the same data source. It

was expected that the national numbers would be comparable, despite being derived with a different methodology and sources. However, none of the numbers showed precise agreement. This highlighted that there were a number of anomalies in the emissions data that need to be explored in order to establish a firm estimate of baseline emissions. This was, however, outside the scope of this study.

In order to develop a robust data set to use for the study, a revised set of GJ per capita for the Auckland region was developed by adopting the median value of the three energy data points for each fuel.

### 2.2.2 Waste and Agricultural Sectors

The Waste and Agricultural data was obtained as follows:

**Waste:** obtained by summing up the total of CCP waste categories for each TA. It is noted that while this was contained within the 'Corporate' inventory it applies to the entire community. There was significant discrepancy between each of the TA's waste inventories – however this was the only data source available.

The total 2001 emissions from waste was calculated as 860,000 tonnes CO<sub>2</sub>-eq.

**Agriculture:** Approximate 2006 data was obtained from NIWA which indicated that agricultural emissions were estimated as approximately 8% of total emissions from the Auckland Region.

The total amount of CO<sub>2</sub> emitted in 2006 was estimated as 760 ktonnes CO<sub>2</sub>-eq, spread over the following categories (of which the first two constitute approximately 80%):

- Emissions from enteric fermentation in livestock
- Emissions from agricultural soils – animal production
- Emissions from manure management
- Direct emissions from agricultural soils
- Indirect emissions from Nitrogen used in agriculture

This relatively low volume of emissions from waste was considered consistent with the largely urbanised nature of the Auckland Region

### 2.2.3 Forestry / Land Use

The principal objective of the Carbon Futures project was to identify policies and strategies that could be adopted by ARC in order to make the carbon footprint of the Auckland region lower than it otherwise would be. In principle, policies and strategies to increase the extent of forested areas in the Auckland region would contribute to meeting that objective. However, due to the complexities in forestry (land use), emissions or sequestration potential were not considered within the regional emissions profile.

However, it was acknowledged that it was an area that needed to be explored further - including, the timeframe of a forest planting programme; the species of trees involved; the nature of the silviculture activity; the Kyoto compliance of forests; the 'permanence' of the forest itself; the relationship between ARC policies and the Emissions Trading Scheme (ETS) and the relationship between ARC policies and the Permanent Forest Sinks Initiative (PFSI).

As an exercise, however some data was gathered on forestry planting within the region. This is presented in Table 2 below and is sourced from a MAF annual report entitled the 'National Exotic Forest Description' (MAF, 2006) which summarises the areas of land planted in different species across the TAs within NZ. The table shows that the established forest estate in the region currently holds about 10 million tonnes of CO<sub>2</sub>, which is about the same as the annual emissions of CO<sub>2</sub> from the Auckland region. The annual change in stock relates to the carbon sequestration potential and is estimated at almost 1 million tonnes.

Data on native forest areas was not able to be obtained at the time of the study, and it was hoped that ARC would be able to source data from the Land Cover Data Base in the future.

Table 2 - Hectares of Forest Planting in the Auckland Region in 2006 (Source- MAF)

Species	Radiata Pine	Eucalyptus, Cypress and Douglas Fir	Other Soft woods and Hard woods	Total
Rodney District	31,558	32	624	32,214
Papakura District	99	0	2	101
50% Franklin District	3,139	34	143	3,316
ACC, WCC, NSCC, MCC	3,830	13	166	4,009
Total	38,626	79	935	39,640
ktonnes of embodied CO <sub>2</sub> in 2006 <sup>1</sup>	10,300	40	60	10,400
Annual increment in CO <sub>2</sub> stock in these forests ktonnes/year <sup>2</sup>	980	2	5	987

<sup>1</sup>Based on carbon profiles of each species and age groups as reported in the NEFD.

<sup>2</sup>Based on annual increase in carbon as a result of growth. Note for Radiata, this equates to an increase of approx 25 tonnes of CO<sub>2</sub> per hectare per year.

