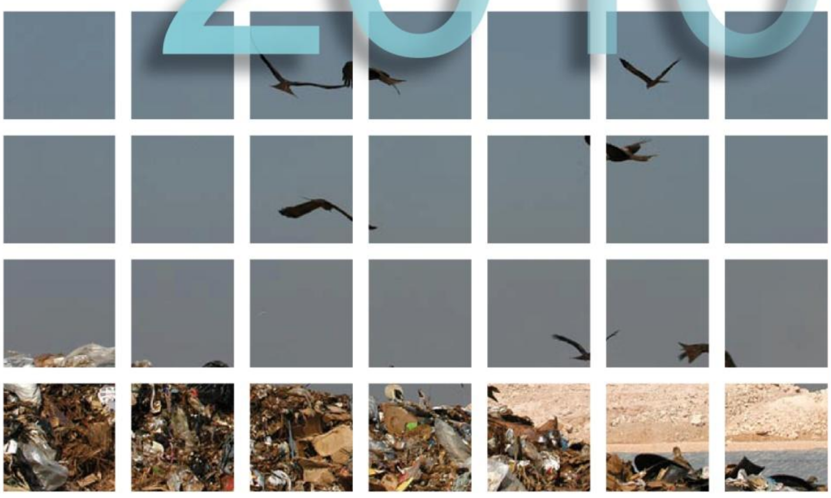
Australian Government
Department of Climate Change and Energy Efficiency

Waste

emissions projections

2010



Published by the Department of Climate Change and Energy Efficiency

ISBN: 978-1-921299-27-8

An appropriate citation for this report is:
Department of Climate Change and Energy Efficiency 2010, Waste: emissions projections (2010), DCCEE, Canberra, ACT.

This document is available on the Internet at the following address:
http://www.climatechange.gov.au
Suggestions and comments would be appreciated. They should be addressed to:
Projections Team Director
Department of Climate Change and Energy Efficiency
GPO Box 854
Canberra ACT 2601

December 2010

Australian Government

Department of Climate Change and Energy Efficiency

Waste

emissions projections

Executive Summary

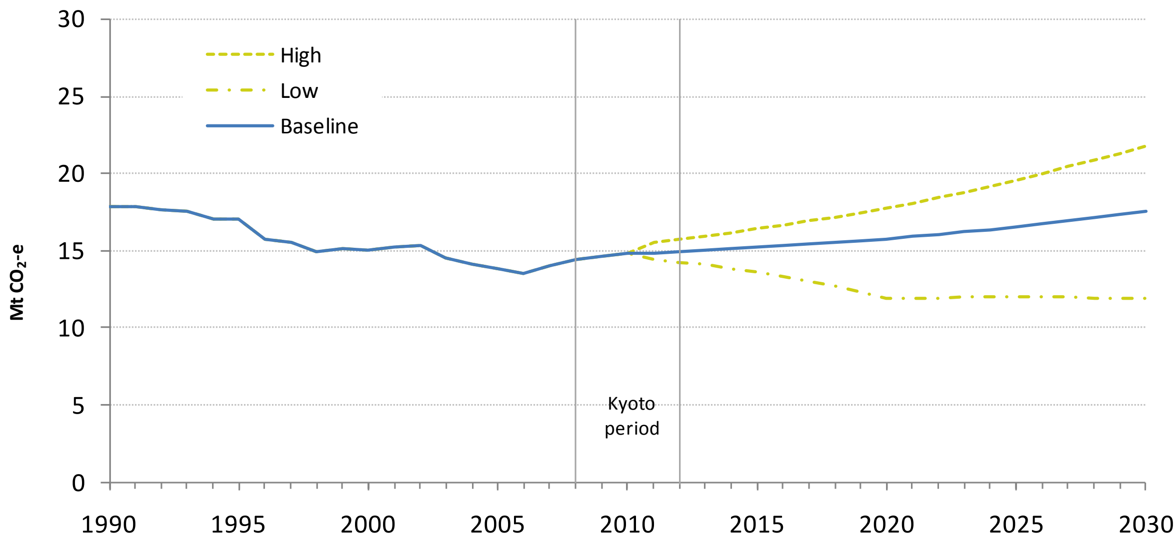
Key Points

- Waste sector emissions accounted for 3 per cent of Australia's total domestic emissions in 2009 at 15 Mt CO_2-e.
- Baseline waste emissions are projected to average 15 Mt CO_2-e per year in the Kyoto period, 21 per cent below 1990 levels. In 2020, waste emissions are projected to be 16 Mt CO_2-e, 5 per cent higher than in 2000.
- Solid waste emissions account for the largest proportion of emissions in this sector, averaging 11 Mt CO_2-e per year over the Kyoto period and 12 Mt CO_2-e in 2020. Emissions from wastewater are expected to average 3.4 Mt CO_2-e per year over the Kyoto period and 4.0 Mt CO_2-e in 2020.
- Indicative modelling suggests waste emissions will reach 18 Mt CO_2-e in 2030.

Baseline projection

- Waste emissions are projected to average 15 Mt CO_2-e per year in the Kyoto period (2008-2012), 21 per cent below 1990 levels[1]. This decrease is due to a decline in waste emissions between 1990 and 2006 was driven by improved waste diversion and methane recovery.

Figure 1 Baseline waste emissions trends, 1990 to 2030



Source: Hyder (2007), DCCEE analysis.

[1] All years in this publication are Australian financial years, ending on the 30 June of the year quoted.

Table 1 Baseline waste emissions, Kyoto period average and 2020

	1990	2000	Kyoto period average 2008-12		2020	
	Mt CO_2-e	Mt CO_2-e	Mt CO_2-e	Increase on 1990 (%)	Mt CO_2-e	Increase on 2000 (%)
Solid waste disposal on land	15	12	11	-24	12	-1
Wastewater	3.8	3.1	3.4	-11	4.0	28
Total	**19**	**15**	**15**	**-21**	**16**	**5**

Note: Totals may not add due to rounding. These 1990 emissions are consistent with Australia's assigned amount for the Kyoto Protocol, which differ to the latest National Greenhouse Gas Inventory (June Quarter 2010).
Source: Hyder (2007), DCCEE analysis.

- Since 2007 emissions from the waste sector have been increasing due to population growth. This trend is expected to continue with waste emissions growing on average 0.7 per cent per year between 2009 and 2020 to be reach 16 Mt CO_2-e in 2020.

Business-as-usual projection

- The business-as-usual projection indicates that without existing policies and measures, waste emission would still average 15 Mt CO_2-e per year in the Kyoto period and 16 Mt CO_2-e in 2020.

