

# TRACKING PROGRESS TOWARDS A LOW CARBON ECONOMY



## 2. POWER

Summary Report

July 2013

Full report available at [www.climateworksaustralia.org/tracking-progress](http://www.climateworksaustralia.org/tracking-progress)

# Executive summary

## Recent Progress

**The emissions intensity<sup>1</sup> of Australia's grid-supplied electricity generation has decreased, with strong reductions in coal generation. Total emissions have decreased by 13 per cent since its peak in 2008-09 to 2012-13.**

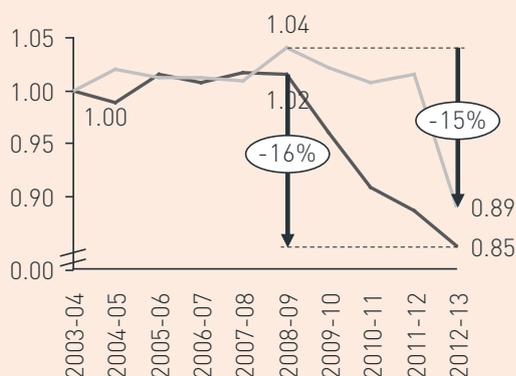
**Demand:** Australia's electricity demand reduced by 5 per cent between 2009-10 and 2012-13, contrary to previous expectations of continued growth in demand. This reduction of about 12,000 GWh is equivalent to eliminating Tasmania's annual electricity use in recent years.

Reductions in electricity demand have come primarily from a reduction in manufacturing output, increased uptake of distributed energy particularly solar PV, milder weather in the last 4 years leading to less heating and cooling, and improvements in energy efficiency in industry and buildings<sup>2</sup>.

**Renewables:** Generation of electricity from large-scale renewables grew by 62 per cent between 2003-04<sup>3</sup> and 2012-13, led mostly by wind and a post-drought recovery in hydro. Renewables now generate 12 per cent of all electricity in Australia, up from 7 per cent a decade ago.

The Large-scale Renewable Energy Target (LRET) legislation requires that Australia generate 41,000 GWh of large-scale renewable energy by 2020. It has driven a surge in investment in wind power, with generation from wind energy growing from 214 GWh in 2003-04 to 7,744 GWh in 2012-13.

**Generation of black and brown coal 2003-04 to 2012-13, index (ESAA 2005-2012, AEMO 2013)<sup>4</sup>**



1 The volume of greenhouse gases emitted for each unit of electricity produced, e.g. tCO<sub>2</sub>e / MWh of electricity produced.  
2 More details on analysis in the Industry and Buildings sectors are presented in Reports 3 and 4 of the *Tracking Progress* series.  
3 Data for this sector was not available for 2002-03.

**Fossil fuels:** Electricity generation from coal decreased by 14 per cent between 2003-04 and 2012-13. This shift has been driven by a combination of the LRET, the carbon price, increased gas generation and a reduction in demand for grid-supplied electricity. The reduction has been most pronounced in the last 4 years.

The historic growth in total emissions from electricity generation has stalled. While emissions from the sector grew steadily from 2003-04 and peaked in 2008-09 at 7 per cent above 2003-04 levels, this trend has since reversed, with a sharp fall in emissions of 13 per cent between 2008-09 and 2012-13.

Emissions from the sector are now almost 3 per cent lower than they were in 2002-03, after having increased steadily between 2002-03 and 2008-09.

### What's driving down coal generation?

The reduction in coal generation has been most pronounced in the last 4 years. Since 2008-09, total coal generation has decreased by 16 per cent, mostly driven by a 16 per cent reduction of black coal generation, as well as a 15 per cent reduction in brown coal generation.

While black coal generation has been steadily declining since 2008-09, brown coal generation remained relatively stable until 2011-12. A sharp decrease (12 per cent) in brown coal generation was seen from 2011-12 to 2012-13.

Many factors contributed to this decrease, including flooding and industrial action at Yallourn, the introduction of the carbon price in July 2012 (which is expected to have impacted brown coal generators the most given their high emissions intensity), and continued reductions in electricity demand.

The steady decrease in black coal generation, however, suggests that black coal generators have been more heavily impacted by the softening demand for grid-supplied electricity and the increase in renewable generation.

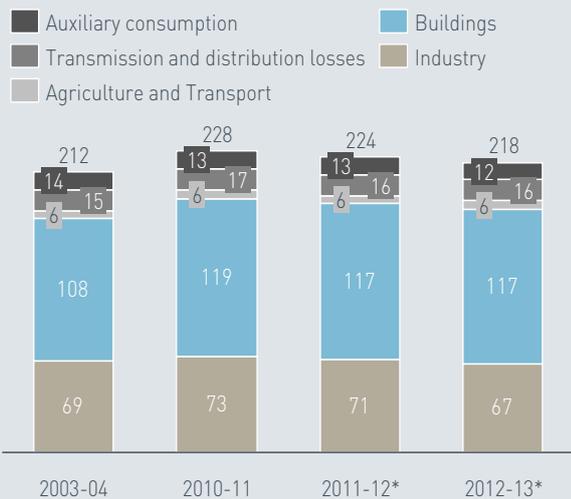
When demand for electricity drops, some power stations must reduce the amount of electricity produced. Renewables such as wind farms have a very low marginal cost (the cost to produce one unit of electricity, once the station is built), as they do not require fuel inputs which means they often take precedence over fossil fuel power stations.