### 3.0 DEVELOPMENT OF BASELINE EMISSION ESTIMATES FOR 2001 AND 2006

In order to provide a temporary basis for projecting forward from CCP-NZ 2001 historical data to 2006 and beyond a number of assumptions were made.

- The 2001 per capita energy consumption for each category was taken as the median of the three values based on national, regional and TA data gathered.
- The electricity emission factor for 2001 was 160.3 kg CO<sub>2</sub>/MWh (MED, 2006, 2007)
- The electricity emission factor for 2006 was 197.4 kg CO<sub>2</sub>/MWh (MED, 2006, 2007)
- The population growth in Auckland Region from 2001 to 2006 was based on Statistics NZ census data.
- The increase in energy data from 2001 to 2006 was determined using the average annual percentage change in GJ/a per capita derived from actual annual sectoral data in reported in Energy Data File for 2001 to 2006.
- Emissions from waste were assumed to increase in proportion to population.
- Agricultural emissions were based on 2006 data.

Land use / forestry related emissions/offsets were excluded.

A total value for 2006 emissions for the Auckland Region was calculated at **12M tonnes**.

Figure 1 below compares baseline emission estimates for 2001 and 2006 by sector. Note that agricultural emissions are sourced from NIWA. Figure 2 shows the split of emissions by sector as a percentage of the whole. As can be seen, transport makes up the vast majority of emissions.

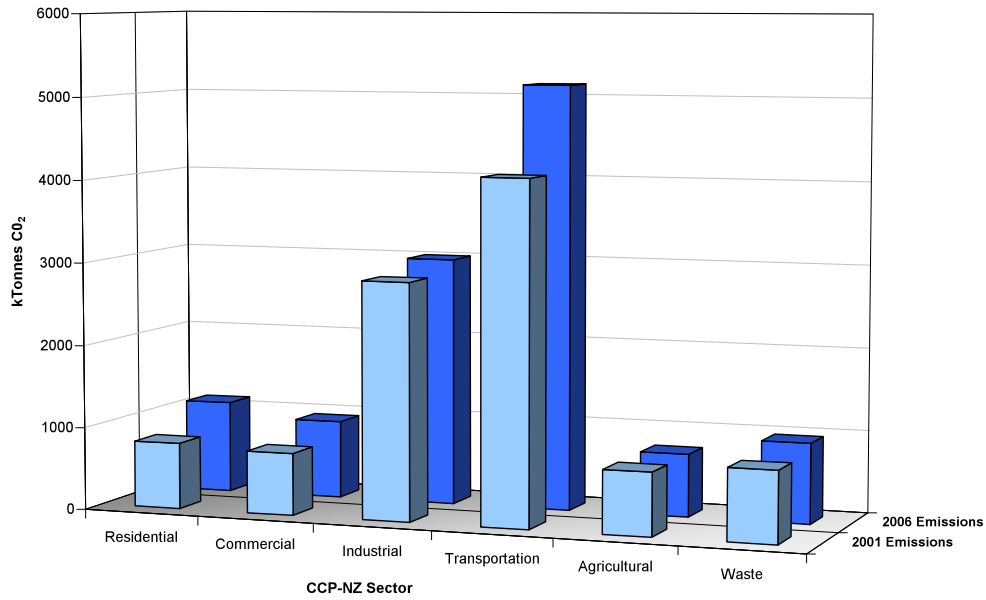


Figure 1 - Provisional CO<sub>2</sub> Emissions Estimates for Auckland Region in 2001 and 2006