Impact of measures

- Greenhouse Friendly is the only measure for which an abatement estimate of waste sector emissions is currently possible. The abatement from Greenhouse Friendly in the waste sector is estimated to be on average 0.7 Mt CO_2-e per year in the Kyoto period and 0.7 Mt CO_2-e in 2020. Emissions abatement from Greenhouse Friendly also occurs in other sectors.

- The abatement from projects that generate electricity from landfill gas under the New South Wales Greenhouse Gas Abatement Scheme (GGAS) and the Renewable Energy Target (RET) has been included in the stationary energy sector.

- The Government has committed to implement the Carbon Farming Initiative (CFI), which provides a mechanism for crediting abatement that occurs in the land sector. The Carbon Farming Initiative is proposed to provide incentives for activities to avoid emissions from landfill waste deposited before July 1 2011. Future projection updates for waste will take into account progress in development of methodologies and any initial indications of project activity in response to the Carbon Farming Initiative.

Changes from 2009 projection

- These waste emission projections are a minor update of the 2009 projections released in *Australia's Fifth National Communication on Climate Change* to the UNFCCC.
- The 2010 waste emission projection is 0.3 Mt CO_2-e higher in 2020 than the 2009 projections. This difference is the result of a 0.6 Mt CO_2-e increase in solid waste emissions and a 0.3 Mt CO_2-e decrease in wastewater emissions.
- These changes result from downward revisions to historical emissions in the National Greenhouse Gas Inventory (NGGI) due to methodology changes and an upward revision of the population forecast.

Contents

Figures

Tables

Introduction

This paper presents projections of greenhouse gas emissions from the Australian waste sector and forms part of the 2010 emissions projections update.

The 2010 waste sector projection is a partial update of the 2009 waste projections. Revisions to historical emissions in the National Greenhouse Gas Inventory (NGGI) and new population forecasts have been incorporated. Indicative projections of waste emissions out to 2030 have also been provided[2].

Table 2 Projections scenarios

Scenario	Description
Business-as-usual (BAU)	Emissions in the absence of Government abatement policies and measures
Baseline	Emissions given current policy settings
High/ low	Sensitivity scenarios around the baseline – determined by modifying key assumptions such as economic growth rates

Two projections scenarios are provided, a baseline and business-as-usual (BAU). High and low sensitivity scenarios are also provided to indicate the level of uncertainty around key assumptions. The baseline projections have been developed on the basis of current policies in place and do not include the impact of a carbon price.

Coverage of the sector

Emissions from the waste sector arise from the following main sources:

- solid waste disposal of organic materials to landfill;
- wastewater emissions including domestic, commercial and industrial wastewater; and
- incineration of wastes.

Waste emissions are predominantly methane (CH_4). This is generated from the anaerobic decomposition of organic matter. Nitrous oxide (NO_x) compounds are also generated through the decomposition of human wastes. Carbon dioxide (CO_2) emissions from the decay or combustion of organic waste are not counted in the National Greenhouse Gas Inventory (NGGI) or projections since they are considered to be part of the natural carbon cycle.

Small amounts of carbon dioxide are generated through the incineration of solvents and clinical waste and are included in the NGGI. Emissions from waste incineration only account

[2] All years in this publication are Australian financial years, ending on the 30 June of the year quoted.

for 0.2 per cent of waste emissions in 2009. Consequently waste incineration emissions were assumed to be negligible during the projection period.

Recent trends – National Greenhouse Gas Inventory

The latest National Greenhouse Gas Inventory (June quarter 2010) estimates total waste sector emissions for 2009 at 15 Mt CO_2-e, accounting for around 3 per cent of Australia's total emissions. More than three quarters of the emissions in this sector were from solid waste disposed on land (11 Mt CO_2-e) and almost a quarter were from wastewater (3.4 Mt CO_2-e). Waste incineration only accounted for 0.2 per cent (0.03 Mt CO_2-e).

Between 1990 and 2006 waste emissions decreased by 4.4 Mt CO_2-e. The majority of this decrease was in solid waste emissions (3.8 Mt CO_2-e), which declined at an average rate of 1.9 per cent per year[3]. This decrease in emissions was due to improvements in waste diversion (in particular paper recycling) and growth in methane capture. During this period industrial wastewater emissions also decreased by 1.0 Mt CO_2-e, at an average rate of 4.8 per cent per year. This rapid decline in emissions was due to a decrease in the wastewater generated by industrial manufacturing processes (e.g. wastewater generated from beer production almost halved between 2000 and 2005). In contrast domestic and commercial wastewater emissions increased 0.5 Mt CO_2-e, at an average rate of 1.7 per cent per year. This increase can be attributed to increased population and lower rates of methane recovery.

Between 2006 and 2009 waste emissions increased. Industrial wastewater emissions rose at the fastest rate during this period at an average 4.3 per cent per year. Solid waste grew at 2.7 per cent per year and commercial and domestic wastewater grew at 2.3 per cent per year. This increase in emissions is a result of strong population growth outweighing improvements in methane recovery and waste diversion.

[3] These 1990 levels are consistent with the latest National Greenhouse Gas Inventory (June quarter 2010), which differ to Australia's assigned amount for the Kyoto Protocol.

Projections results

Waste sector emissions are projected to average 15 Mt CO_2-e per year in the Kyoto period, 21 per cent below 1990 levels. This decline reflects the fact that potential emissions from increased waste generation have been reduced by waste diversion and methane recovery initiatives.

Table 3 Baseline waste emissions, Kyoto period average and 2020

	1990	2000	Kyoto period average 2008-12		2020	
	Mt CO_2-e	Mt CO_2-e	Mt CO_2-e	Increase on 1990 (%)	Mt CO_2-e	Increase on 2000 (%)
Solid waste disposal on land	15	12	11	-24	12	-1
Wastewater	3.8	3.1	3.4	-11	4.0	28
Total	**19**	**15**	**15**	**-21**	**16**	**5**

Note: Totals may not add due to rounding. These 1990 emissions are consistent with Australia's assigned amount for the Kyoto Protocol, which differ to the latest National Greenhouse Gas Inventory (June Quarter 2010).
Source: Hyder (2007), DCCEE analysis.

Waste emissions are projected to increase by 8 per cent between 2009 and 2020 to reach 16 Mt CO_2-e. This growth is due to increased waste generation which is primarily driven by population growth. Indicative modelling suggests that baseline emissions will reach 18 Mt CO_2-e in 2030.