<sup>4</sup> 2012-13 data is based on estimates using National Electricity Market (NEM) data. A detailed bibliography is available in the full Power report (Report 2) of the *Tracking Progress* series.

## What has driven recent decreases in grid-supplied electricity demand?

Latest data suggests that reductions in demand for grid-supplied electricity have been primarily from decreases in industrial production, as well as from reductions in auxiliary consumption by coal power plants, a stabilisation in buildings electricity consumption and strong uptake of residential solar PV.

Estimated grid-supplied electricity use distribution, TWh (BREE 2012, ClimateWorks team analysis)



\*More detail on this analysis is presented in Report 1: National Progress Report of the *Tracking Progress* series.

## Outlook to 2020

**Assuming the Renewable Energy Target is met, and if other abatement trends in the Power sector are sustained, Power sector emissions would continue to fall slightly to 2019-20 with new renewables more than meeting the additional demand for grid-supplied electricity<sup>5</sup>.**

Without any further emissions reduction activity in the Industry and Buildings sectors, higher demand for grid-supplied electricity from more industrial activity, growth in total building stock and increased use of appliances would put upward pressure on power sector emissions between now and 2019-20. In this case, if the emissions intensity of grid-supplied electricity were to remain constant at 2009-10 levels, emissions from the Power sector would grow by 32 MtCO<sub>2</sub>e between 2010-11 and 2019-20.

However, a range of factors are expected to see the Power sector reduce its overall emissions from 173 MtCO<sub>2</sub>e in 2012-13 to 171 MtCO<sub>2</sub>e by 2019-20, leading

<sup>5</sup> This differs from emissions projections undertaken by the Australian Government. A detailed description of the differences is contained in Report 1: National Progress Report in the *Tracking Progress* report series.

to a 11 per cent decrease in emissions intensity of grid-supplied electricity.

**Demand:** Existing policies and trends in the Buildings and Industry sectors are expected to keep demand for grid-supplied electricity low, with a net increase of 6 per cent in grid-supplied electricity demand expected between 2010-11 and 2019-20 (compared to 2012 forecasts of around 14% growth over the same period).

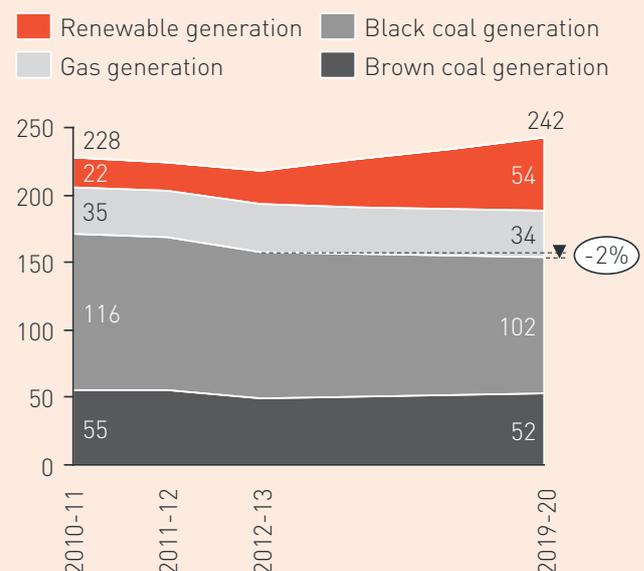
**Renewables:** The LRET is expected to continue to drive new renewable energy projects. Fewer than half of the projects currently in the pipeline would be required to meet the LRET, although implementing the projects needed to meet the LRET would require a significant increase in the rate of construction of renewable generation assets.

**Fossil fuels:** An increase in renewables and soft demand for grid-supplied electricity are expected to lead to a decrease in generation from coal and gas. If recent trends are sustained, generation from existing coal assets would further decrease by 2 per cent from 2012-13 to 2019-20 (see graph below).

If recent trends in abatement activity are sustained, around 32 per cent of the abatement potential identified in the *Low Carbon Growth Plan for Australia* for this sector would be captured by 2019-20.

Future demand for grid-supplied electricity, the availability of renewable technologies at reasonable cost, the carbon price and future fuel prices – in particular gas prices – are the key influencing factors that will determine whether current trends are sustained or can be increased.

