



**Australian Government**  
**Department of Climate Change  
and Energy Efficiency**

# Industrial processes

emissions  
projections

# 2010



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December 2010



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## Executive Summary

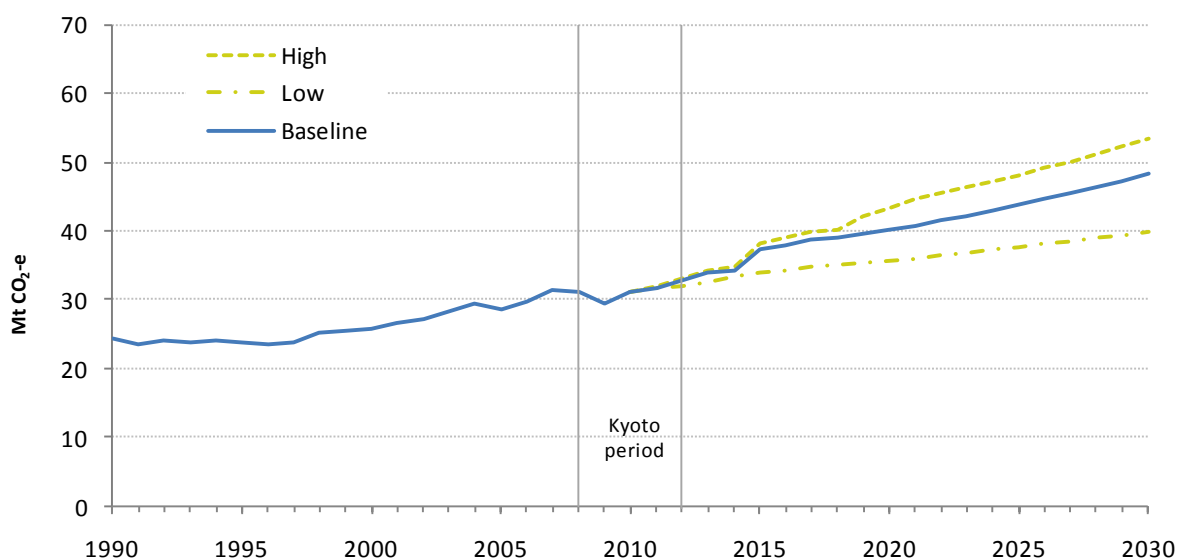
### Key Points

- Emissions from the industrial processes sector accounted for 5 per cent of Australia's total domestic emissions in 2009 at 29 Mt CO<sub>2</sub>-e.
- Industrial processes emissions are projected to average 31 Mt CO<sub>2</sub>-e per year in the Kyoto period, 29 per cent higher than the 1990 level. In 2020, emissions are projected to be 40 Mt CO<sub>2</sub>-e, 56 per cent higher than in 2000.
- Metal production emissions account for the largest proportion of industrial processes emissions, projected to average 11 Mt CO<sub>2</sub>-e per year over the Kyoto period and 14 Mt CO<sub>2</sub>-e in 2020.
- Without further policy action, modelling suggests emissions will reach 48 Mt CO<sub>2</sub>-e in 2030.

### Baseline projection

- Greenhouse gas emissions in the industrial processes sector are projected to average 31 Mt CO<sub>2</sub>-e per year over the Kyoto period (2008-2012), 29 per cent above 1990 the level.<sup>1</sup>

Figure 1 Baseline industrial processes emissions, 1990 to 2030



Source: DCCEE analysis.

<sup>1</sup> All years in this publication are Australian financial years, ending on the 30 June of the year quoted.

- Industrial processes emissions are projected to be 40 Mt CO<sub>2</sub>-e in 2020, an increase of 36 per cent or 11 Mt CO<sub>2</sub>-e between 2009 and 2020. Output from the chemical industry and metal production, and consumption of halocarbons are expected to grow strongly.

**Table 1** Baseline industrial processes emissions, Kyoto period average and 2020

	1990	2000	Kyoto period average 2008-12		2020	
	Mt CO <sub>2</sub> -e	Mt CO <sub>2</sub> -e	Mt CO <sub>2</sub> -e	Increase on 1990 (%)	Mt CO <sub>2</sub> -e	Increase on 2000 (%)
Chemical industry	2	3	6	242	10	219
Consumption of halocarbons and sulphur hexafluoride	0.5	2	7	1276	9	283
Metal production	15	14	11	-29	14	-1.1
Mineral products	6	6	7	23	7	17
Other production (food and drink)	0.1	0.1	0.1	75	0.1	12
<b>Total</b>	<b>24</b>	<b>26</b>	<b>31</b>	<b>29</b>	<b>40</b>	<b>56</b>

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

- Metal production emissions account for the largest proportion of industrial processes emissions, projected to average 11 Mt CO<sub>2</sub>-e per year over the Kyoto period and 14 Mt CO<sub>2</sub>-e in 2020.
- Indicative modelling suggests that without further policy action industrial processes emissions will reach 48 Mt CO<sub>2</sub>-e in 2030.

## Business-as-usual projection

- The business-as-usual projection indicates that without existing policies and measures, industrial processes emissions would average around 34 Mt CO<sub>2</sub>-e per year in the Kyoto period. Emissions in 2020, compared with the baseline emission projections, would be unchanged because the impact of abatement measures falls to zero by then.

## Impact of measures

- Two policies have been implemented to reduce emissions in the industrial processes sector:
  - Greenhouse Challenge Plus (ceased operation in 2009)
  - Greenhouse Gas Abatement Program (no further funding rounds)

- The net abatement from policies and measures in the industrial processes sector is estimated to average 3 Mt CO<sub>2</sub>-e per year in the Kyoto period. No abatement is projected in 2020, as the impact of these measures is projected to decline to zero by that time.
- Abatement achieved through synthetic greenhouse gas legislation is considered to be part of the business-as-usual scenario.

### Changes from 2009 projection

- These industrial processes emission projections update the 2009 projections released in Australia's Fifth National Communication on Climate Change to the UNFCCC.
- Over the Kyoto period, annual emissions from the industrial processes sector are projected to average 1 Mt CO<sub>2</sub>-e lower than in the 2009 projections. Projected emissions in the sector have been revised up by 3 Mt CO<sub>2</sub>-e in 2020.
- The main drivers of the differences from the 2009 projections are:
  - revisions to the National Greenhouse Gas Inventory (NGGI), including the use of data from the National Greenhouse Energy and Reporting system;
  - the impact of the global financial crisis; and
  - higher projected growth in iron and steel production and the chemical industry.
- For the first time an indicative 2030 projection has been included.



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## Introduction

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

The 2010 industrial processes sector projection is a full update of the 2009 industrial processes projections. It is produced from in-house, bottom-up modelling of emissions growth in the activities that make up the sector.

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.

**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 plausible modifications to key assumptions such as economic growth rates and major development projects

These projections have been developed on the basis of current policies in place regarding carbon pricing both in Australia and internationally. They illustrate expectations of Australia's industrial processes emissions in the absence of a carbon price.

The Australian Government has reiterated its intention to introduce a carbon price in Australia to reduce emissions and meet the 2020 target. The projections will be updated as domestic and international climate change policies evolve.

### Coverage of the sector

The industrial processes sector includes emissions generated from production processes involving the use of carbonates (e.g. limestone and dolomite); carbon when used as a chemical reductant (e.g. iron and steel or aluminium production); chemical industry processes (e.g. ammonia and nitric acid production) and the production and use of synthetic gases such as halocarbons.

Greenhouse gas emissions from industrial processes are primarily by-products of production, and they vary with the process technology used and the level of industrial output. The emissions arise from non-energy related sources – energy-related emissions are counted in the stationary energy sector.

In certain subsectors activity data, and therefore emissions estimates, are commercial-in-confidence. Emission estimates are aggregated where needed to preserve confidentiality.

The sources of emissions from industrial processes include:

- Metal production – e.g. carbon dioxide and perfluorocarbon emissions from aluminium smelting; and carbon dioxide, methane and nitrous oxide emissions from iron and steel production.
- Chemical industry – nitrous oxide emissions from the production of nitric acid (largely used in production of ammonium nitrate); carbon dioxide emissions from ammonia production; and methane emissions from the production of organic polymers and other chemicals.
- Mineral products – carbon dioxide emissions from cement clinker and lime production, the use of limestone and dolomite in industrial smelting processes, soda ash use and production, magnesia production, and the use of other carbonates (sodium bicarbonate, potassium carbonate, barium carbonate, lithium carbonate and strontium carbonate).
- Consumption of halocarbons and sulphur hexafluoride – synthetic gases emitted from the use of halocarbons in refrigeration and air conditioning equipment, foam blowing, aerosols, metered dose inhalers, fire extinguishers, solvent use, and electrical equipment.
- Food and drink production – carbon dioxide emissions from ammonia production, carbon dioxide wells, ethylene oxide production and sodium bicarbonate use.

Production of halocarbons and sulphur hexafluoride is also covered by the industrial processes sector but these products are not produced in Australia.