Table 4 Baseline waste emissions, 1990 to 2030, Mt CO_2-e

	1990	2009	KPA	2020	2030
Solid waste disposal on land	15	11	11	12	13
Wastewater	3.8	3.4	3.4	4.0	4.6
Total	**19**	**15**	**15**	**16**	**18**

Note: Totals may not add due to rounding. These 1990 emissions are consistent with Australia's assigned amount for the Kyoto Protocol, which differ to the latest National Greenhouse Gas Inventory (June Quarter 2010).
Source: Hyder (2007), DCCEE analysis.

The baseline projections do not include the effect of the National Waste Policy, as this is still under development. It is likely that this policy will impact future waste emissions. The policy is composed of 16 strategies that cover a broad range of waste issues.

The strategies that may influence waste emissions are the:

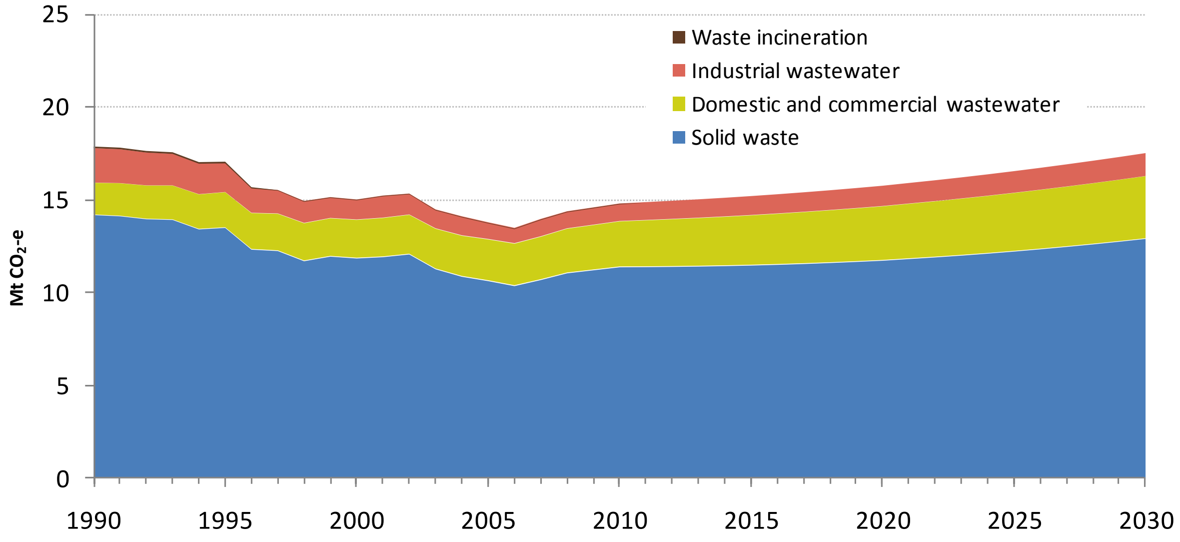
- continued government focus to reduce the amount of biodegradable material sent to landfill;

- strategy for emissions from landfills and other waste activities not covered by the operation of a future emissions trading scheme or carbon price; and
- improvements in waste avoidance and re-use of materials in the commercial and industrial waste stream.

Trends in the waste sector projections

Over the period to 2020, waste emissions are projected to continue to grow. This growth is due to increased waste generation from population growth. The magnitude of this growth is somewhat suppressed by increased methane capture at landfills.

Figure 2 Baseline waste emissions trends, 1990 to 2030

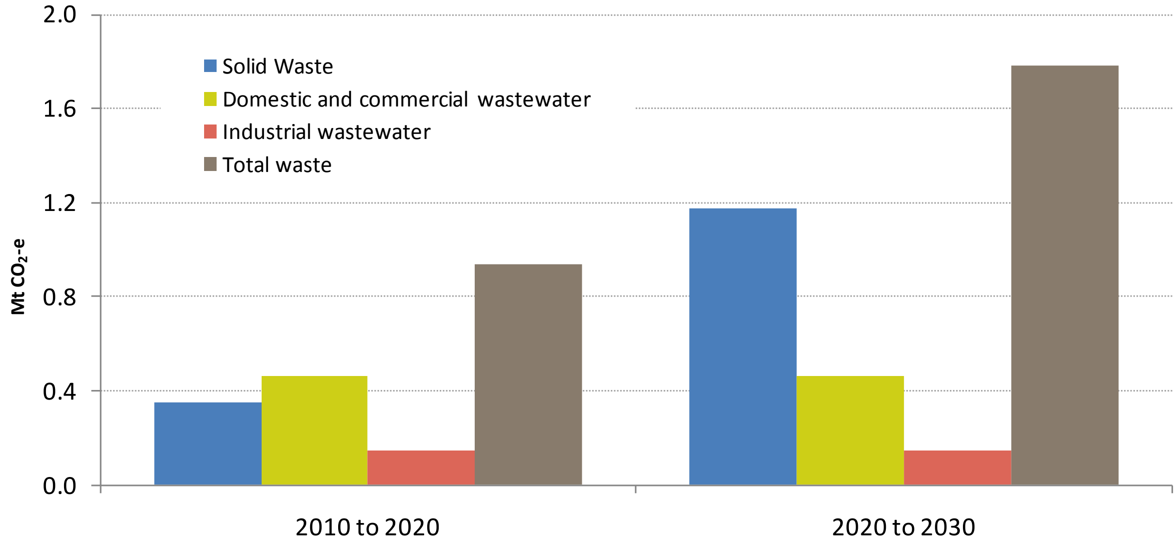


Source: Hyder (2007), DCCEE analysis.

Between 2010 and 2020 waste emissions are projected to grow 0.9 Mt CO_2-e. Despite being a smaller contributor to waste emissions than solid waste, domestic and commercial wastewater was the largest contributor to growth in waste emissions between 2010 and 2020, accounting for 0.5 Mt CO_2-e of the growth. This is due to the strong growth in emissions from this subsector of on average 1.8 per cent per year. This strong growth is the result of population growth and no projected improvements in methane capture in wastewater from current levels. For similar reasons industrial wastewater is projected to grow on average 1.4 per cent per year between 2010 and 2020. Solid waste emissions are only projected to grow on average 0.3 per cent per year, due to improving methane capture at landfills.

Between 2020 and 2030, population growth combined with lower projected improvements in methane recovery at landfills, results in emissions from solid waste increasing on average 1.0 per cent per year (compared with 0.3 per cent per year in the previous decade). Domestic and commercial wastewater emissions are projected to grow at 1.5 per cent per year and industrial wastewater emissions are projected to grow at 1.2 per cent per year during this period.

Figure 3 Growth in waste emissions, 2010 to 2030



Source: Hyder (2007), DCCEE analysis.