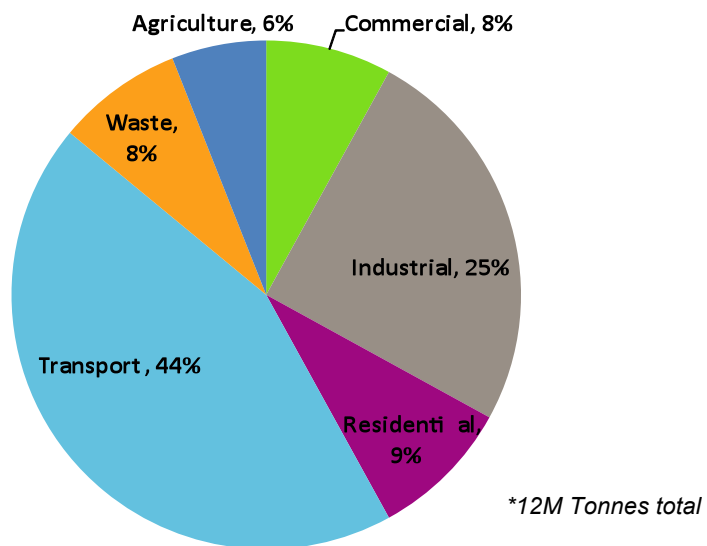


Figure 2 - Provisional % CO<sub>2</sub> Emissions Estimates for Auckland Region in 2006\*



## 4.0 BUSINESS AS USUAL FORECAST TO 2040

### 4.1 Methodology

This stage of the project required the 2006 Community emissions to be projected forward to 2040 under a business-as-usual scenario. In addition, back-casting of CO<sub>2</sub> emissions from the Auckland Region to 1990 was required to provide an historical benchmark.

The projections were based on the use of national trends in the per capita energy use data from the Energy Data File (EDF) for the period 2001-2006. While, in many cases the energy use by sector and fuel recorded in the EDF did not display regular trends that could be reliably used as a model for projected business-as-usual CO<sub>2</sub> emissions, trend lines were determined as described below.

The energy use trends were determined on the basis of per capita energy use. This assumption was based on the rationale that, to a first approximation, all energy using activities in the residential, commercial, industrial and transport sectors are broadly proportional to the number of people in the country carrying out those activities.

### 4.2 Forecast of Energy Use

For each subsector of energy use, assumptions were made relating to the likely future increase in per capita energy use to 2040. This was based on historical trends between 2001 and 2006. The back-casting to 1990 was based on the same rates as the 2001-2006 period.

The majority of energy subsectors were assumed to have no increase in per capita use (eg residential electricity, residential LPG, residential coal). Some were assumed to increase at the same historical per capita rate per annum (eg commercial and industrial electricity use) and some were assumed to decrease (commercial and industrial coal use).

### 4.3 Waste and Agricultural Sectors

It was assumed that the per capita waste emissions remain constant and the *total* agricultural emissions remains constant (ie unaffected by population).