## Recent trends – National Greenhouse Gas Inventory

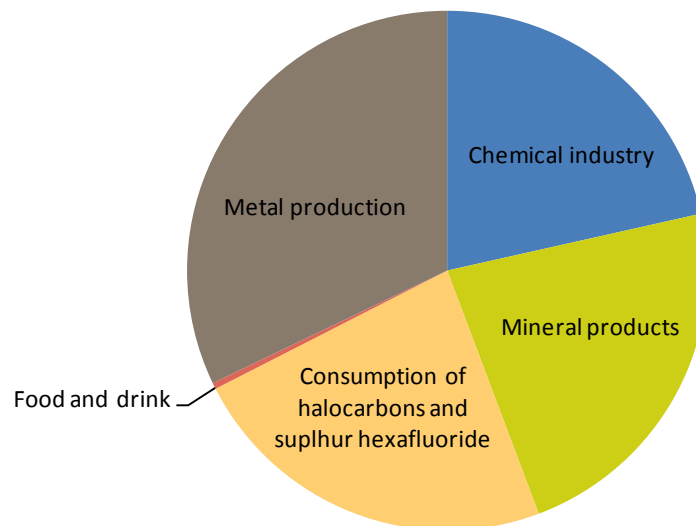
The latest National Greenhouse Gas Inventory (NGGI) (June Quarter 2010) estimates total industrial processes sector emissions for 2009 at 29 Mt CO<sub>2</sub>-e, accounting for around 5 per cent of Australia's total emissions.

Almost one-third of emissions in the sector in 2009 were from metal production (9 Mt CO<sub>2</sub>-e), which consists mainly of iron and steel and aluminium production. Mineral products and consumption of halocarbons and sulphur hexafluoride each contributed almost a quarter of total industrial processes emissions. About 20 per cent of emissions were from the chemical industry.

Changes introduced in the 2009 NGGI result in confidential data now being allocated to their appropriate industry sub-sector. Previously they were reported in aggregate under the classification 'Other – confidential'.

Industrial process emissions from food and drink production were also introduced in the 2009 NGGI. Emissions in 2009 were 0.1 Mt CO<sub>2</sub>-e, less than one per cent of emissions total industrial processes emissions.

Figure 2 Industrial processes emissions, 2009



Source: DCCEE analysis.

## Projections results

Industrial processes emissions are projected to increase by 11 Mt CO<sub>2</sub>-e, or 36 per cent, between 2009 and 2020 to reach 40 Mt CO<sub>2</sub>-e.

From 2009 to 2020, emissions growth is projected to be around 2.8 per cent per year on average. This growth is driven by the chemical industry, metal production, and emissions from consumption of halocarbons.

Over the Kyoto period industrial processes emissions are projected to average 31 Mt CO<sub>2</sub>-e per year, 29 per cent higher than the 1990 level. The chemical industry and emissions from consumption of halocarbons and sulphur hexafluoride have grown strongly since 1990, and from a very low base in the case of halocarbons and sulphur hexafluoride. This growth has been partially offset by a significant decline in emissions from metal production.

Indicative modelling suggests that without further policy action, industrial processes emissions will reach 48 Mt CO<sub>2</sub>-e in 2030.

**Table 3** Baseline industrial processes emissions, Kyoto period average and 2020

	1990	2000	Kyoto period average 2008-12		2020	
	Mt CO <sub>2</sub> -e	Mt CO <sub>2</sub> -e	Mt CO <sub>2</sub> -e	Increase on 1990 (%)	Mt CO <sub>2</sub> -e	Increase on 2000 (%)
Chemical industry	2	3	6	242	10	219
Consumption of halocarbons and sulphur hexafluoride	0.5	2	7	1276	9	283
Metal production	15	14	11	-29	14	-1.1
Mineral products	6	6	7	23	7	17
Other production (food and drink)	0.1	0.1	0.1	75	0.1	12
<b>Total</b>	<b>24</b>	<b>26</b>	<b>31</b>	<b>29</b>	<b>40</b>	<b>56</b>

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

### Trends in the industrial processes projections

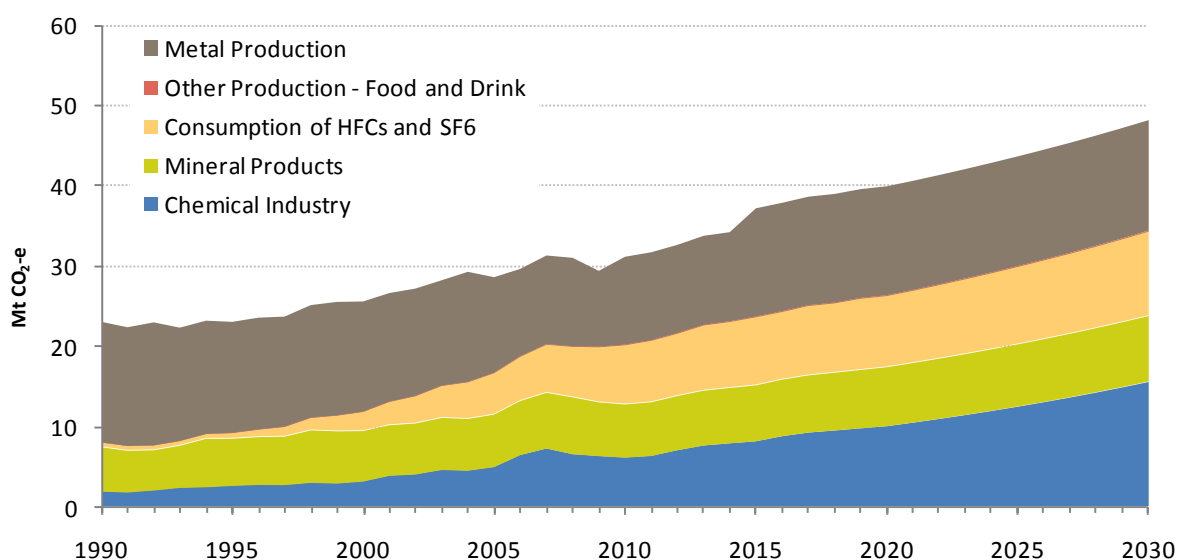
Strong growth in industrial process emissions is projected to 2020. Metal production will continue to be the largest contributor to industrial process emissions. The chemical industry will continue to grow strongly, with its share increasing to around a quarter of emissions by 2020. The rapid growth in emissions from consumption of halocarbons and sulphur hexafluoride is projected to ease slightly.

Table 4 Industrial processes emissions, 1990 to 2030, Mt CO<sub>2</sub>-e

	1990	2009	KPA	2020	2030
Chemical industry	2	6	6	10	16
Consumption of halocarbons and sulphur hexafluoride	0.5	7	7	9	11
Metal production	15	9	11	14	14
Mineral products	6	7	7	7	8
Other production (food and drink)	0.1	0.1	0.1	0.1	0.1
<b>Total</b>	<b>24</b>	<b>29</b>	<b>31</b>	<b>40</b>	<b>48</b>

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

Figure 3 Baseline industrial processes emissions trends, 1990 to 2030



Source: DCCEE analysis.

Emissions are projected to grow faster than the historical average of 1.0 per cent per year. In part this is due to recovery during the early years of the projection from a contraction between 2007 and 2009, when emissions fell 6 per cent mainly as a result of the global financial crisis. Further drivers are the return of the metal production industry to positive emissions growth, reversing a decline from 1990 to 2009, and the growing importance of the chemical industry.

### Main drivers of sectoral activity

Greenhouse gas emissions from industrial processes are the by-products of materials and reactions used in the production process.

In the mineral, chemical and metal subsectors, annual production levels of the relevant product largely drive emissions. Over time technological change in production processes can

have a significant impact on process emissions. For example, improved process monitoring and control has resulted in a substantial reduction in perfluorocarbon emissions from aluminium smelting. Nonetheless, process chemistry places a physical limit on emissions reductions.

Emissions from the consumption of halocarbons and sulphur hexafluoride are associated with leakages from equipment charged with synthetic greenhouse gases. Emissions in these subsectors have increased rapidly from a low base as hydrofluorocarbons replace ozone-depleting substances, whose use is controlled by the Montreal Protocol. The key drivers of these emissions include growth in demand for products and equipment that require synthetic gases in operation (such as air conditioning units and electrical switchgear) and the amount of gas leakage occurring from those products. Emissions can be reduced through improved sealing, handling and maintenance of equipment.

These projections have been developed on the basis of current policies in place regarding carbon pricing both in Australia and internationally. They illustrate expectations of Australia's industrial processes emissions in the absence of a domestic carbon price.

The Australian Government has reiterated its intention to introduce a carbon price in Australia to reduce emissions and meet its 2020 targets. These projections assume current levels of global policy action on climate change. Consistent with the domestic policy assumptions, they do not include additional global action, such as actions to implement all of the Copenhagen Accord pledges.

The projections will be updated as domestic and international climate change policies evolve.

### Business-as-usual scenario and measures estimates

The business-as-usual projection indicates that without existing policies and measures, industrial processes emissions would average around 34 Mt CO<sub>2</sub>-e per year in the Kyoto period. Emissions in 2020 would be 40 Mt CO<sub>2</sub>-e, unchanged from the baseline because the impact of abatement measures falls to zero by then.

Two policies have been implemented to reduce emissions in the industrial processes sector:

- Greenhouse Challenge Plus (ceased operation in 2009)
- Greenhouse Gas Abatement Program (no further funding rounds)

Abatement resulting from synthetic greenhouse gas legislation is considered to be part of the business-as-usual scenario and is not estimated.