Main drivers of sectoral emissions

The key driver of greenhouse gas emissions from the solid waste subsector is the amount of waste deposited at landfills. This in turn is a function of population, gross domestic product (GDP), and the type of landfill where this waste is deposited (i.e. whether recycling facilities are available). Emissions from landfills are reduced by two types of measures:

1. The diversion of solid waste, which covers reduced waste generated through cleaner production, recycling, composting organic material and diverting waste for energy production; and

2. The capture of methane released from landfill, which includes both flaring of emissions and generating electricity from landfill gas.

The key drivers of greenhouse gas emissions from the wastewater subsector are population growth and GDP growth rates. Emissions from wastewater are reduced by methane capture from treatment plants and improved sewerage connectivity.

Business-as-usual scenario and measures estimates

The business-as-usual projection indicates that without existing policies and measures, waste emission would have averaged 15 Mt CO_2-e per year in the Kyoto period and 16 Mt CO_2-e in 2020.

Greenhouse Friendly is the only measure in the waste sector for which an abatement estimate is currently possible. The abatement from Greenhouse Friendly is estimated to be on average 0.7 Mt CO_2-e per year in the Kyoto period and 0.7 Mt CO_2-e in 2020.

Projects that generate electricity from landfill gas are covered by the New South Wales Greenhouse Gas Abatement Scheme (GGAS) and the Renewable Energy Target (RET). The abatement from these projects is included in the stationary energy sector.

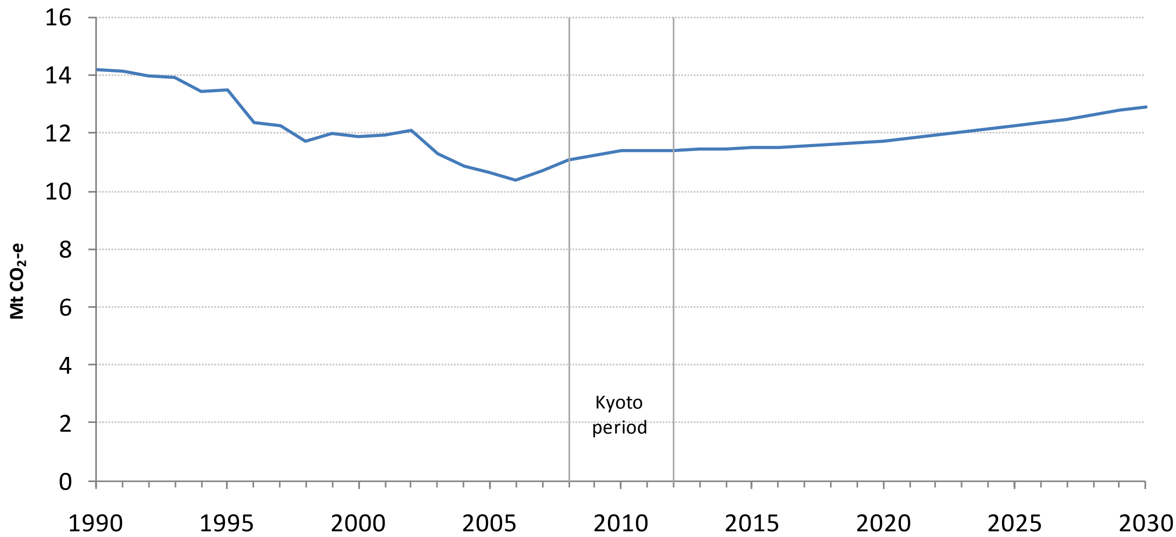
The Government has committed to implement the Carbon Farming Initiative (CFI), which provides a mechanism for crediting abatement that occurs in the land sector. The Carbon Farming Initiative is proposed to provide incentives for activities to avoid emissions from landfill waste deposited before July 1 2011. Future projection updates for waste will take into account progress in development of methodologies and any initial indications of project activity in response to the Carbon Farming Initiative.

Solid waste

Between 1990 and 2006 solid waste emissions decreased at an average 1.9 per cent per year. This was a result of waste diversion and methane recovery initiatives more than offsetting increased waste generation due to population growth and increased per capita waste generation.

Between 2007 and 2010 emissions from solid waste have been increasing. Solid waste emissions are projected to average 11 Mt CO_2-e per year in the Kyoto period and grow to 12 Mt CO_2-e in 2020. This growth results from the amount of waste sent to landfill growing faster than waste diversion and methane recovery rates.

Figure 4 Solid waste emissions, 1990 to 2030



Source: Hyder (2007), DCCEE analysis.

Solid waste emissions are projected using estimates of the future amount of waste sent to landfill and rates of methane capture. The current composition of waste is expected to remain constant into the future.

Waste to landfill

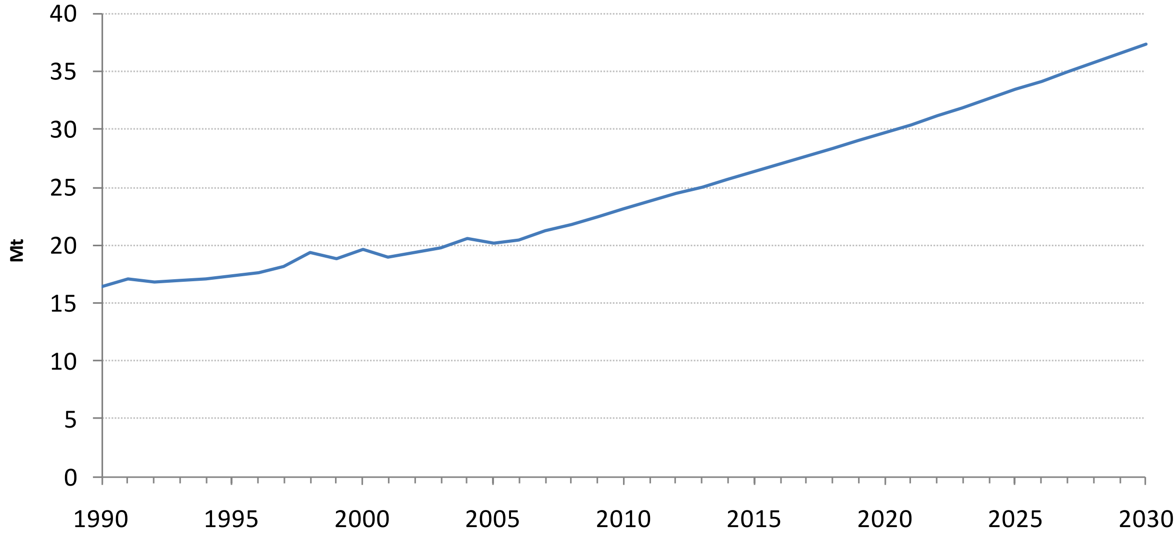
The amount of waste sent to landfill per person is estimated to grow at 1 per cent per year. This effectively assumes that the current waste diversion rates will remain constant throughout the projection period[4].