Outlook for generation mix to 2019-20, TWh (ESAA 2005-2012, AEMO 2013, ClimateWorks team analysis)



# Background

## About the *Tracking Progress* project

Tracking Progress is the first national index of Australia's progress towards a low carbon economy.

With increasing business and community focus on how best to transition to a low carbon future, it is critical to have a robust measurement and evaluation framework for low carbon activity.

In order to understand how Australia is progressing towards our national emissions reduction targets, a good understanding of this activity — and the factors that are supporting or impeding it — is required. Building this evidence is critical for achieving an efficient, least-cost transition while maintaining our economic growth, competitiveness and prosperity.

The reports that make up this project provide an assessment of activity occurring across the Australian economy that reduces or avoids greenhouse gas emissions, pulling together all the available information and data across key sectors. We have tracked and reported progress through our national progress report series covering Power, Industry, Buildings and Land-Use & Waste<sup>6</sup>.

In addition we have produced a Special Report of factors influencing large industrial energy efficiency.

No other research provides a national aggregation of data on the underlying investments and activity that lead to future abatement. National measurements currently focus on actual emissions and energy use each year. This only reveals 'the tip of the iceberg' of abatement activity.

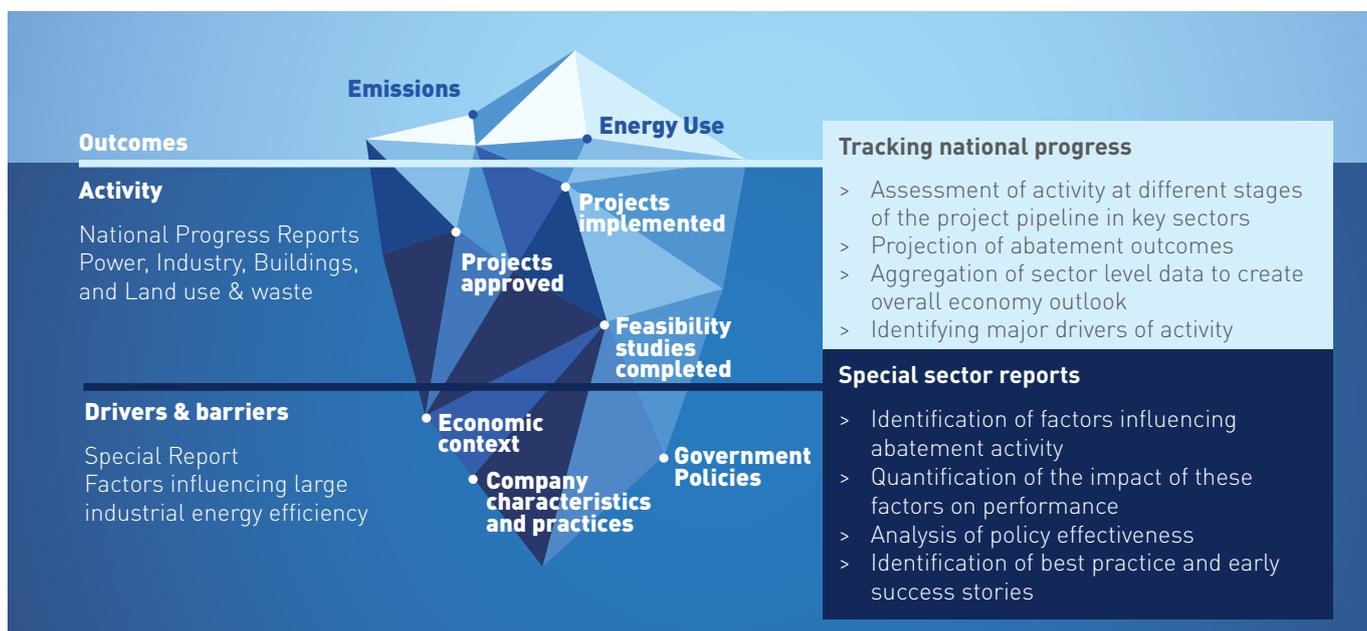
This series of reports reveals the hidden part of the story including:

**LEVEL OF CURRENT ACTIVITY** across key sectors of the economy. This includes activities that will deliver emissions savings in the future, some of which do not yet appear in national energy and emissions metrics but which are sufficiently advanced to make a known contribution to reducing future emissions.

**FUTURE ABATEMENT** that can be achieved if recent trends in abatement activity are sustained to 2019-20

**FACTORS INFLUENCING EMISSIONS REDUCTION ACTIVITY** for large industrial energy efficiency — from broad economic influences to company specific factors — including an understanding of the common qualities of companies that achieve the most emissions reductions.

<sup>6</sup> The Transport sector has not been assessed in the 2013 *Tracking Progress* report series but will be addressed in a future report series.