In total, the two measures contribute around 3 Mt CO<sub>2</sub>-e of abatement over the Kyoto period and none in 2020. For more details see Appendix A.

## Metal production

Emissions from metal production are projected to average 11 Mt CO<sub>2</sub>-e per year in the Kyoto period, 29 per cent lower than the 1990 level.

Historically, iron and steel production have constituted about two thirds of metal production emissions in the industrial process sector with process emissions from aluminium production making up the remainder. This relationship is projected to remain fairly constant.

**Table 5** Baseline metal production emissions, 1990 to 2030, Mt CO<sub>2</sub>-e

	1990	2009	KPA	2020	2030
Iron and steel production	9.1	6.0	7.2	9.9	9.9
Aluminium production	6.0	3.4	3.5	3.7	4.0
<b>Total</b>	<b>15.1</b>	<b>9.5</b>	<b>10.7</b>	<b>13.6</b>	<b>13.8</b>

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

Over the period from 1990 to 2009 emissions from metal production declined. Emissions intensities fell for aluminium production, and to a lesser extent for iron and steel production. In addition there was a fall in the level of iron and steel production. From 2010 iron and steel production is projected to increase, with investment in a new integrated iron and steel plant mid-decade projected. The improvements in emissions intensity are not projected to continue.

In 2020, emissions from metal production are projected to be 14 Mt CO<sub>2</sub>-e, an increase of 4 Mt CO<sub>2</sub>-e from 2009. Most of this growth is from iron and steel production. Indicative modelling suggests less than 1 Mt CO<sub>2</sub>-e of emissions growth between 2020 and 2030.

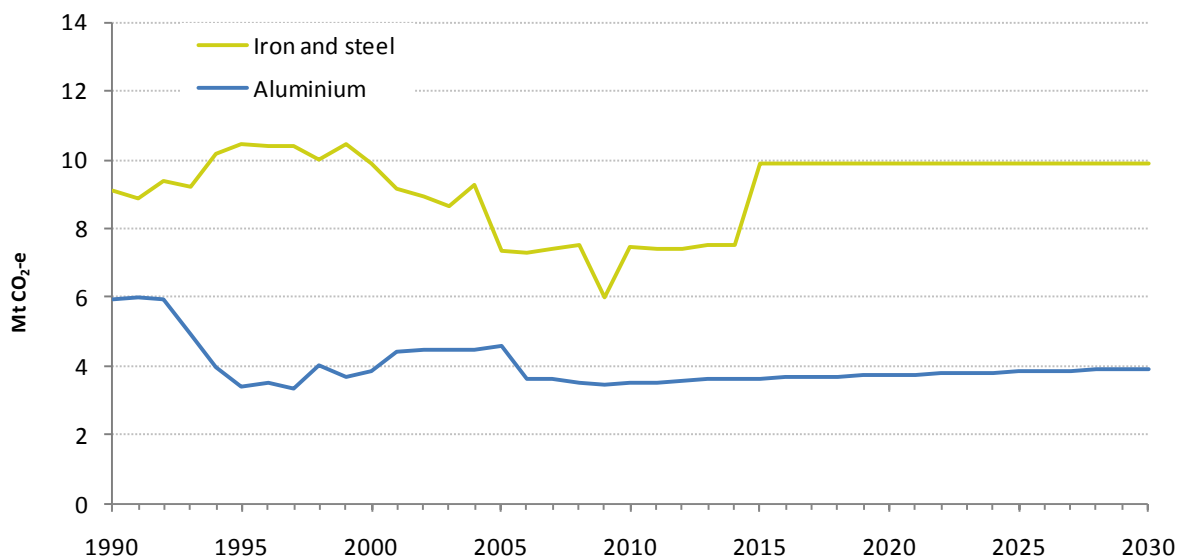
### Trends in the metal production projections

Between 1990 and 2009 metal production emissions decreased at an average 2 per cent per year, with emissions declining for both aluminium and iron and steel production.

- Emissions from perfluorocarbons in aluminium production declined as industry efficiency improved. Aluminium production grew at over 2 per cent per year over this period.
- The emissions intensity of iron and steel production also declined between 1990 and 2009. Iron and steel production reached a peak in 1998, and then fluctuated around the 1990 level from 2000 until 2008.
- Production fell in 2009 due to the temporary closure for relining of a blast furnace at Pt Kembla.

Emissions from metal production are projected to grow 4 Mt CO<sub>2</sub>-e between 2009 and 2020. The decline in the emissions intensity of metal production is not projected to continue.

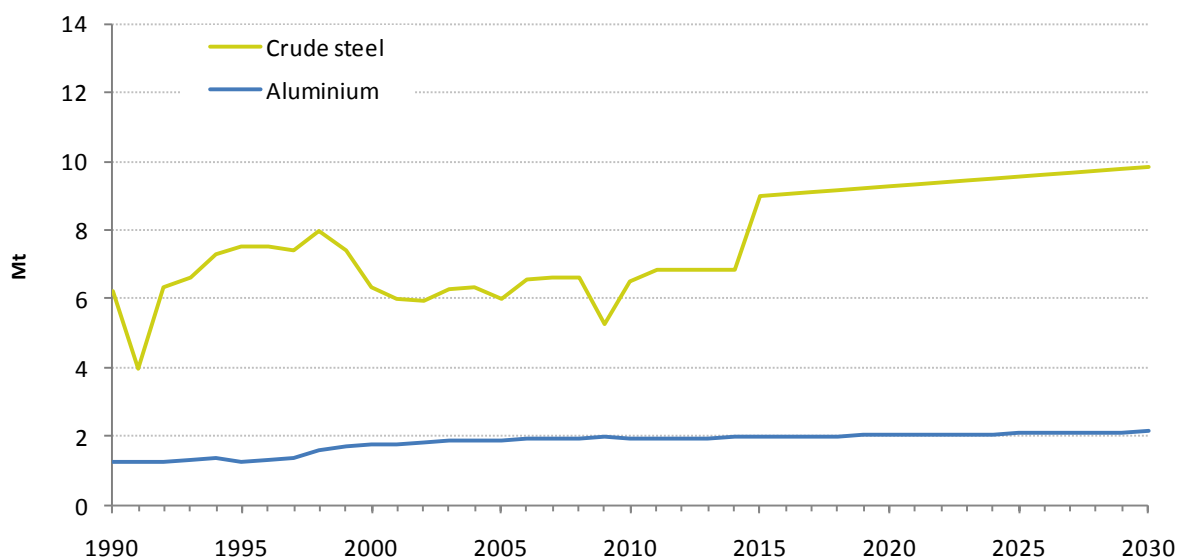
Figure 4 Metal production emissions, 1990 to 2030



Source: DCCEE analysis.

In the short term, the completion of blast furnace relining at Pt Kembla and recovery from the global financial crisis will see output recover, and emissions grow by around 1.4 Mt CO<sub>2</sub>-e in 2010 and 2011. Boulder Steel’s Australian Iron and Steel Project in Gladstone is projected to commence production in 2015. It is projected to contribute around 2.4 Mt CO<sub>2</sub>-e of emissions per year.

Figure 5 Metal production, 1990 to 2030



Source: DCCEE analysis.

There was a relatively small contraction in aluminium production in 2010, as Alcoa reportedly reduced production at its Portland plant in response to weak demand. ABARES projects a slow recovery in 2011, and in the projection this continues until 2014 when output returns to the 2009 level. From 2014 the industry is assumed to be operating close to capacity, with slow efficiency-driven growth in output.

Less than 1 Mt CO<sub>2</sub>-e of growth in metal production emissions is projected between 2020 and 2030. Slow growth in output and emissions, of less than 1 per cent per year, are projected through to 2030. This growth results from productivity improvements in both aluminium and iron and steel. No investment in new production capacity is projected between 2020 and 2030.

## Chemical industry

The outputs of the chemical industry are used principally in the production of explosives for mining and in nitrogen-based fertilisers, as well as in paints and other chemical products. Production of explosives is driven by demand from the domestic mining market, while fertilisers are traded internationally and subject to world demand and prices.

Emissions from the chemical industry are projected to average 6 Mt CO<sub>2</sub>-e per year in the Kyoto period, 242 per cent higher than the 1990 level. Emissions were 6 Mt CO<sub>2</sub>-e in 2009.

**Table 6** Baseline chemical industry emissions, 1990 to 2030, Mt CO<sub>2</sub>-e

	1990	2009	KPA	2020	2030
<b>Total</b>	<b>1.9</b>	<b>6.3</b>	<b>6.5</b>	<b>10.1</b>	<b>15.7</b>

Source: DCCEE analysis.

Note: No breakdown is possible due to confidentiality of chemical industry emissions data.

In 2020, emissions from the chemical industry are projected to be 10 Mt CO<sub>2</sub>-e, an increase of 4 Mt CO<sub>2</sub>-e from 2009. Following a decline in 2010, emissions are projected to grow 5 per cent per year on average to 2020.

Indicative modelling suggests that without further policy action emissions will reach around 16 Mt CO<sub>2</sub>-e by 2030, an increase of almost 6 Mt CO<sub>2</sub>-e from 2020. Emissions growth will ease slightly to around 4.5 per cent per year.