The scope for increases in diversion rates vary greatly between waste types. For example, paper has historically experienced significant improvements in recycling. From 1990 to 2009

4 Waste diversion rates estimated for 2007 based on Hyder (2008) and NGGI.

paper to landfill decreased by 44 per cent despite population growth. Currently, 70 percent of paper waste is diverted in Australia, implying that further improvements in diversion are limited. In contrast only around 2 per cent of food waste is currently diverted in Australia.

Figure 5 Waste to landfill, 1990 to 2030



Source: DCCEE analysis.

Future rates of waste diversion will depend on policies like the National Waste Policy. Without further improvement in waste diversion rates, emissions are projected to increase slowly to 2020.

Methane recovery

Methane can be captured at landfill sites and either flared or used to generate electricity. Methane recovery occurs for a variety of reasons, including:

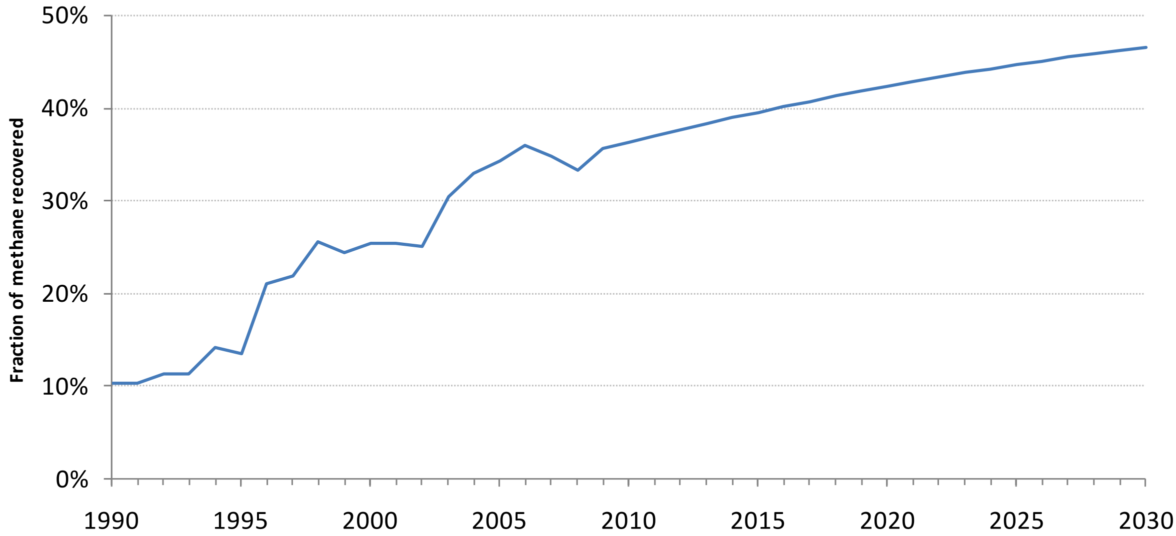
- reducing the smell associated with landfill sites;
- generating electricity for onsite or offsite use; and
- safety.

Combusting methane reduces its global warming potential to that of CO_2. When the methane is used to generate heat and/or electricity it also displaces electricity from the grid. There are several constraints to the viability of methane capture that inhibit the current take up rate. The main constraint is the size of the landfill, with shape, age and stream mix also important in estimating the methane generation potential.

Methane capture rates grew strongly between 2000 and 2010 due to high take up rates of power generation from landfill gas and the introduction of large bioreactors.

Methane recovery rates are projected to increase into the future. This assumes the continuation of historical methane capture trends. Hyder (2007) used a logarithmic regression to extrapolate historical state specific methane recovery rate time series to 2020. This was further extrapolated by DCCEE to 2030.

Figure 6 Solid waste methane recovery rates, 1990 to 2030

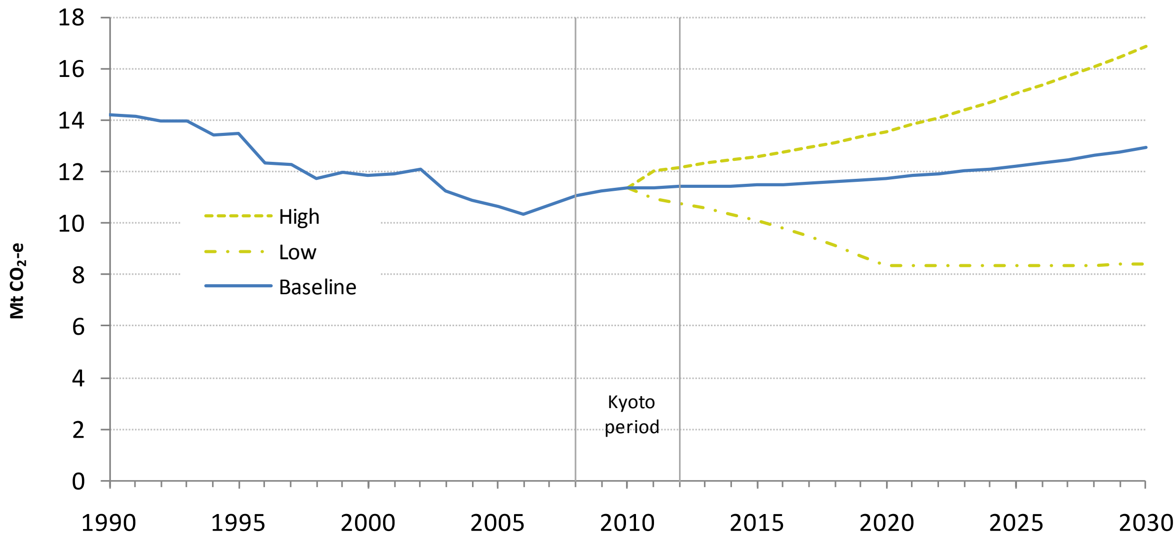


Source: Hyder (2007), DCCEE analysis

Key uncertainties and sensitivity analysis

The key uncertainties for the solid waste projections are the waste to landfill and methane recovery rates. The amount of waste sent to landfill is determined by the future population, amount of waste generated per person and waste diversion rates. Sensitivity analyses were performed on population growth, waste to landfill per person and methane capture rates to understand the bounds of this uncertainty.

Figure 7 Solid waste sensitivities



Source: Hyder (2007), DCCEE analysis.