## Description of the Power sector

This report investigates emissions reduction activity from large-scale grid-connected electricity generation assets – both fossil fuel and renewables. It also examines electricity transmission and distribution networks across Australia. Grid-connected electricity is defined as electricity supplied by:

- > the National Electricity Market (NEM), which covers Queensland, New South Wales, Victoria, Tasmania and South Australia
- > the South West Interconnected System (SWIS), which covers Perth and other major population centres in the south west region of Western Australia
- > the North West Interconnected System (NWIS), which covers the Pilbara region and other communities in the north west of Western Australia
- > Scheduled, semi-scheduled and non-scheduled generators in the Northern Territory

Small-scale solar power, other forms of distributed energy generation and off-grid electricity generation are addressed in the Buildings and Industry reports in the Tracking Progress series.

A full report on progress in the Power sector – along with a National Progress report, reports on progress in Industry, Building, Land-use and Waste, and a Special Report on factors influencing large industrial energy efficiency – is available at [www.climateworksaustralia.org/tracking-progress](http://www.climateworksaustralia.org/tracking-progress)

## Emissions profile

Emissions from the combustion of fossil fuels for the generation of grid-supplied electricity contribute a third of Australia’s national emissions, representing 33 per cent of total emissions (N.B - does not equal 34 per cent due to rounding), or 187 MtCO<sub>2</sub>e, in 2010-11 (see graph opposite).

This is comprised of emissions from electricity consumed in buildings (53% of grid-supplied electricity emissions) and industry (32%), with the remainder from consumption of grid-supplied electricity in other sectors (e.g. agriculture and electric-powered transport) as well as electrical losses in transmission and distribution networks and auxiliary consumption in power stations.

## Breakdown of the sector’s emissions

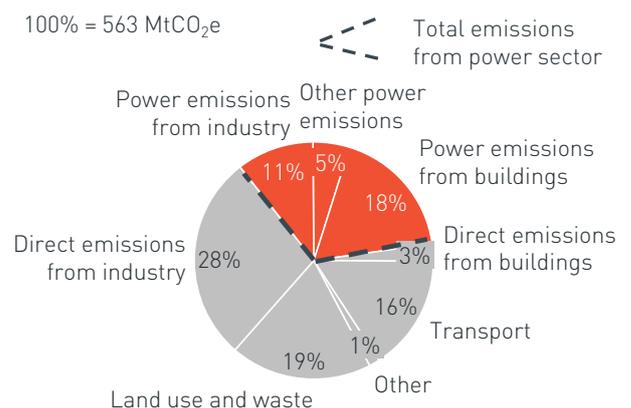
The process of generating electricity from the combustion of fossil fuels releases greenhouse gases, primarily carbon dioxide (see graph opposite).

The emissions intensity of electricity generation differs for different fuel types. 91 per cent of the sector’s emissions come from coal-fired generation that accounts for 75 per cent of total electricity generated in 2010-11.

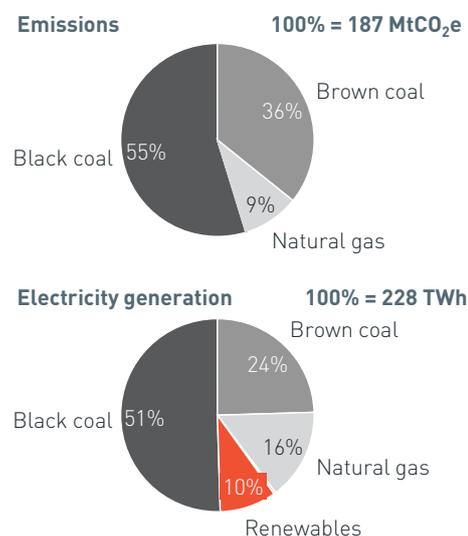
In 2010-11, highly emissions-intensive brown coal accounted for 36 per cent of total emissions from electricity generation, despite producing only 24 per cent of all electricity generated. More than half of all electricity generation emissions came from black coal.

Gas generates electricity at a lower emissions intensity and therefore accounted for only 9 per cent of total emissions, despite generating 16 per cent of Australia’s grid-supplied electricity.

Breakdown of Australian emissions and sector coverage in 2010-11, % (DIICCS RTE 2013a)



Breakdown of emissions and generation of grid-supplied electricity in 2010-11, % (DIICCS RTE 2013a, ESAA 2011, ClimateWorks team analysis)



# Index of Progress

## 1. Overall sector

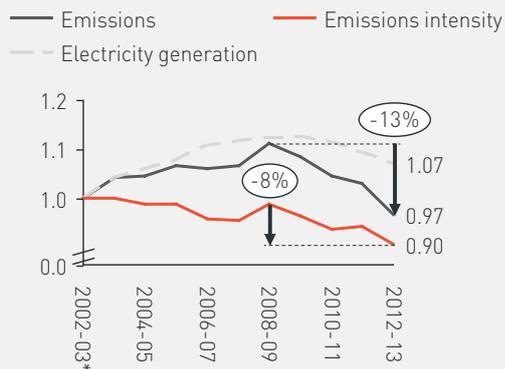
The index of progress for the Power sector illustrated here relates to progress in the generation mix of grid-supplied electricity. Progress relating to demand reduction in Buildings and Industry and the corresponding abatement achieved is addressed in the Buildings and Industry sector reports in the Tracking Progress series.