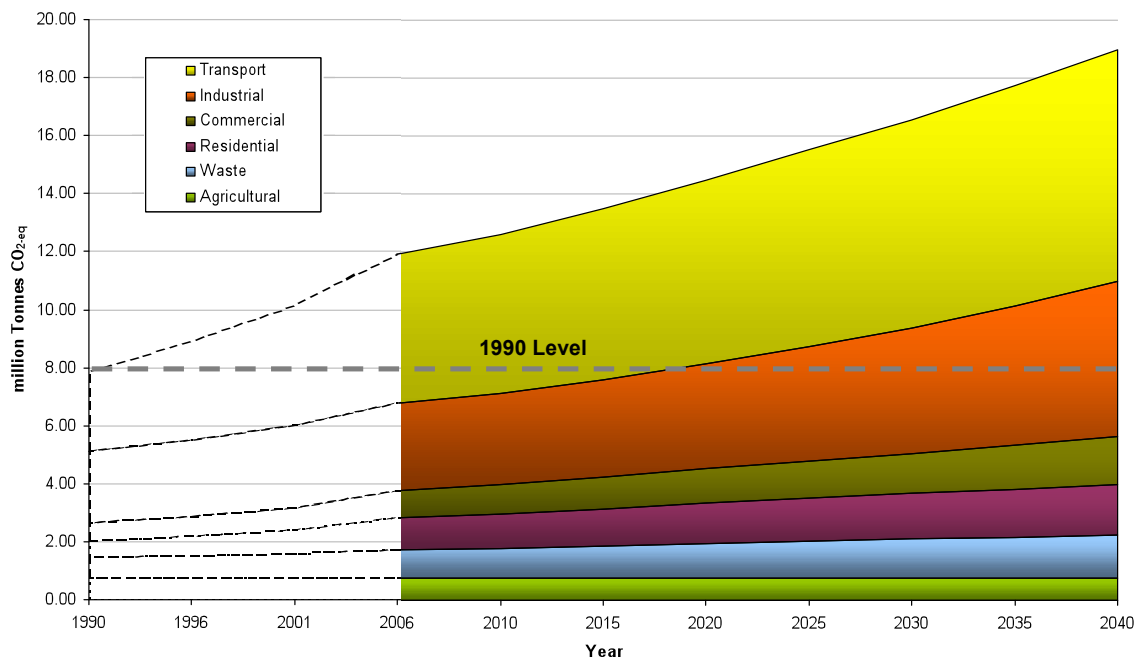
### 4.4 Regional Population Projections

Regional population data and projections were obtained from Statistics New Zealand. Projections were available to 2030, and were extrapolated to 2040 using the same growth rate as used for the years 2025-2030.

These projections were used to project the overall growth in business-as-usual CO<sub>2</sub> emissions in the Auckland Region.

### 4.5 Projected Business-as-usual CO<sub>2</sub> emissions in the Auckland Region

The figure below shows the resulting business-as-usual CO<sub>2</sub> emissions for Auckland Region for to 2040 following the trends derived above. From 2010 to 2040, the emission factor for electricity was assumed to be 200 kgCO<sub>2</sub>/MWh.



**Figure 3 - Provisional Estimate of Business-As-Usual CO<sub>2</sub> Emissions Projections for Auckland Region**

The above graph indicates that emissions for the Auckland Region are projected to rise from 12M tonnes in 2006 to around 19M tonnes in 2040. This is 11M tonnes above the estimated 1990 level of 8M tonnes.

## 5.0 KEY LEARNING FROM DATA GATHERING

It is worth making a number of key points in relation to the data gathering stage:

- a) While it was always understood that the data from the CCP would be approximate only, it was felt that in general it was a good approximation of baseline emissions for the region.
- b) Discrepancy in Electricity Emission Factor: The electricity emissions factor used by CCP-NZ did not take into account the variance in the different sources of electricity between, say, coal and hydro. It was felt that either the actual annual emission factors should be used, or generic figures of 150 kg CO<sub>2</sub> per MWh for 2001 and 200 kg CO<sub>2</sub> per MWh for 2006.
- c) It was noted that there is currently no reliable method to gain accurate, region wide electricity usage data. Nor is there a reliable method to attribute electricity usage across energy sectors. One potential source is from the sum of the electricity flows through grid exit points (GXPs) within the Auckland Region. This has the potential to provide an on-going, practical measure of the total electricity consumption in the Auckland Region. However, it would not provide a basis for determining the distribution of that energy supply between the residential commercial, industrial and transport sectors. Commercial sensitivities may also cause problems in obtaining such data. If reliable data sourcing is not resolved, it may prove difficult to monitor Community emissions at the level of disaggregation required, and therefore it may be difficult to provide measured evidence of progress against targets.