Solid waste emissions were found to be most sensitive to the uncertainty surrounding the methane capture rates. These rates were based on work conducted by Hyder for the Department of the Environment and Water Resources in 2007. In the baseline, 36 per cent of the methane generated from landfills in Australia is captured in 2020. Using Hyder's high state-specific methane capture rate this increases to 56 per cent in the high methane capture rate scenario and decreased to 35 per cent in the low scenario.

The second most influential variable was the per capita waste sent to landfill. The baseline projections were based on conservative assumptions of new future improvements in waste diversion levels and continued growth in per capita waste generation. It is possible that waste generation per capita could be higher than projected. However, it is more likely there will be future improvements in waste diversion rates which will decrease per capita waste to landfill and hence solid waste emissions.

Table 5 Solid waste sensitivity scenarios

	Deviation	2020		2030	
		Difference, Mt CO_2-e	Change on baseline (%)	Difference, Mt CO_2-e	Change on baseline (%)
High population growth	+ 0.1 percentage points	0.0	0.3	0.1	1.1
Low population growth	- 0.1 percentage points	0.0	-0.3	-0.1	-1.1
High growth in waste to landfill per capita	1.5 per cent per year	0.2	1.8	0.7	5.6
Low growth in waste to landfill per capita	- 1 per cent per year	-0.7	-6.4	-2.3	-18
Low methane capture rate	High Hyder (2007) scenario	1.5	13	2.9	22
High methane capture rate	Low Hyder (2007) scenario	-2.8	-24	-2.6	-20
Overall high scenario		1.8	15	3.9	31
Overall low Scenario		-3.4	-29	-4.5	-35

Note: The impacts of each sensitivity scenario do not add to give the overall high and low scenarios. Source: Hyder (2007), DCCEE analysis.

The uncertainty surrounding future population growth was found to have a smaller impact on solid waste emissions than the other key parameters. This is primarily because a smaller deviation was used in the sensitivity analysis for population growth compared to the other parameters. This reflects the lower level of uncertainty surrounding this variable. For example, it is plausible for future diversion rates to be significantly higher than current levels.

Overall high and low scenarios were also constructed to reflect the overall uncertainty in the solid waste emission projections. The overall high scenario incorporated all the deviations in the key parameters that increased waste emissions: high population growth, high growth in waste to landfill per capita and low methane capture rates. The overall low scenario incorporated the deviations in parameters that increased waste emissions: low population growth, low growth in waste to landfill per capita and high methane capture rates.

Wastewater

Wastewater emissions are expected to average 3.4 Mt CO_2-e per year over the Kyoto period and 4.0 Mt CO_2-e in 2020. Emissions from domestic and commercial sewage contributed 72 per cent of wastewater emissions in 2009 and industrial wastewater contributed 28 per cent. All sources of wastewater emissions are projected to grow over the projection period.

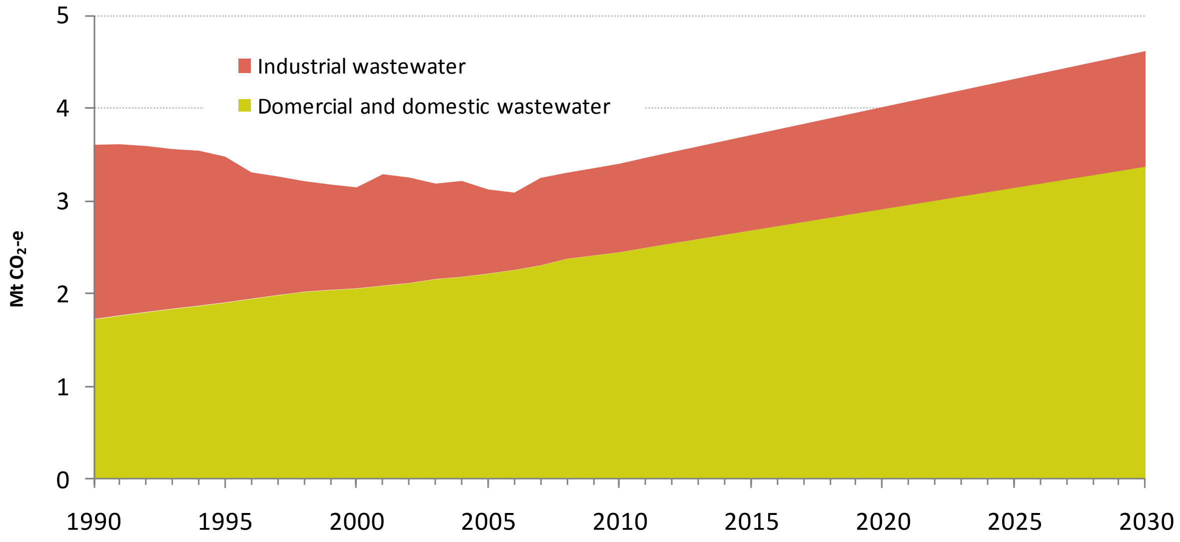
Table 6 Wastewater emissions, Mt CO_2-e

	1990	2009	KPA	2020	2030
Commercial and domestic wastewater	1.9	2.4	2.5	2.9	3.4
Industrial wastewater	1.9	0.9	1.0	1.1	1.3
Total	**3.8**	**3.4**	**3.4**	**4.0**	**4.6**

Note: Totals may not add due to rounding. These 1990 emissions are consistent with Australia's assigned amount for the Kyoto Protocol, which differ to the latest National Greenhouse Gas Inventory (June Quarter 2010).
Source: Hyder (2007), DCCEE analysis.

Commercial and domestic wastewater emissions are projected to grow on average 1.8 per cent per year between 2010 and 2020 and 1.5 per cent per year between 2020 and 2030. This trend is similar to the historical growth of 1.8 per cent per year between 1990 and 2009[5].

Figure 8 Wastewater emissions, 1990 to 2030



Source: NGGI (2010), DCCEE analysis.

[5] These 1990 levels are consistent with the latest National Greenhouse Gas Inventory (June quarter 2010), which differ to Australia's assigned amount for the Kyoto Protocol.

Industrial wastewater emissions are projected to grow on average 1.4 per cent per year between 2010 and 2020 and 1.2 per cent per year between 2020 and 2030. This trend differs to the decline of on average 4.8 per cent per year in industrial waste emissions observed before 2006, due to improvements in industrial processes to minimise wastewater generation. However, this projected growth is consistent with the recent growth in emissions of 3.6 per cent per year observed since 2006. This recent growth suggests that opportunities to minimise industrial wastewater may be close to fully utilised.

Commercial and domestic wastewater emissions are projected based on population growth. As this projection is only a minor update and no new information is available about future wastewater trends is available, the proportion of population serviced by a sewer, biological oxygen demand, the proportion of waste treated anaerobically and methane capture rates are assumed to remain at the 2008 levels throughout the projection period.