### Trends in the chemical industry projections

The chemical industry grew by an average of 7 per cent per year between 1990 and 2009, from a relatively low base of 2 Mt CO<sub>2</sub>-e. Between 2000 and 2009 emissions grew 8 per cent per year, and total emissions doubled. A significant contribution to this was a new ammonia plant commissioned by Burrup Fertiliser in Western Australia in 2006. Several other ammonia and ammonium nitrate plants were also commissioned during this time.

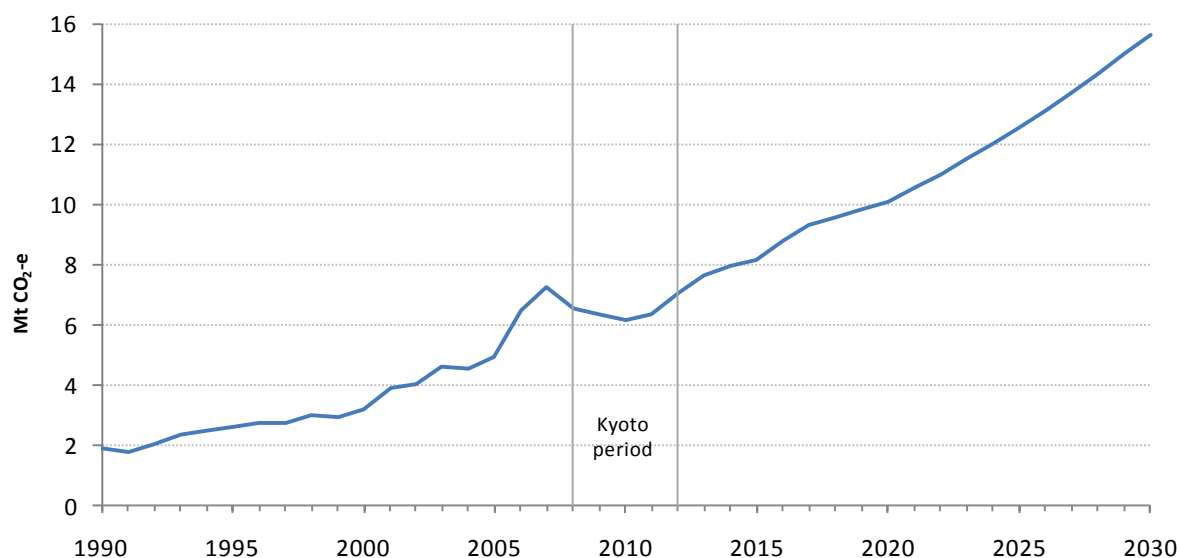
The chemical industry's share of total industrial process emissions increased from 8 per cent in 1990 to 21 per cent in 2009.

Chemical industry emissions fell from 2007 to 2010. Production of nitrogen-based fertilisers is reported to have declined in this time in response to a substantial fall in global fertiliser prices which meant that production costs exceeded returns. This situation is not projected to continue, and fertiliser prices have already begun to recover.

Industry is proposing significant further capacity expansions for ammonia and ammonium nitrate production between 2010 and 2020. These include Incitec Pivot (Dampier Nitrogen project at Burrup Peninsula WA, and Moranbah Ammonium Nitrate project at Moranbah Qld), Orica Resources (Kooragang Island expansion at Newcastle NSW), CSBP (expansion

at Kwinana WA plant), and Burrup Holdings (at Burrup Peninsula WA). This last project may be affected by the current receivership process for Burrup Holdings.

Figure 6 Chemical industry emissions, 1990 to 2030



Source: DCCEE analysis.

The projection assumes that not all of these projects will proceed, but that several will do so. For this reason, substantial increases in ammonia and ammonium nitrate production capacity are projected to come online before 2020, amounting to around 740 kt a year of additional ammonium nitrate production capacity.

Further investment in new capacity is assumed to occur between 2020 and 2030, however this is smoothed over the decade in the absence of information about likely timing or other specifics of this investment.

## Mineral products

Mineral products emissions are projected to average 7 Mt CO<sub>2</sub>-e per year in the Kyoto period, 23 per cent higher than the 1990 level.

In 2020, emissions from mineral products are projected to be 7 Mt CO<sub>2</sub>-e, an increase of less than 1 Mt CO<sub>2</sub>-e between 2009 and 2020.

Table 7 Baseline mineral products emissions, 1990 to 2030, Mt CO<sub>2</sub>-e

	1990	2009	KPA	2020	2030
Cement production	3.5	3.8	3.8	4.1	4.6
Lime production	0.8	1.2	1.2	1.4	1.6
Limestone and dolomite use	1.3	1.7	1.8	1.9	1.9
<b>Total</b>	<b>5.5</b>	<b>6.7</b>	<b>6.8</b>	<b>7.4</b>	<b>8.2</b>

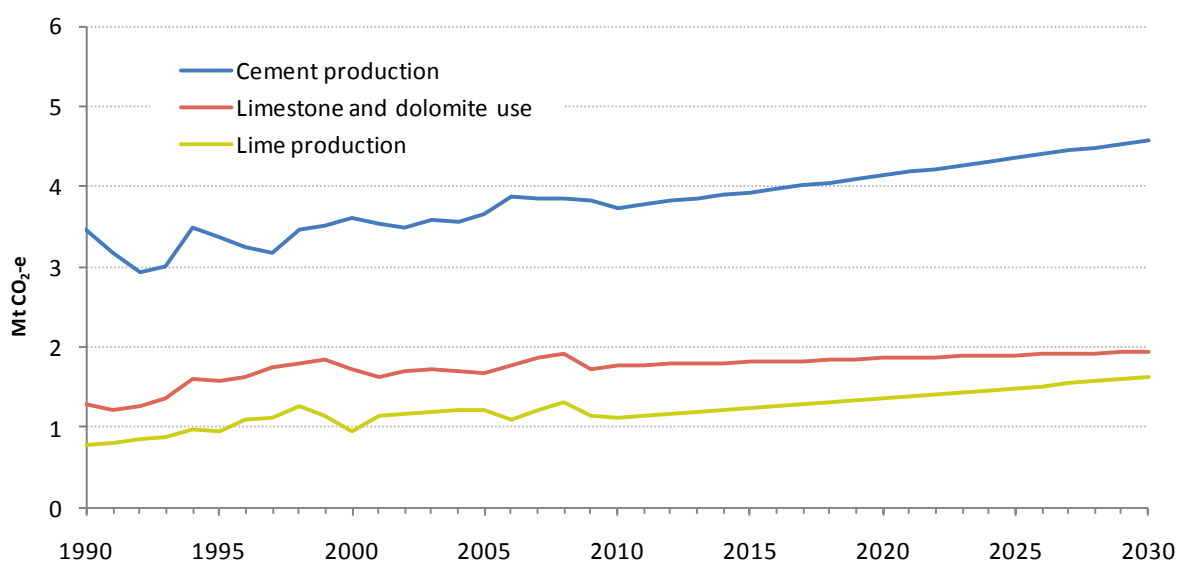
Source: DCCEE analysis. Totals may not add due to rounding.

Indicative modelling suggests that without further policy action emissions will grow less than 1 Mt CO<sub>2</sub>-e between 2020 and 2030.

### Trends in the mineral products projections

Between 1990 and 2009 emissions from mineral products grew just over 1 Mt CO<sub>2</sub>-e, at an average rate of 1 per cent per year. Its share of industrial processes emissions remained steady, at just under one quarter of all emissions.

Figure 7 Mineral products emissions, 1990 to 2030



Source: DCCEE analysis.

Emissions growth from mineral products is projected to average just under 1 per cent per year between 2009 and 2020. Between 2009 and 2030, cement production, lime production and limestone and dolomite use are all projected to grow at a rate consistent with ongoing productivity improvements. The rates are consistent with historical average annual growth rates for these subsectors.

## Consumption of halocarbons and sulphur hexafluoride

Emissions from consumption of halocarbons and sulphur hexafluoride are projected to average 7 Mt CO<sub>2</sub>-e per year in the Kyoto period. This is an increase of 6.3 Mt CO<sub>2</sub>-e above the 1990 level of 0.5 Mt CO<sub>2</sub>-e.

**Table 8** Baseline emissions from consumption of halocarbons and sulphur hexafluoride, 1990 to 2030, Mt CO<sub>2</sub>-e

	1990	2009	KPA	2020	2030
<b>Total</b>	<b>0.5</b>	<b>6.8</b>	<b>7.2</b>	<b>8.9</b>	<b>10.6</b>

Source: DCCCE analysis.