## 6.0 STAGE 2 – DEVELOPMENT OF MITIGATION OPTIONS

### 6.1 The Process

A staged process was undertaken with input from key stakeholders in order to generate a suite of GHG mitigation options suitable for the region. The process was as follows:

- Develop Options Long List (based on research and international best practice)
- Develop Options Short List (through workshop)
- Quantitative Assessment of shortlist (potential for GHG reduction and rough cost)
- Multi-Criteria Assessment of shortlist – prioritisation (through workshop)
- Input from Sector Specialists to enhance understanding
- Final Outputs

Stakeholders who were involved included: ARC and the TAs, Auckland Regional Transport Authority (ARTA), Ports of Auckland, Employers and Manufacturers Association, Auckland, Regional Holdings, Ministry for Economic Development.

### 6.2 Long list and short list

The initial long-list totalled around 90 options. This was sent to all stakeholders and each option was given a high/medium/low ranking for a range of criteria:

- GHG Reduction
- Level of Control (TA, ARC)
- Environmental Co-benefits
- Social Co-benefits
- Indicative Cost
- Linkage to other National Strategies or Programmes

Rankings were discussed in a workshop situation and a short-list of 30 options was developed for further analysis. The majority of options fell within the transport sector, residential and commercial/industrial sector.

### 6.3 Quantitative Analysis

Next, a high level cost benefit analysis of each option was undertaken in order to quantify potential costs for implementation in relation to potential GHG reductions. This involved:

- Broadly estimating the ‘order of magnitude’ costs of each option to the ARC/TA. Costs per tonne abated were ranked as high/medium/low, based on a combination of analysis and research into similar initiatives implemented in other cities.
- Quantifying the GHG emission reductions
- Identifying other potential economic costs and benefits (qualitative assessment)

To quantify the GHG emission reduction for each shortlisted option, data was obtained and a number of assumptions were developed in order to estimate the potential GHG reductions over the short (2015), medium (2025) and long (2040) terms.

The percentage uptake at each date was generally assumed to be 30%, 50% and 70% respectively at each of the years mentioned above. However, options relying on evolving technology or long term planning were assessed on a delayed basis of 1% uptake, by 2015, 5% uptake by 2025 and 50% uptake by 2040.

For example, the potential savings through, say, retrofitting households with energy efficient lighting was calculated as follows: Max potential reduction in energy use for lighting was assumed as 50% (conservative); this was multiplied by potential uptake as above giving reductions in *lighting energy use* of 15%, 25% and 35% over each of the 3 periods.

## 6.4 Qualitative, Multi-Criteria Assessment

A multi-criteria analysis (MCA) framework was also developed in order to evaluate the various options. This was used in the final workshop to qualitatively compare the options. Criteria used included:

**Table 3 - MCA Criteria**

	Criteria	Description
1	Ease of implementation	How simple the project will be to get underway
2	Socio Economic Fairness	Fairness across income groups, ethnic groups (equity).
3	Environmental Impacts	Measure to show if there were any additional positive or negative environmental effects (other than GHG reduction)
4	Community / Cultural Impacts	Measure to show if there were any additional positive or negative cultural / community effects
5	Economic Impacts to Households / Businesses	Indicates if the option would have a financial implication if introduced – and the degree to which this would be incurred.
6	Affordability – Cost per tonne abated	Pre-calculated: indicates order of magnitude of the cost per tonne abated for each option
7	Scale of GHG Reduction	Pre-calculated: indicates the overall scale of option (eg wind farm vs light bulb).

Each of the options was then ranked for the above criteria on a scale from A-E: A representing ‘Excellent’, B – ‘Improvement’, C – ‘No Change’, D – ‘Disadvantage’ and E – ‘Bad’. Each letter assigned to an option would weight that by a factor of 5 (A) through 1(E).

The ‘Cost per tonne abated’ Criteria was given a weighting of 5 (<\$20/t) through 1(>\$1000/t). The ‘Scale of GHG Reduction’ was weighted from 5 (>200,000t) through 1 (<5000t).

Finally, each criterion was given a weighting based on what the group considered to be the most important factors. The group discussion resulted in the weightings that are shown below in Table 4.