Industrial wastewater emissions are also projected based on population growth. The projected wastewater generation rate per unit of production, chemical oxygen demand (COD) generation rate, fraction of COD anaerobically treated, and the fraction of methane recovery for each industry are assumed to remain at the 2008 levels.

Key uncertainties and sensitivity analysis

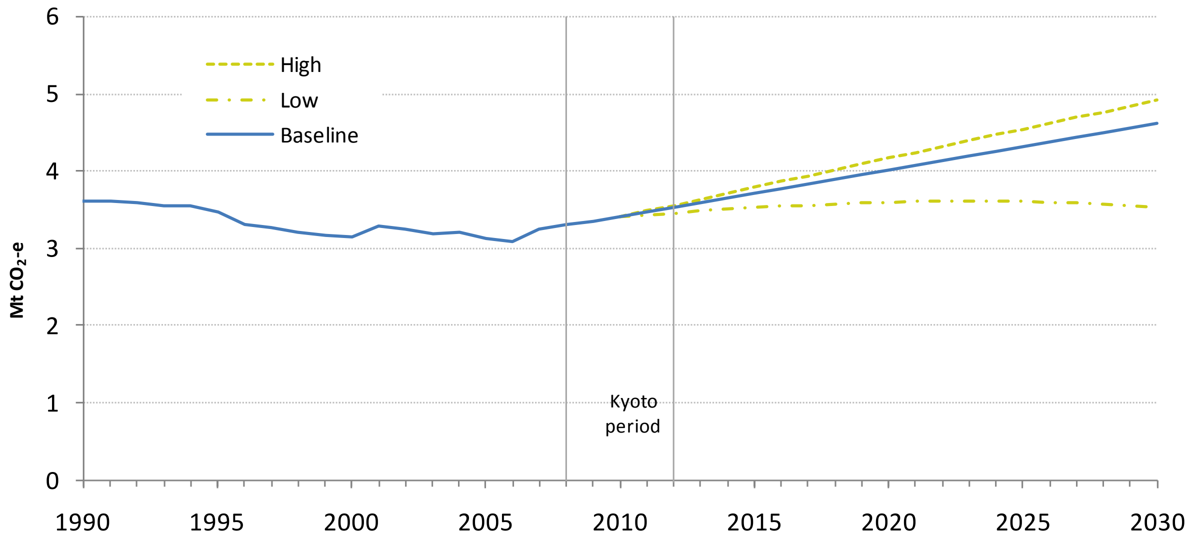
The key uncertainty for commercial and domestic wastewater emissions is population growth and future methane recovery rates.

They key uncertainties for industrial wastewater emissions are both future wastewater production, which is related to population growth and improvements in methane capture rates. Historically, growth rates in industrial wastewater have been highly variable, as both the wastewater generation and methane capture from various industries is highly influenced by specific large projects.

Sensitivity analyses were performed to understand the impact of the uncertainty surrounding population growth and methane recovery rates on wastewater emissions.

The uncertainty surrounding methane recovery rates had a larger impact on emissions than the uncertainty surrounding population growth. This reflects the higher level of uncertainty surrounding future methane recovery rates. The baseline projections were based on the conservative assumption that methane capture rates will remain at current levels throughout the projection period. In the sensitivity analysis a larger deviation was applied to the high methane capture rate scenario than the low capture scenario. This is because it is likely that methane capture could continue to improve over time and less likely for methane capture rates to decrease.

Figure 9 Wastewater high and low scenarios



Source: NGGI (2010), DCCEE analysis.

Overall high and low scenarios were also constructed to reflect the overall uncertainty in the wastewater emission projections. These results reflect the possibility of higher methane capture rates in the future and hence lower wastewater emissions.

Table 7 Wastewater sensitivity scenarios

	Deviation	2020		2030	
		Difference, Mt CO_2-e	Change on baseline (%)	Difference, Mt CO_2-e	Change on baseline (%)
High population growth	+ 0.1 percentage points	0.0	1.0	0.1	2.0
Low population growth	- 0.1 percentage points	0.0	-1.0	-0.1	-2.0
High methane capture rate	5 per cent higher	-0.4	-9	-1.0	-22
Low methane capture rate	2 per cent lower	0.1	3	0.2	4
Overall high scenario		0.2	4	0.3	6
Overall low Scenario		-0.4	-10	-1.1	-24

Note: Totals may not add due to rounding. Source: DCCEE analysis.

Appendix A – Measures

Table 8 Greenhouse gas abatement from waste measures

Name	Kyoto period average ($Mt\ CO_2$-e)	2020 ($Mt\ CO_2$-e)
Greenhouse Friendly	0.7	0.7
Total	**0.7**	**0.7**

Greenhouse Friendly

The Greenhouse Friendly program certified carbon-neutral products and services and approved abatement credits for sale on the voluntary market.

Renewable Energy Target

The Renewable Energy Target (RET) scheme is designed to ensure that 20 per cent of Australia's electricity supply will come from renewable sources by 2020. The RET scheme has been separated into two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). Wholesale purchasers of electricity have a legal liability to proportionally contribute to the targets by surrendering renewable energy certificates (RECs). Electricity generation from landfill gas is eligible to generate RECs under the RET.

Waste sector emissions abatement from this program has been included in the stationary energy sector.

NSW Greenhouse Gas Reduction Scheme

The NSW Greenhouse Gas Reduction Scheme (GGAS) commenced on 1 January 2003. It is a mandatory greenhouse gas emissions trading scheme that aims to reduce greenhouse gas emissions associated with the production and use of electricity. Electricity generation from landfill gas is eligible under this scheme.

Waste sector emissions abatement from this program has been included in the stationary energy sector.

Carbon Farming Initiative

The Government has committed to implement the Carbon Farming Initiative (CFI), which provides a mechanism for crediting abatement that occurs in the land sector.

The Carbon Farming Initiative is proposed to provide incentives for activities to avoid emissions from landfill waste deposited before July 1 2011. Future projection updates for waste will take into account progress in development of methodologies and any initial indications of project activity in response to the Carbon Farming Initiative.

Appendix B – Changes from 2009 projection

These waste emission projections are a minor update of the 2009 projections released in Australia's Fifth National Communication on Climate Change to the UNFCCC.

The 2010 waste emission projection is 0.3 Mt CO_2-e higher in 2020 than the 2009 projections. This difference is the result of a 0.6 Mt CO_2-e increase in solid waste emissions and a 0.3 Mt CO_2-e decrease in wastewater emissions.

These changes result from downward revisions to historical emissions in the National Greenhouse Gas Inventory (NGGI) due to methodology changes and an upward revision of the population forecast.