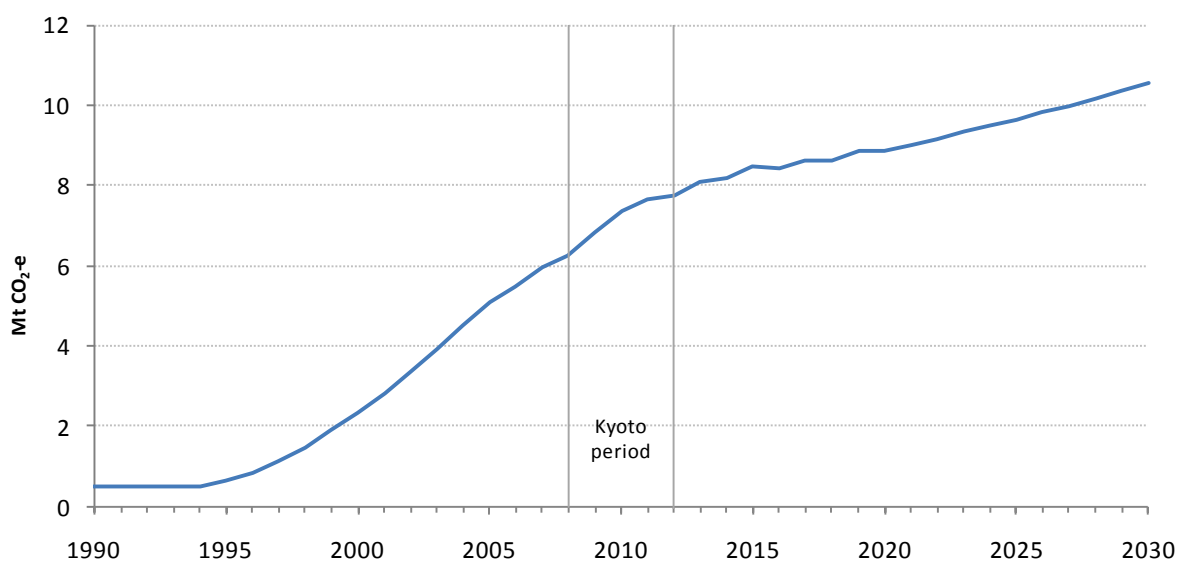
Note: No breakdown is possible as the aggregate projection has been scaled to take account of new aggregate data for 2009 and 2010.

In 2020, emissions from consumption of halocarbons and sulphur hexafluoride are projected to be 9 Mt CO<sub>2</sub>-e, an increase of 2 Mt CO<sub>2</sub>-e between 2009 and 2020. Indicative modelling suggests that without further policy action emissions will grow just under 2 Mt CO<sub>2</sub>-e between 2020 and 2030.

### Trends in the projections of emissions from consumption of halocarbons and sulphur hexafluoride

Between 1990 and 2009 the share of total industrial processes emissions made up by emissions from consumption of halocarbons and sulphur hexafluoride increased from 2 per cent to 23 per cent. This rapid growth resulted from the replacement of ozone-depleting substances with synthetic greenhouse gases in equipment such as refrigerators and air conditioners. The share is projected to remain fairly steady to 2020 and 2030.

**Figure 8** Emissions from consumption of halocarbons and sulphur hexafluoride, 1990 to 2030

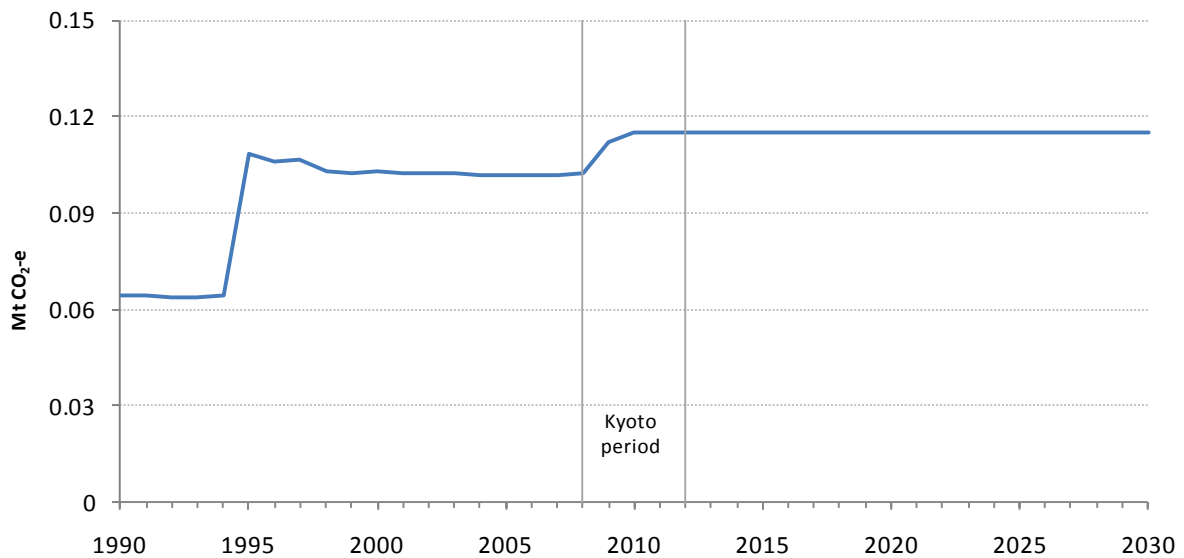


Source: DCCCE analysis.

## Other production – food and drink

Food and drink emissions were included in the NGGI for the first time in 2010, and constitute 0.4 per cent of emissions from industrial processes. Total emissions were 0.1 Mt CO<sub>2</sub>-e in 2009, and emissions grew about 0.05 Mt CO<sub>2</sub>-e between 1990 and 2009. Emissions grew by less than 0.01 Mt CO<sub>2</sub>-e in 2010. No emissions growth is projected between 2010 and 2030.

Figure 9 Food and drink production emissions, 1990 to 2030



Source: DCCEE analysis.

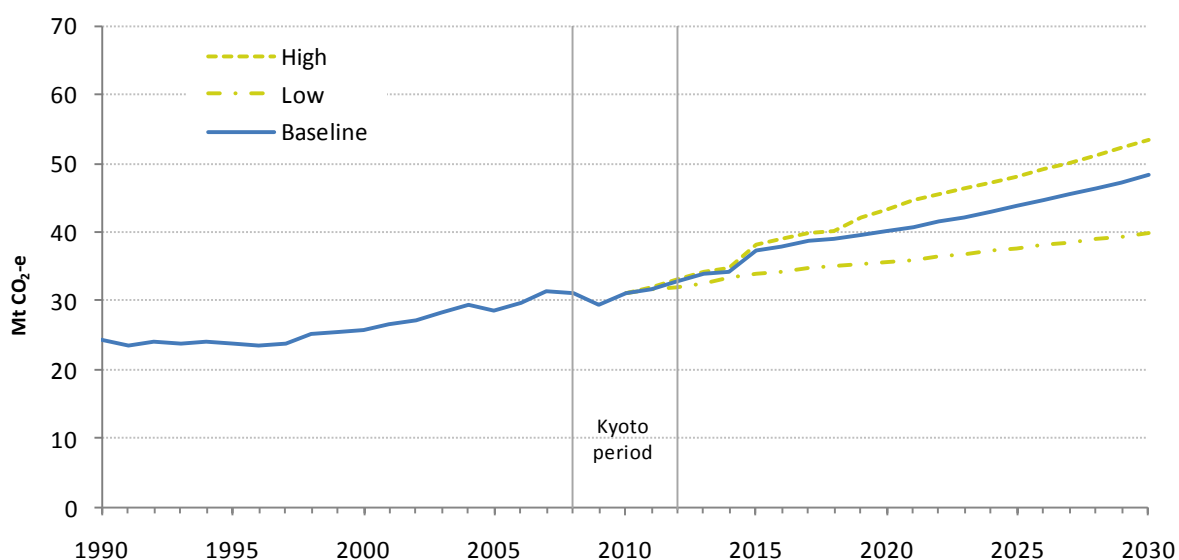
## Key uncertainties and sensitivity analysis

Principal sources of uncertainty in industrial processes emissions growth are the outlooks for the iron and steel sector and the chemical industry, where substantial emissions growth is projected. The baseline iron and steel projection assumes substantial output growth resulting from a new integrated iron and steel plant, a change from the slight decline between 1990 and 2009. The chemical industry has been growing rapidly and in the baseline this is projected to continue, although at a slightly slower rate.

In the iron and steel sector, the baseline projection assumes that stage 1 of the proposed Boulder Steel iron and steel plant in Gladstone goes ahead around the middle of the decade to 2020. Stage 1 would produce 2.1 Mt of steel annually, an increase in Australia's steel production of around 30 per cent. The plant would increase industrial processes emissions by 2.4 Mt CO<sub>2</sub>-e, around 7 per cent in the year it is commissioned. In the low scenario the project is assumed not to go ahead. The high scenario assumes that stage 2 of the project – which is of a similar size to stage 1 – goes ahead around 2020.

In the chemical industry the baseline projection assumes that several new ammonia and ammonium nitrate plants, a new titanium dioxide plant and a new synthetic rutile plant are all commissioned between 2009 and 2020. The baseline also assumes that emissions growth after 2020 is consistent with further expansion in the chemical industry, though no individual plants are identified. The low scenario assumes that most proposed plants do not go ahead. The high scenario assumes that further proposed ammonia and ammonium nitrate plants go ahead, and that the rest of the industry grows more rapidly than in the baseline.