**Table 4 - Weightings Developed for MCA Criteria**

<b>Criteria</b>	<b>Weighting</b>
Ease of implementation	10%
Socio-economic fairness	5%
Environmental Impacts	5%
Community/Cultural impacts	5%
Economic Impacts to Household / Business	20%
Affordability - Cost per tonne abated	20%
Scale of GHG Reduction	35%
TOTAL	100%

This weighting indicates that the ‘Scale of GHG Reduction’, ‘Cost per Tonne Abated’ and ‘Economic Impacts to Households/Business’ were considered to be more important criteria, and should influence the evaluation to a larger extent.

## **6.5 Discussion of MCA Assessment**

The following key points were made in relation to the MCA results:

1. Options that scored within the top 10 for each group included those that involved household/business retrofits and behaviour change / awareness raising.
2. Public transport improvements also scored well, despite being costly in terms of \$/tonne abated. This was offset by the high score for ‘Scale of GHG Reduction’.
3. Transit Oriented Development scored well, due to being essentially a policy-based approach and not involving significant cost. It also has potential for large reductions.
4. Establishment of Carbon Sinks (tree planting) scored well due to there being no real downsides.
5. Energy from burning clean wood scored the highest of all the energy options – primarily because it was perceived to be relatively easy to implement, to potentially be more accessible for lower-income families and be relatively cost-effective.
6. The other energy options are all involved with local generation of electricity. Domestic Solar PV and, Onsite Wind scored relatively poorly due to technology issues and perceived problems with use within an urban area.
7. Medium Scale Wind farms feeding into the local distribution network and Bioenergy electricity generators at a local community scale scored slightly better than the small scale generation initiatives.
8. Options such as congestion charging and carbon pollution tax scored in the middle of the range – due to them being difficult to implement (for political reasons), yet they had potential to achieve good reductions.
9. The work/school travel plans, cycling plan and walking plan all scored relatively poorly due to the small scale of reductions likely to be achievable and large cost to build walkways and cycle tracks.

## 7.0 SCENARIOS FOR REDUCING EMISSIONS FOR AUCKLAND

As a result of the MCA assessment the 30 options were ranked from ‘best’ to ‘worst’. Three scenarios were developed:

- **Tier 1: ‘Achievable’:** This scenario consists of those first ten options as ranked via the MCA process. The total reduction able to be achieved by 2040 has been estimated as 27% of the BAU projection at that date.
- **Tier 1+Tier 2: ‘Challenging’:** This scenario consists of the first ten Tier 1 options plus the next ten Tier 2 options as ranked via the MCA process. The total reduction able to be achieved by 2040 has been estimated as 35% of the BAU projection at that date. This relatively small incremental increase is due to the fact that those mid-range options are all relatively small in scale.
- **Tier 1 + Tier 2 + Tier 3: ‘Stretch’:** This scenario consists of the complete list of 32 options as ranked via the MCA process. The total reduction able to be achieved by 2040 has been estimated as 45% of the BAU projection at that date.

The following table summarises the complete list of options in each tier.