### Recent progress

**Emissions from electricity generation have started to decrease**

The emissions intensity of Australia's power generation decreased by 8% from 2008-09 to 2012-13, with overall emissions decreasing by 13% since 2008-09

Change in emissions, generation and emissions intensity, indices [ESAA, ClimateWorks team analysis]



#### What factors influenced the abatement activity?

- ▲ Decrease in demand for grid-supplied electricity
- ▲ Renewable Energy Target
- ▲ Carbon price
- ▼ Prolonged drought reducing hydro generation

#### Change relative to historical levels & expectations

- No improvement or backwards
- Patchy or limited improvement
- Some improvement
- Moderate improvement
- Strong improvement

#### Legend

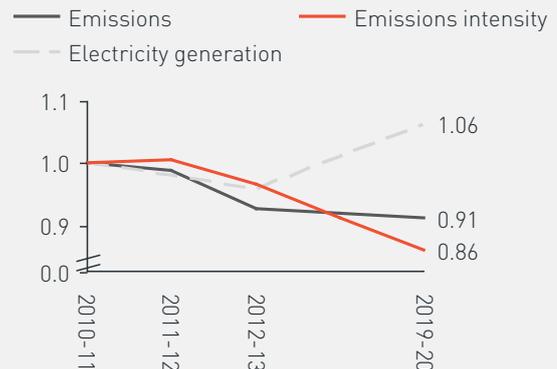
- ▲ Upside factors
- ▼ Downside factors

### Outlook to 2020

**Current trends could deliver 32% of the LCGP potential**

A strong pipeline of renewable energy projects and slow growth in grid-electricity demand are expected to see overall power sector emissions decline by 2019-20

Change in emissions, generation and emissions intensity, indices [ESAA, ClimateWorks team analysis]



#### What factors will influence abatement activity?

- ▲ Grid electricity demand remaining soft
- ▲ Renewable Energy Target
- ▲ Carbon price
- ▼ Increase in gas prices

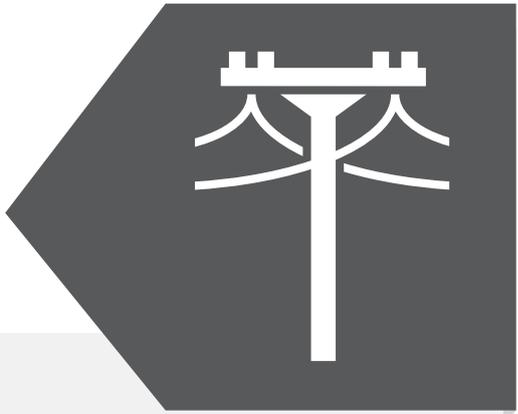
#### Share of potential identified in the Low Carbon Growth Plan (LCGP) that current trend would deliver

- No abatement captured
- Little abatement captured (1-25%)
- Some abatement captured (26-50%)
- Moderate abatement captured (51-75%)
- Significant abatement captured (>75%)

#### Legend

- ▲ Upside factors
- ▼ Downside factors

\* No generation data was available for grid-supplied electricity for 2002-03, emissions intensity was assumed equal to 2003-04. Data in other sectors starts in 2002-03.