Figure 10 Industrial processes emissions sensitivities

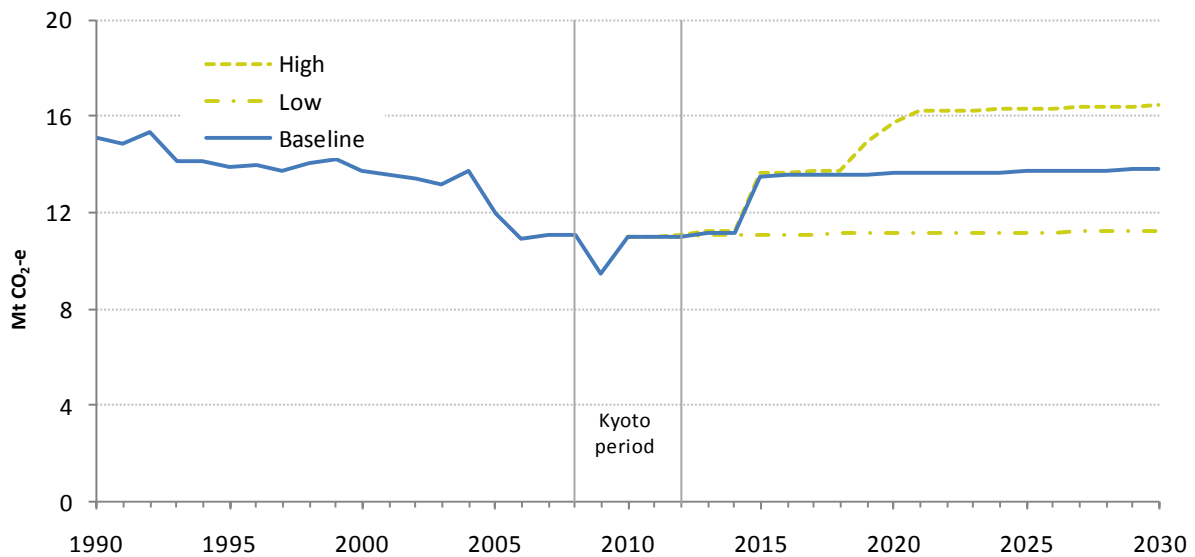


Source: DCCEE analysis.

Other drivers of emissions growth historically have included reductions in the emissions intensity of aluminium production and of iron and steel production. The baseline scenario

assumes that these improvements do not continue. The low scenario has slower emissions growth from aluminium production, allowing for further improvements to the emissions intensity of production, or potentially slower growth in output.

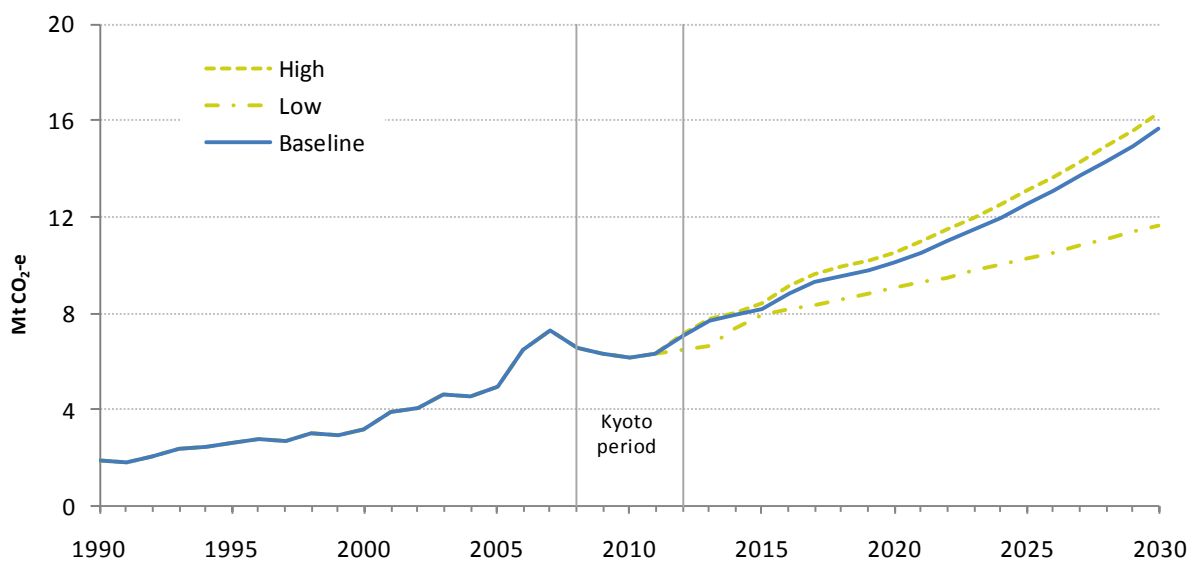
Figure 11 Metal production emissions sensitivities



Source: DCCEE analysis.

A potential driver of emissions reductions in the chemical industry is new technology that uses a catalyst during nitric acid production, reducing the nitrous oxide emissions from ammonium nitrate production. Industry has reported reduced emissions from nitric acid production of over 60 per cent in application of the technology overseas. The high scenario assumes that two new ammonium nitrate plants use the technology. The low scenario assumes slower underlying emissions growth than the baseline which would be consistent with a limited application of the technology. For more information see Appendix D.

Figure 12 Chemical industry emissions sensitivities



Source: DCCEE analysis.

## Appendix A – Measures

Table 9 Greenhouse gas abatement from industrial processes measures

Name	Kyoto period average (Mt CO <sub>2</sub> -e)	2020 (Mt CO <sub>2</sub> -e)
Greenhouse Challenge Plus	2.6	0
Greenhouse Gas Abatement Program	0.3	0
<i>Overlap</i>	<i>0.3</i>	<i>0</i>
<b>Total</b>	<b>2.6</b>	<b>0</b>

Notes: (1) Total abatement is less than the sum of the two programs because industrial processes abatement from the Greenhouse Gas Abatement Program is also counted toward Greenhouse Challenge Plus. (2) Synthetic greenhouse gas legislation is considered to be part of the business-as-usual scenario.

### Greenhouse Challenge Plus

The Greenhouse Challenge program was a joint voluntary initiative between the Australian Government and industry. Its objectives were to encourage abatement; improve greenhouse gas management; improve emissions measurement and monitoring; and strengthen government/industry information sharing. Challenge participation was mandatory for entities claiming over \$3 million in fuel tax credits.

The program ceased operation in 2009.

Abatement in the industrial processes sector from Greenhouse Challenge Plus is estimated to be 2.6 Mt CO<sub>2</sub>-e during the Kyoto period. Abatement is projected to be zero in 2020 as the impact of the measures is projected to decline to zero by that time.

### Greenhouse Gas Abatement Program (GGAP)

GGAP was a competitive grants program established in 2001 and designed to reduce net emissions by supporting activities likely to result in substantial emissions reductions or offset emissions. A number of grants were issued for projects to reduce emissions in the industrial processes sector. No further grants are being offered.

All projects in the industrial processes that were funded under GGAP are also counted under Greenhouse Challenge Plus. Abatement from the Greenhouse Challenge Plus projects covered by GGAP in the Kyoto period is estimated to be 0.3 Mt CO<sub>2</sub>-e in the industrial processes sector. Abatement is projected to be zero in 2020 as the impact of the measures is projected to decline to zero by that time.

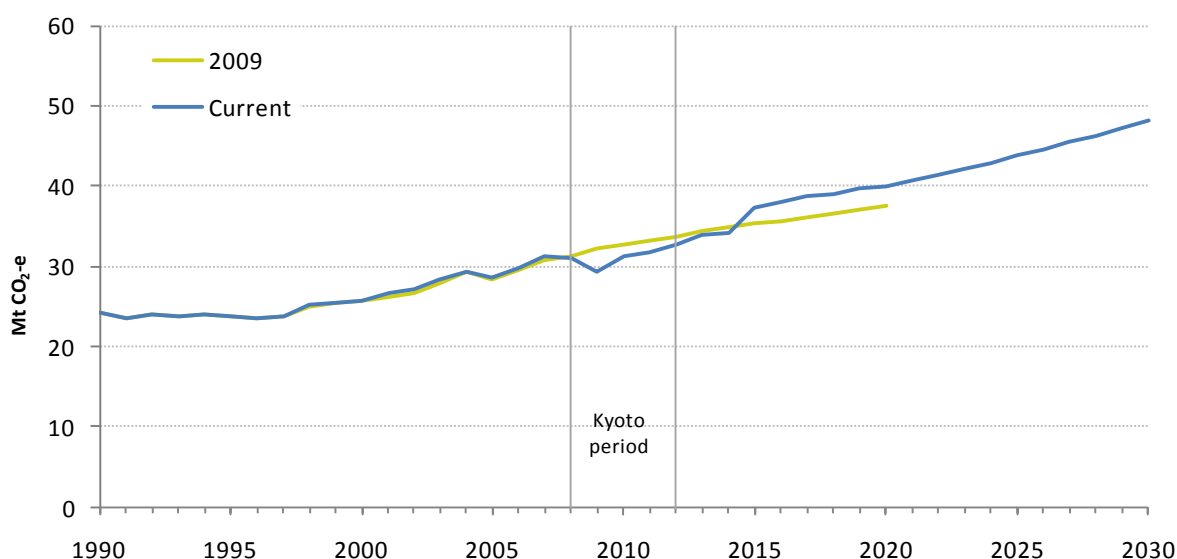
## Appendix B – Changes from 2009 projection

These industrial processes emission projections update the 2009 projections released in Australia's Fifth National Communication on Climate Change to the UNFCCC.

Emissions in 2020 are projected to 2.5 Mt CO<sub>2</sub>-e higher than in the 2009 projections. The main drivers of this difference are:

- forecast commencement of production at Boulder Steel's new integrated iron and steel plant at Gladstone in 2015;
- forecast stronger growth in the chemical industry, with new ammonia and nitric acid plants to be commissioned; and
- emissions in 2009 are 2.7 Mt CO<sub>2</sub>-e lower due to changes in the NGGI and the impact of the global financial crisis.