**Table 5 - GHG Emission Reductions – as ranked via MCA**

Num	Initiative	Emissions Saved (ktonnes)			% Reduction (cf BAU projected)		
		Short 2015	Med 2025	Long 2040	Short 2015	Med 2025	Long 2040
2.1	Energy efficiency awareness - industrial	267	526	978	2.0%	3.4%	5.2%
1.1	Res behavioural change (energy audits, awareness campaign)	77	148	245	0.6%	1.0%	1.3%
3.5	Improvement & Integration of Public Transport	166	301	457	1.2%	1.9%	2.4%
1.2	Retrofitting households - low cost capital projects (lighting, low flow shower head, etc)	27	52	86	0.2%	0.3%	0.5%
4.2	Carbon Sink	162	310	532	1.2%	2.0%	2.8%
1.3	Retrofitting households – med cost (insulation, & ventilation).	31	57	92	0.2%	0.4%	0.5%
3.1	Transit Oriented Development (TOD)	6	31	358	0.0%	0.2%	1.9%
3.1	Electric vehicles*	34	183	1982	0.2%	1.2%	10.4%
2.2	Retrofits in business - low cost (lighting)	30	57	102	0.2%	0.4%	0.5%
2.3	Retrofits in business - med cost (heating)	58	115	213	0.4%	0.7%	1.1%
1.4/1.5	Retrofitting households with capital projects - hot water and space heating – high cost.	112	206	330	0.8%	1.3%	1.7%
3.8	Car Parking Policy	17	30	46	0.1%	0.2%	0.2%
3.14	Pricing Reform	35	66	103	0.3%	0.4%	0.5%
3.11	Road user Charging*	174	328	515	1.3%	2.1%	2.7%
4.1	Organic Waste Management	50	95	158	0.4%	0.6%	0.8%
3.12	Congestion charging	35	66	103	0.3%	0.4%	0.5%
2.4	Business Engagement Programmes	0	0	0	0.0%	0.0%	0.0%
2.5	Green Procurement	27	53	98	0.2%	0.3%	0.5%
3.9	Cleaner fuel for buses (compressed natural gas)	4	8	12	0.0%	0.0%	0.1%
3.13	Carbon Pollution Tax	35	66	103	0.3%	0.4%	0.5%
3.2	Heavy freight logistics and spoil management	34	62	100	0.2%	0.4%	0.5%
5.2	Biogas from green waste	38	75	136	0.3%	0.5%	0.7%
3.6	Work travel plan	56	102	154	0.4%	0.7%	0.8%
3.3	Cycling Programme	42	78	125	0.3%	0.5%	0.7%

Num	Initiative	Emissions Saved (ktonnes)			% Reduction (cf BAU projected)		
		Short 2015	Med 2025	Long 2040	Short 2015	Med 2025	Long 2040
3.4	Walking programme	17	31	50	0.1%	0.2%	0.3%
5.1.	Medium Scale Wind	77	150	272	0.6%	1.0%	1.4%
3.7	School Travel Plan	10	18	27	0.1%	0.1%	0.1%
5.4	Solar photovoltaic	8	49	641	0.1%	0.3%	3.4%
5.5	Solar photovoltaic farm*	8	49	641	0.1%	0.3%	3.4%
5.6	Energy action hub	0	0	0	0.0%	0.0%	0.0%
5.3	On site wind	8	15	27	0.1%	0.1%	0.1%

The following graph summarises each scenario relative to 2006 emissions.