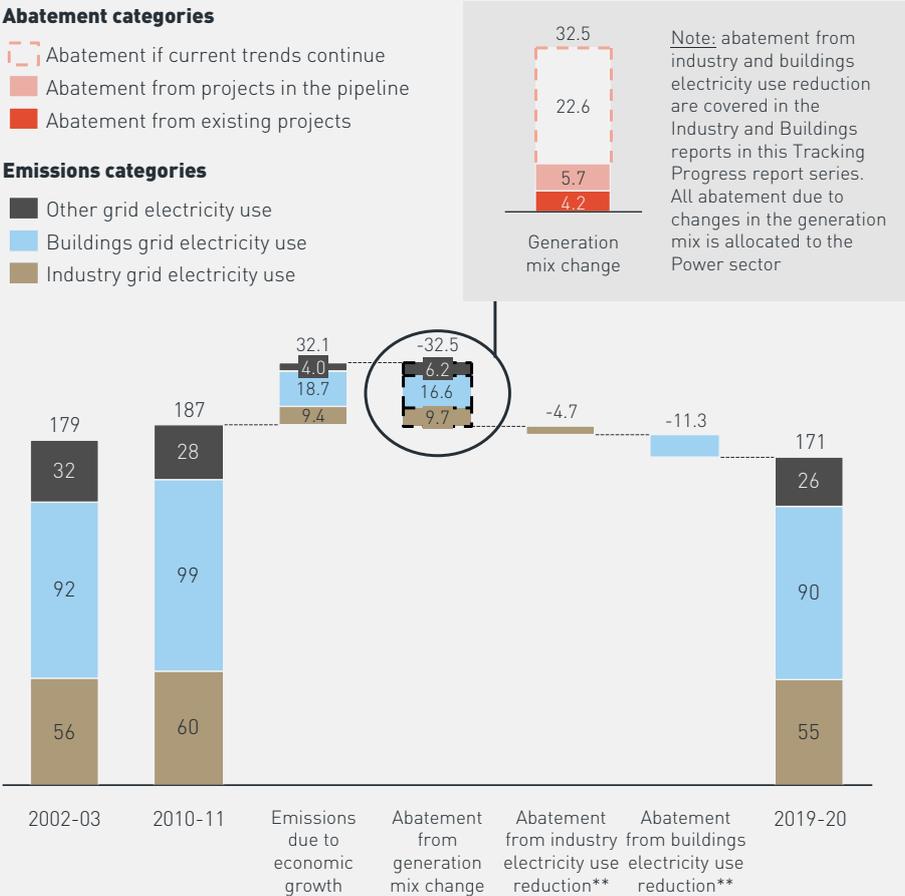
Between 2002–03 and 2010–11, emissions from grid-supplied electricity grew by only 4 per cent while generation grew by 12 per cent, due to strong improvements in average emissions intensity of electricity generation as a result of changes in the generation mix. With no further abatement activity beyond 2009–10<sup>7</sup>, emissions would grow by 17 per cent by 2019–20, driven in particular by growth in demand in the Buildings sector.

If current trends are sustained, abatement activity would deliver 48.5 MtCO<sub>2</sub>e of emissions reductions, more than compensating for the growth in emissions and leading to an overall decrease in emissions of 9 per cent between 2010–11 and 2019–20. The largest contribution would come

from changes in the generation mix, with a 32 MtCO<sub>2</sub>e reduction in emissions delivered by 2019–20 if the Renewable Energy Target is met and coal generation is further reduced. Demand reduction would contribute 16 MtCO<sub>2</sub>e of abatement simply by reducing the volume of electricity generated<sup>8</sup> if current trends are maintained (this abatement is allocated to the Industry and Buildings sectors).

The Buildings sector would contribute nearly three quarters of this abatement, in particular through reductions in electricity use per household and increased uptake of solar PV in the residential sector. Some demand reduction would also occur in the Industry sector through energy efficiency and an increase in off-grid electricity generation.

Emissions from the Power sector, MtCO<sub>2</sub>e (DIICCSRTE 2013a, ESAA 2011, ClimateWorks team analysis)



\*\* Abatement allocated to the Industry and Buildings sectors

7 Abatement from 2009-10 to 2010-11 has been captured as abatement from existing projects in the graph above.

8 The impact of reduced demand on the generation mix is captured in the abatement from generation mix change.

## 2. Index of progress for each abatement category



# Recent progress

### How much activity is happening?

Demand for grid-supplied electricity across Australia decreased by 5% between 2009-10 and 2012-13, contradicting strong growth projections

**Shift in direction relative to strong historic increases**

### What are some key achievements?

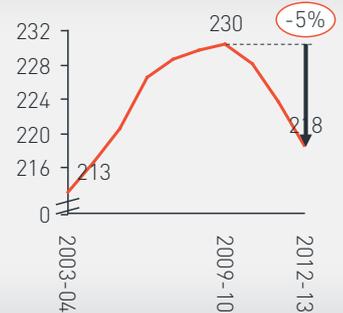
- ★ National Electricity Market (NEM) demand in 2012-13 was 10% lower than was projected for this period in 2010
- ★ Rapid uptake of small-scale solar PV has substituted up to 3 TWh of grid-supplied electricity in 2011-12

### What factors influenced the activity?

- ▶ Increase in solar PV uptake
- ▶ Higher electricity prices
- ▶ Milder weather
- ▶ Improved energy efficiency in Buildings and Industry
- ▶ Decreasing manufacturing output
- ▶ Population growth

### Key metric

Electricity generation, TWh\*



GRID ELECTRICITY DEMAND

Generation of large-scale renewables has grown by 62% between 2003-04 and 2012-13, led by an increase in wind and a recovery in hydro generation.