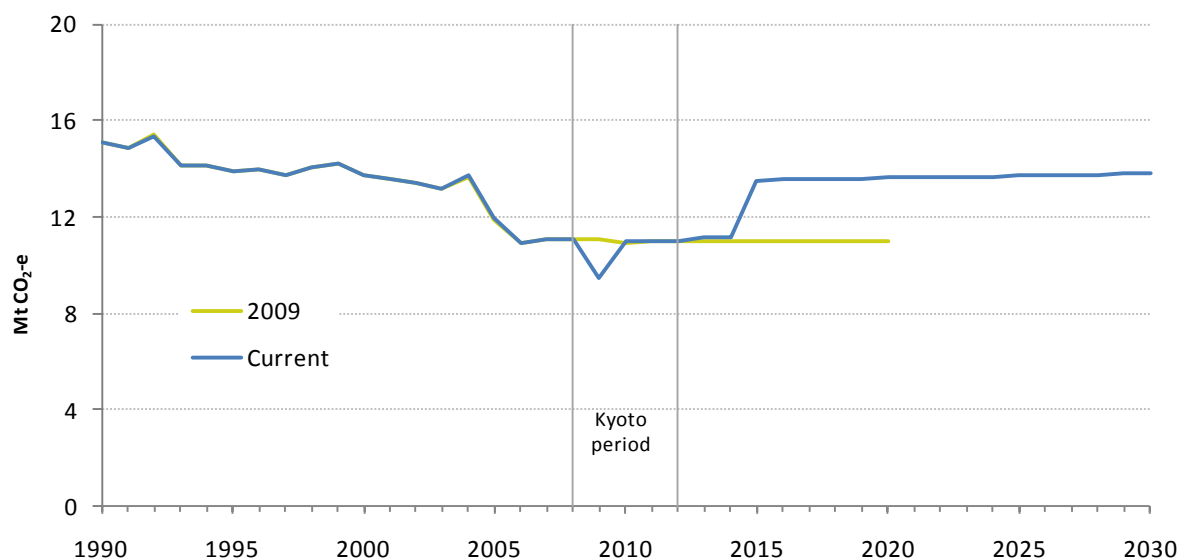
Figure 13 Industrial processes emissions, comparison with 2009 projection



Source: DCCEE analysis.

The key differences in the projection of emissions from metal production from the previous projection are the temporary closure of the blast furnace at Pt Kembla in 2009 and commissioning of Boulder Steel's Gladstone plant in 2015.

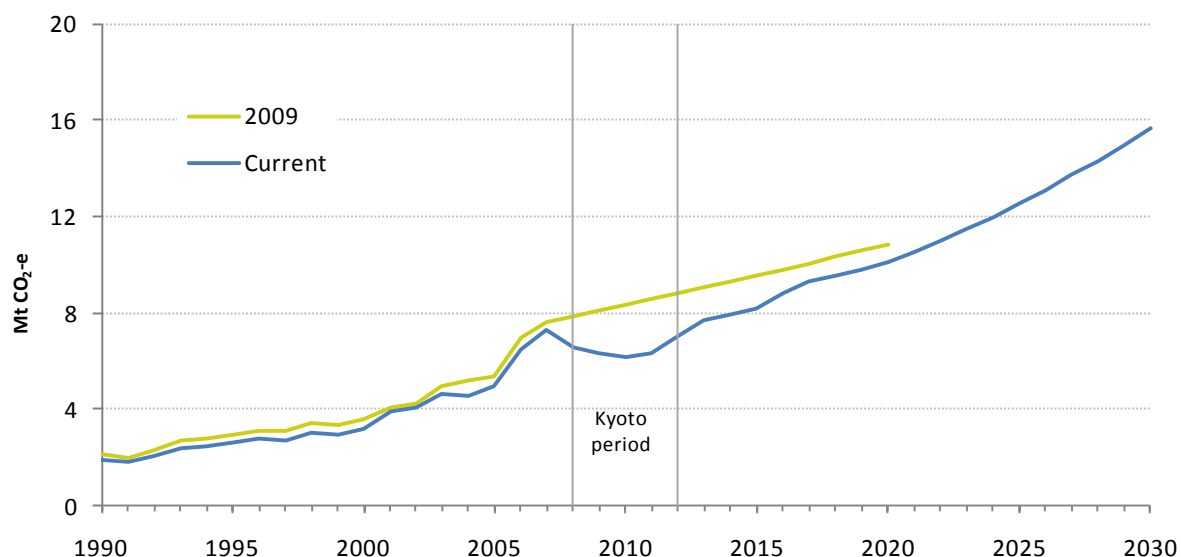
Figure 14 Metal production emissions, comparison with 2009 projection



Source: DCCEE analysis.

Key differences in the chemical industry projection from the last projection are new NGGI data showing a decline in emissions from 2007 through to 2010, and expansions of ammonia and ammonium nitrate production capacity. The decline in emissions resulted from reduced production as global prices fell sharply during the global financial crisis. Historical emissions have also been revised using data from the National Greenhouse and Energy Reporting System.

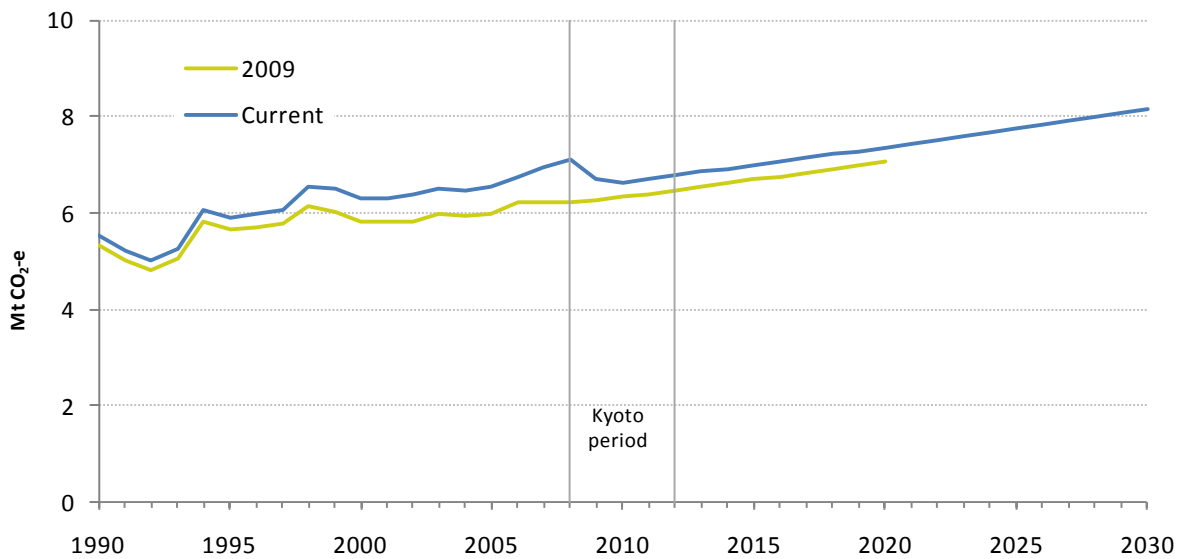
Figure 15 Chemical industry emissions, comparison with 2009 projection



Source: DCCEE analysis.

A key difference in the projection of mineral products emissions since the last projection is the revision of historical emissions in the NGGI, using data from the National Greenhouse and Energy Reporting system. This has led to the counting of emissions from some activities which were not previously accounted for.

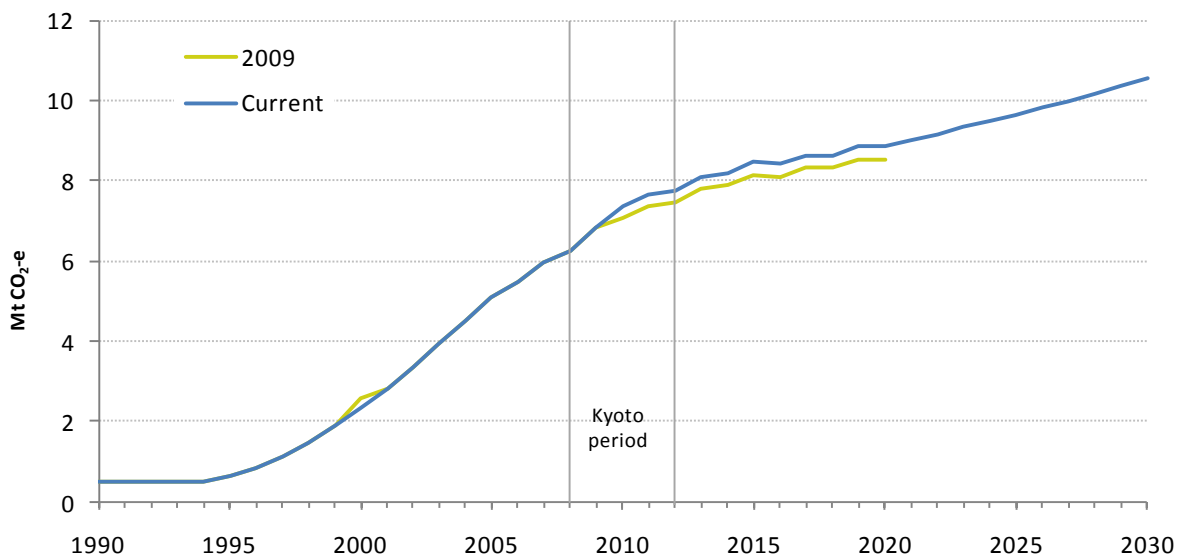
Figure 16 Mineral products emissions, comparison with 2009 projection



Source: DCCEE analysis.