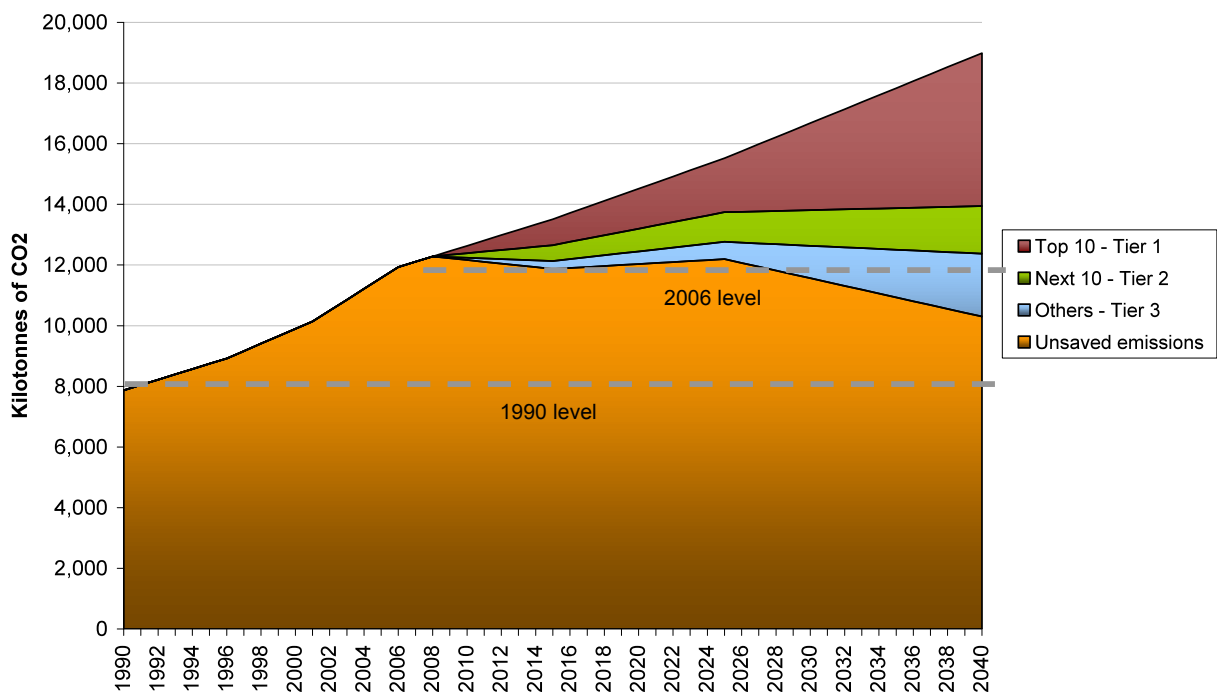


Figure 4 - Emissions Scenarios to 2040

As shown in Figure 4, the Top 10 initiatives achieve 61% of the total savings which were estimated. The second 10 achieve an additional 14% and the final 11 options achieve approx 25%. It is noted that if all 3 Tiers of options are implemented, the emissions levels are still approx 3M tonnes above 1990 levels at 2040, which equates to an increase of approximately 40%



The following table summarises the reductions achieved by each tier of options:

**Table 6 - Emissions reductions by Tier at 2040**

Tier	% increase / decrease		% of total achievable
	Cf 1990	Cf 2006	
Tier 1 (Top 10)	80% (above)	18% (above)	61%
Tier 2 (Top 20)	65% (above)	9% (above)	14%
Tier 3 (All)	40% (above)	-8% (below)	25%
			100%

Based on this summary, it would make sense to concentrate initially on these ‘Top 10’.

It is noted that 10% of this reduction is attributed to the ‘Electric Vehicle’ option. If this was removed from the list the top 10 would constitute approximately 50% of total reductions.

## 8.0 CONCLUDING REMARKS

This options evaluation went into significant detail in modelling potential emissions reductions for a range of options across all sectors of the GHG spectrum. It is important to note that all the options investigated and presented in the study were based on a vast range of assumptions and limited high-level source data available to the project team. Due to this inherent uncertainty, the modelled GHG reductions were based on what are deemed to be conservative assumptions. These assumptions and data can well be questioned and debated, which may lead to different levels of reduction being adopted.

Recommendations were made as follows:

- That the model developed for this Carbon Futures work should be used to inform discussions of appropriate groups of initiatives that might be pursued by ARC and the TLAs to reduce emissions across the Auckland Region (to this end the database model developed allows each of the initiatives to be switched on or off and assumptions to be adjusted).
- That ARC work with the TLAs in developing realistic CO<sub>2</sub> emission reduction targets for the short, medium and long term. The findings in this report will help in achieving this. It is recommended that targets for 2040 might lie between 2006 levels and 10% below 2006 levels. This involves all three ‘Tiers’ of options.
- That more detailed financial analysis be undertaken on a group of options deemed to be worthy of taking forward. This group of options will depend on the overall targets set.
- The Top 10 options were estimated to achieve approximately 60% of the total potential savings, and as such it was recommended that these be focussed on initially.

## 9.0 REFERENCES

Intergovernmental Panel on Climate Change (2006), *Guidelines for National Greenhouse Gas Inventories (2006 Guidelines)*

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