**Renewable generation has grown substantially**

- ★ Wind generation now accounts for 31% of all renewable generation, enough to power 1 million households
- ★ Renewable generation now accounts for 12% of total grid electricity generation compared to 7% in 2003-04

- ▶ Renewable Energy Target (RET) driving investment in new renewable capacity
- ▶ Drought conditions affecting rainfall and dam levels for hydro generation

Renewable energy generation, TWh\*



RENEWABLES

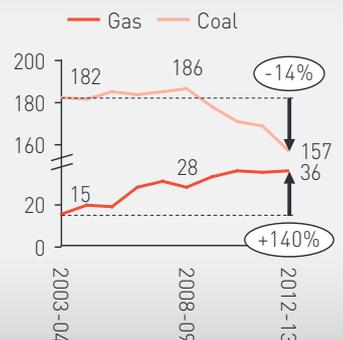
Generation from coal decreased by 14% between 2003-04 and 2012-13, and gas generation doubled

**Shift to less emissions intensive generation has begun**

- ★ Generation from coal decreased by 16% over the past 4 years, with decreasing utilisation rates leading a few coal generators to mothball some units
- ★ Gas generation (OCGT & CCGT) more than doubled since 2003-04
- ★ Fuel efficiency levels were maintained in coal generation assets, despite reduced utilisation which can affect efficiency

- ▶ Decreasing electricity demand
- ▶ Fuel efficiency improvements are likely to have counterbalanced the impact of reduced utilisation on plant thermal efficiency
- ▶ Queensland Gas Scheme and GGAS driving growth in gas generation

Generation from fossil fuels, TWh\*



FOSSIL FUELS

\* Multiple data sources. See Power full report for details.

Change relative to historical levels & expectations

- No improvement
- Limited improvement
- Some improvement
- Moderate improvement
- Strong improvement
- Data unavailable

- ▾ No abatement captured
- ▾ 1–25%
- ▾ 26–50%
- ▾ 51–75%
- ▾ 76%+
- ▾ Data unavailable

# Outlook to 2020

## How much activity could happen?

Reduction in demand for grid-supplied electricity from manufacturing and residential buildings (including solar PV) expected to contain demand rise to 6% growth from 2010–11 to 2019–20

**Current trends could capture 44% of the total abatement identified in LCGP**

## What's in the pipeline?

- > Uptake of rooftop solar PV is likely to continue increasing in residential and commercial buildings, possibly generating 9 TWh in 2019–20
- > Buildings and Industry are likely to become more efficient through energy efficiency initiatives and increased response to high electricity prices

## What factors will influence the activity?

- ▾ Soft economic outlook
- ▾ Continued improvements in energy efficiency
- ▾ Continued increase in solar PV uptake
- ▾ Potential changes in electricity market rules
- ▾ Population growth
- ▾ Connection of new LNG plants in QLD to electricity grid

## Key metric

Electricity generation, TWh\*



GRID ELECTRICITY DEMAND

Meeting the Renewable Energy Target (RET) would more than double renewable generation by 2019–20

**Current trends could capture 40% of the total abatement identified in LCGP**

- > There is twice as much renewable energy capacity in the pipeline as is needed to meet the Renewable Energy Target
- > Significant funding is being targeted at research and demonstration of new renewable technologies

- ▾ Decrease in renewable technology costs
- ▾ Perceived uncertainty around the RET could defer investment
- ▾ Challenges in securing finance for new projects
- ▾ State planning regulations make it challenging to implement projects
- ▾ Rainfall and dam levels on hydro

Renewable energy generation, TWh\*



RENEWABLES

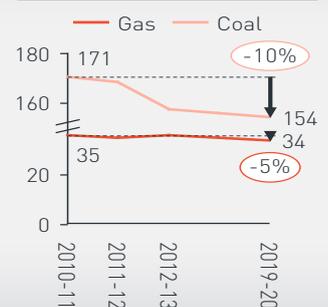
Expected future demand for grid-supplied electricity and increased renewables are expected to keep coal generation at 2012–13 levels

**Current trends would deliver 20% of the LCGP potential for this sector**

- > There is no prospect of lock-in from new major coal projects before 2019–20
- > Generation from black coal is expected to be the most affected, with a potential decrease in generation of 12% between 2010–11 and 2019–20

- ▾ Demand decreasing further
- ▾ Higher carbon price could increase costs of fossil fuel generation
- ▾ Rising gas costs could impact on the profitability of gas vs coal generation
- ▾ Uncertainty around the carbon price could slow the displacement of coal

Generation from fossil fuels, TWh\*



FOSSIL FUELS

### 3. What more could be done?

#### There is still significant potential to reduce power sector emissions<sup>9</sup>

Each sector has the potential to contribute additional emissions reductions by 2019-20. This potential was outlined in ClimateWorks' *Low Carbon Growth Plan for Australia*.

That research, published in 2010 and updated in 2011, provides an indication of the scale of emissions reduction potential available in Australia without changes to the business mix of our economy or to our lifestyles. It also provides details of the activities that can deliver these emissions reductions.

The *Low Carbon Growth Plan for Australia* found that there is enough abatement potential to achieve a 25 per cent emissions reduction target in Australia, using technologies and practices already available. However further policy or economic incentives would be required to drive the uptake of those activities.