The key change in the projections of emissions from consumption of halocarbons and sulphur hexafluoride from the previous projection is the availability of NGGI data for 2009 and 2010. Emissions in 2010 are 0.3 Mt CO<sub>2</sub>-e higher than previously projected, reflecting new data about the stock of synthetic greenhouse gases. The change to stocks affects future emissions.

Figure 17 Emissions from consumption of halocarbons and sulphur hexafluoride, comparison with 2009 projection



Source: DCCEE analysis.

Emissions from food and drink production are included in the projections for the first time this year, following their inclusion in the NGGI.

## Appendix C – Methodology

Industrial processes sector emissions are projected using in-house models consistent with the methodology used for the NGGI. The overall projection and the sub-sectoral projections are aggregated from projections of emissions from individual activities.

The projections for activities draw on ABARES' assessments of industry outlook and major expansions of production capacity. They are consistent with the forecast for these activities in the stationary energy sector.

The projection of emissions from consumption of halocarbons and sulphur hexafluoride uses the stock model that underpins the emissions estimation in the NGGI.

The projection uses data from the June 2010 quarter update of the NGGI, and from the 2008 NGGI, published in 2010 (*Australian National Greenhouse Accounts National Greenhouse Gas Inventory accounting for the Kyoto target*). Historical emissions in the most recent NGGI have been revised due to the availability of additional data, in particular the first year of data from the National Greenhouse and Energy Reporting System.

The baseline projection takes into account past, present or committed policies and measures that have an impact on greenhouse gas emissions in the transport sector. No carbon price is assumed in the projections.

The business-as-usual projection is the sum of the baseline projection and the impact of abatement from measures.

## Appendix D – Key Assumptions

Key assumptions of the projections are forecasts of production, growth rates, major new development projects and emissions factors.

### Metal production

The projection assumes that one major development project goes ahead in the iron and steel sector. Stage 1 of Boulder Steel's Australian Iron and Steel Project is assumed to go ahead between 2010 and 2020. Stage 2 is not included in the projection.

No major new developments are assumed for the aluminium industry.

**Table 10** Major development projects assumptions, metal production, 2009 to 2020

	Commissioning year	Capacity
Boulder Steel – Australian iron and Steel Project Stage 1	2015	2.1 Mt crude steel annually

Metal production is assumed to recover by 2011 from the closure of a blast furnace at Pt Kembla for relining in 2009, based on NGGI data and ABARES commodity forecasts. Emissions are then projected to grow slowly throughout the projections period, at rates reflecting reasonable production efficiency improvements. The emissions intensity of aluminium production is projected to remain unchanged through the projections period, while that of iron and steel production falls marginally.

### Chemical industry

The projection assumes that several major development projects go ahead in the chemical industry over the decade.

For ammonia and ammonium nitrate production, significant capacity expansions are proposed by industry between 2010 and 2020. Proposed projects include Incitec Pivot (Dampier Nitrogen project at Burrup Peninsula WA, and Moranbah Ammonium Nitrate project at Moranbah Qld), Orica Resources (Kooragang Island expansion at Newcastle NSW), CSBP (expansion at Kwinana WA plant), and Burrup Holdings (at Burrup Peninsula WA). This last project may be affected by the current receivership process for Burrup Holdings.

The projection assumes that some of these projects or similar will go ahead, resulting in additional ammonium nitrate production capacity of around 740 kt a year by 2020.

The projection also assumes that:

- a titanium dioxide plant is commissioned in 2011 and 2012, with production capacity of 40 kt titanium dioxide pigment annually
- a synthetic rutile plant is commissioned in 2015 and 2016, with production capacity of 60 kt synthetic rutile annually
- a methanol plant is commissioned over 2016-19, with production capacity of 1.75 Mt of methanol annually.

For most of the chemical industry the projections assume that output from existing plant grows at a moderate rate over the projections period, consistent with efficiency improvements.

While no further projects are forecast after 2020 because of lack of information, projected growth between 2020 and 2030 includes the likelihood of some further major developments in the chemical industry.

### Mineral products

The mineral products projections are based on production forecasts, assuming that long-term production growth rates continue. Emissions factors are constant based on historical NGGI data. For some smaller categories of limestone and dolomite use, where production data are not available and there is no clear trend, the projections assume no growth in emissions.

No assumptions are made about major development projects in the mineral products sector.

### Consumption of halocarbons and sulphur hexafluoride

Emissions reported in the NGGI are estimated using a model of the stock of synthetic gases is in a range of equipment including refrigerators and air conditioners. The NGGI uses estimates of, among other things, losses of gases from these equipments at initial charging, during the lifetime of the equipment, and at disposal; replenishment of equipment during its lifetime; equipment lifetimes; and imports of these gases into Australia.

The projections use the underlying parameters of the NGGI model, and project growth in the stocks of equipment charged with synthetic greenhouse gases. The growth projections are calculated for individual equipment types. For most equipment types, growth rates are based on historical growth rates. For domestic refrigerators and air conditioners, projections by the Australian Bureau of Statistics of population growth and the household penetration of air conditioners and refrigerators are used.

Between 2020 and 2030 the projections assume that annual emissions growth is the same as the average annual rate from 2016 to 2020.

### Food and drink production

No growth is assumed in emissions from the production of food and drink.

### High and low scenarios

The changes from the assumptions used for the baseline projections that have been made for the high and low scenarios are listed below.

**Table 11** Sensitivity scenario assumptions – changes from baseline assumptions

Sub-sector	Low scenario	High scenario
Metal production	Boulder Steel iron and steel plant Stage 1 does not go ahead Slower growth in aluminium emissions	Boulder Steel Stage 2 goes ahead around 2020 Hls melt resumes production from 2012 at approx 10 per cent of stated capacity Faster aluminium emissions growth
Chemical industry	Delayed entry of 1 ammonium nitrate plant, commissioned 2014 to 2015 Other plants not going ahead except for titanium dioxide plant Slower underlying emissions growth	Additional ammonia plant (2012-13) and ammonium nitrate plant (2015-16) Two ammonium nitrate plants use new technology to reduce emissions by 50 per cent Faster underlying emissions growth
Mineral products	Emissions grow at 50% of baseline annual rate	Emissions grow at 150% of baseline annual rate
Consumption of halocarbons and sulphur hexafluoride	Emissions grow at 70% of baseline annual rate	Emissions grow at 125% of baseline annual rate
Other production – food and drink	Emissions steady at average for 1995-2010	Emissions grow at average annual rate 2000-2009

Where project-level information are available the high and low scenarios incorporate either changes to timing, projects not going ahead, or additional projects going ahead. Uncertainty in the project-level assumptions is greater on the low side.

Assumptions about underlying growth rates have also been varied, to put bands of approximately 5 per cent around underlying emissions growth in 2020 and 10 per cent in 2030.

## Appendix E – References

Australian Bureau of Agricultural and Resource Economics (2010), *Minerals and Energy Major Development Projects – April 2010 listing*, Australian Government.

Australian Bureau of Agricultural and Resource Economics – Bureau of Rural Sciences (2010), *Australian Commodities, September quarter 2010*, Australian Government.

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Orica (2010), *2010 Sustainability Report*, <http://www.orica.com/sustainability/?page=30>.

## Appendix F – Glossary

### Abbreviations

<i>ABARES</i>	Australian Bureau of Agricultural and Resource Economics and Sciences, formerly Australian Bureau of Agricultural and Resource Economics – Bureau of Rural Sciences
<i>BAU</i>	Business as Usual
<i>DCCEE</i>	Department of Climate Change and Energy Efficiency
<i>GFC</i>	Global Financial Crisis
<i>IPCC</i>	Intergovernmental Panel on Climate Change
<i>KPA</i>	Kyoto period average
<i>kt</i>	Kilotonne (1 thousand tonnes)
<i>Mt CO<sub>2</sub>-e</i>	Megatonne (1 million tonnes) carbon dioxide equivalent
<i>NGGI</i>	National Greenhouse Gas Inventory
<i>UNFCCC</i>	United Nations Framework Convention on Climate Change

### Explanations

<i>Baseline</i>	Refers to the level of emissions expected to occur in the absence of an emissions trading scheme, but including the impact of all other measures.
<i>Business-as-usual</i>	Refers to a projection that incorporates changes in activity levels and greenhouse gas emission factors, but with the exclusion of any effects that are directly attributable to greenhouse policy measures.
<i>Measures</i>	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. Also referred to as <i>measures impacts</i> .
<i>High emissions</i>	A 'high emissions' scenario adopting plausible high-emission assumptions.
<i>Low emissions</i>	A 'low emissions' scenario adopting plausible low-emission assumptions.
<i>Kyoto period</i>	Includes the years 2008 through to 2012, as specified by the Kyoto Protocol.