Table 9 Changes from 2009 projections

	Kyoto period average 2008-12	**2020**
	Mt CO_2-e	Mt CO_2-e
Solid Waste	0.2	0.6
Wastewater	-0.2	-0.3
Total	**-0.1**	**0.3**

Source: DCCEE (2010), DCCEE analysis.

Appendix C – Methodology

This projection was prepared by DCCEE using an in-house waste model which is consistent with the methodology used for the National Greenhouse Gas Inventory (NGGI).

Waste to landfill is projected using population forecasts and estimated future per capita waste to landfill rates. Landfill waste decays and emits methane over several decades, so methane emissions generated in one year depend on the waste that has been sent to landfill over many preceding years. A state-by-state carbon stock model, with data starting in 1940, is used to stimate NGGI emissions and this is adopted in the projections. This model also incorporates estimated landfill methane recovery rates to calculate net emissions.

Wastewater emissions consist of emissions from domestic and commercial sewage and industrial wastewater. Industrial wastewater emissions are projected on a national basis based on projected population growth, the projected wastewater generation rate, chemical oxygen demand (COD) generation rate, fraction of COD anaerobically treated, and the fraction of methane recovery for each industry. Commercial and domestic emissions are projected at the individual states level based on projected population growth, the proportion of population serviced by a sewer, biological oxygen demand, the proportion of waste treated anaerobically, and methane capture rates.

Appendix D – Key Assumptions

The key driver of waste emissions is population. Population numbers consistent with the *Pre-Election Economic and Fiscal Outlook (PEFO) 2010* and *Intergenerational Report (IGR) 2010* were used.

Table 10 Population assumptions

	2010 to 2020	2020 to 2030
Population (average annual percentage growth)	1.4	1.3

Source: PEFO(2010), IGR (2010)

Solid waste

The state specific waste to landfill per person was assumed to grow at 1 per cent per year over the projection period from the 2008 levels. The state-specific waste compositions were assumed to remain constant at the 2008 levels.

State specific methane recovery rates from Hyder (2007) were used for the projections and extrapolated by DCCEE out to 2030.

Table 11 Waste composition assumptions, mass fraction, per cent

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Food	29.6	22.0	23.1	23.1	18.1	32.6	21.3	13.1
Paper	6.1	4.8	4.9	4.9	3.9	6.3	4.5	3.3
Garden	10.2	8.0	9.1	9.1	8.1	12.7	8.9	5.8
Wood	4.5	4.9	4.4	4.4	4.5	3.7	4.4	5.3
Textiles	3.4	2.6	2.4	2.4	1.6	3.1	2.1	1.5
Sludge	0.9	0.7	0.6	0.6	0.3	0.7	0.5	0.4
Nappies	1.9	1.3	1.7	1.7	1.5	2.6	1.7	0.9
Rubber and leather	2.4	1.8	1.6	1.6	1.0	1.9	1.3	1.0
Other	40.1	53.2	51.7	51.7	60.6	40.0	55.0	68.5
Wood waste	0.9	0.7	0.5	0.5	0.3	0.6	0.4	0.4

Source: DCCEE analysis

Table 12 Fraction of methane recovered, per cent

	1990	2009	2020	2030
ACT	0	59	62	62
NSW	0	26	35	42
NT	0	33	37	37
QLD	0	25	34	41
SA	4	42	43	43
TAS	0	24	27	28
VIC	0	28	36	40
WA	0	35	39	39

Source: NGGI (2010), DCCEE analysis.

Wastewater

For commercial and domestic wastewater emissions, wastewater generated per person, the proportion of population serviced by a sewer, biological oxygen demand, the proportion of waste treated anaerobically, and methane capture rates were assumed to remain constant at 2008 levels.

For industrial wastewater emissions, industrial wastewater from all industries was assumed to grow proportionally with population. While, chemical oxygen demand (COD) generation rate, fraction of COD anaerobically treated, and the fraction of methane recovery for each industry were assumed to remain constant at 2008 levels throughout the projection period.

Appendix E – References

Australian Bureau of Statistics 2008, *Australian Historical Population Statistics (cat. no. 3105.0.65.001),* available online at www.abs.gov.au.

Australian Government 2010, *Australia's Fifth National Communication on Climate Change*: A report under the United Nations Framework Convention on Climate Change, Department of Climate Change, Canberra.

Australian Government 2010, *Australian National Greenhouse Accounts: Quarterly Update of Australia's National Greenhouse Gas Inventory June Quarter 2010*, Department of Climate Change and Energy Efficiency, Canberra.

Australian Government 2010, *Intergenerational Report 2010*: Australia to 2050: future challenges, The Treasury, Canberra.

Australian Government 2010, *Pre-Election Economic and Fiscal Outlook 2010*: A report by the Secretary to the Treasury and the Secretary to the Department of Finance and Deregulation, The Treasury and Department of Finance and Deregulation, Canberra.

Hyder Consulting 2007, *Review of Methane Recovery and Flaring from Landfills*, Unpublished report to the Australian Government Department of the Environment and Water Resources.

Appendix F – Glossary

Abatement	Refers to emissions reductions made beyond that which would have been achieved in the business as usual scenario.
Baseline	Emissions given current policy settings.
Business as usual (BAU)	Emissions in the absence of Government abatement policies and measures.
COD	Chemical oxygen demand
GDP	Gross domestic product
High scenario	A ‘high emissions’ scenario applying plausible high emission assumptions to the ‘baseline’ scenario.
IGR	Intergeneration Report
Incineration subsector	Includes emissions resulting from the incineration of solvents and clinical waste.
Kyoto period average (KPA)	The Kyoto period average refers to the average of emissions over the 5 year Kyoto Protocol reporting period, 2008-2012.
Low scenario	A ‘low emissions’ scenario applying plausible low emission assumptions to the ‘baseline scenario.
Measures	Refers to past, current or committed Australian, State/Territory or local government policy actions that have an impact on greenhouse gas emissions, causing them to deviate from the BAU path after the base year of 1990.
Methane recovery	Includes both flaring methane and generating electricity from methane.
Mt CO_2-e	Megatonnes of carbon dioxide equivalent
PEFO	Pre-Election Economic and Fiscal Outlook
Solid waste subsector	Includes emissions resulting from anaerobic decomposition of organic matter in landfills.
Waste diversion	Refers to the diversion of solid waste, which covers reduced waste generated through cleaner production, recycling, composting organic material and diverting waste for energy production.
Wastewater subsector	Includes emissions resulting from anaerobic decomposition of organic matter in sewerage facilities (including on-site systems such as septic tanks) during treatment and disposal of wastewater.