The graph below compares the abatement observed in the Power sector to date as shown in this *Tracking Progress* report series with the potential described in the *Low Carbon Growth Plan for Australia*, noting that total abatement figures per sector do not align exactly due to the different methodologies used for the two reports and changes in the economic context between 2011 and today<sup>10</sup>.

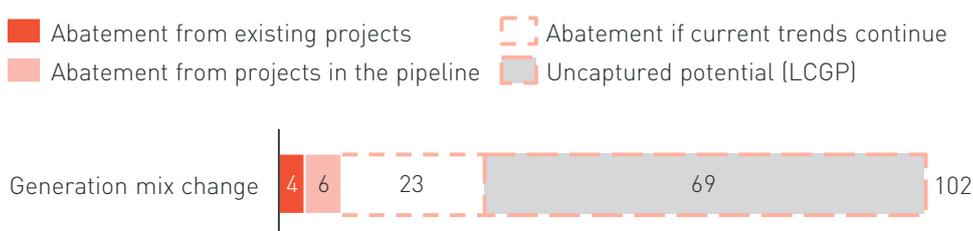
In the Power sector, an additional 69 MtCO<sub>2</sub>e would be required in 2019-20 to meet the 25% emissions reduction potential modelled in ClimateWorks' *Low Carbon Growth Plan for Australia*.

Most of the additional potential resides in further increases in renewable generation (mostly from wind, solar and biomass), as well as increases in efficient gas generation, which would allow further displacement of coal generation or retirement of some coal generators.

Additional potential resides in energy efficiency in the Power sector, in particular energy efficiency improvements in power plants.

Further abatement could be achieved through partial use of biomass in coal-fired plants and pilots in carbon capture and storage.

Relative share of emissions reduction potential by sector, MtCO<sub>2</sub>e (ClimateWorks 2011, ClimateWorks team analysis)



<sup>9</sup> Please note that abatement related to demand reduction from the Buildings and Industry sectors is discussed in Report 3: Industry and Report 4: Buildings in the *Tracking Progress* series, however the impact that demand reduction in these sectors could have on the generation mix of grid-supplied electricity is captured in this report on the Power sector. Any further reduction in demand for grid-supplied electricity demand is likely to reduce fossil fuel generation.

<sup>10</sup> The *Low Carbon Growth Plan for Australia* (LCGP) is used only as a benchmark indication of how much potential remains available. The numbers presented in this report differ from the numbers presented in the LCGP given that those two analyses have slightly different scopes: the LCGP assessed abatement potential above the Australian Government's business-as-usual emissions projection, whereas this *Tracking Progress* study reports on all abatement activity undertaken, including abatement that would have been regarded as part of business-as-usual by government projections. For example, installation of new renewable capacity to meet the Renewable Energy Target was included in the Government's business-as-usual projection, but has been included in our abatement calculation in this report. This means that the 'total potential' referenced in this report appears larger than what was reported in the LCGP.

# Case studies



## Australia's largest wind farm

AGL is one of Australia's leading integrated renewable energy companies with 30 per cent of its generation portfolio consisting of renewable capacity.

In a joint venture with Meridian Energy, AGL constructed the Macarthur Wind Farm, comprised of 140 individual 3 MW wind turbines and fully operational since January 2013. Macarthur Wind Farm is currently the largest wind farm in the southern hemisphere.

The wind farm is estimated to produce approximately 1.2TWh of electricity a year – equivalent to more than 220,000 average Victorian households - and abate more than 1.7 MtCO<sub>2</sub>e of greenhouse gases every year - the equivalent of taking more than 420,000 cars off the road.



Image supplied by AGL ©



## Improving emissions intensity in coal generation

Delta Electricity is one of the largest electricity generators in the National Electricity Market (NEM), supplying up to 12 per cent of the NEM's electricity needs. Delta Electricity operates about 3,700 MW of black coal generation capacity across New South Wales.

Delta Electricity's sustainability team has investigated the carbon content of different black coal supplies used in its generation portfolio, finding that its geographically diverse operations means that different sites receive coal with variable greenhouse gas emissions profiles and energy contents.

This finding has led Delta Electricity to start considering the quality of black coal in its purchasing decisions. Delta Electricity has found that coal from one mine could have 2 per cent more greenhouse gas emissions than an equivalent energy amount from another mine, equivalent to 43 kg of CO<sub>2</sub> per tonne of coal.

Full case studies are available in the full Power report (Report 2) from the 2013 *Tracking Progress* report series.

# CONTACT US

For further information about this project,  
and to view all reports in the Tracking Progress series, visit

[www.climateworksaustralia.org/tracking-progress](http://www.climateworksaustralia.org/tracking-progress)

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A detailed bibliography is available in the full report for the Power sector at  
[www.climateworksaustralia.org/tracking-progress](http://www.climateworksaustralia.org/tracking-progress)

