Conscious uncoupling?

Low Carbon Economy Index 2015

October 2015

1.3%
Annual fall in carbon intensity since 2000

3%
Annual carbon intensity reduction needed to achieve Paris targets

6.3%
Annual carbon intensity reduction needed for 2°C

$700bn
Estimated annual low carbon investment in EU and China

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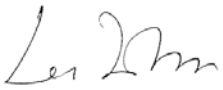
Foreword

The 2015 Low Carbon Economy Index (LCEI) bucks the trend. For the first year in the seven since the Index began, we have what looks like the uncoupling of growth and emissions; GDP grew by 3.3% in 2014, with energy emissions up by only 0.5%. And the stage is set for national commitments in Paris in December 2015 to drive the rate of decarbonisation even further. The pledges made to date, according to the 2015 LCEI analysis, would drive the decarbonisation rate from now to 2030 up to 3% per year.

What are the implications for business and government? Coal is under pressure, as countries focus on pathways to rapid decarbonisation; reductions in emissions from coal-fired power plants are at the forefront of many national pledges for Paris. On the opportunity side for business, the global investment horizon for renewables is starting to open up. China, one of the index's emerging markets leaders in decarbonisation, has proposed to more than double its installed wind energy capacity by 2020, aiming to add, in just five years, onshore wind capacity equivalent to the EU's entire capacity today. The scale of investment needed to meet just China's wind and solar targets is likely to add up to around $230bn. But this is also a developed markets story. In the EU, renewable capacity will increase from 12% of the energy mix today to 27% in 2030. Investment in the EU's energy and transport infrastructure is estimated to be $300bn every year. In the US, wind and solar's share of the electricity mix are expected to rise from 7% today to 12% in 2030.

2015 marks progress, a gathering of momentum, but by no means the end of the policy story. Even the 3% rate pledged for Paris still falls far short of what's needed for 2°C. Our analysis concludes that to prevent warming in excess of 2°C, the global economy needs to cuts its carbon intensity by 6.3% a year, every year from now to 2100. On our current burn rate, we will use up the carbon budget for the century by 2036. Just as important as the pledges made for Paris, will be the mechanisms agreed to monitor performance and ratchet up decarbonisation targets to keep us within 2°C.

Could we bridge this decarbonisation gap? LCEI confirms three grounds for cautious optimism. First, while the performance is mixed across the emerging economies (E7), China continues to improve its carbon intensity. Second, underpinning these improvements globally is not just energy efficiency – limited in its upside – but the rapid growth of renewables across both the G7 and E7. Third, at the US-China summit, China has just committed to launch a national emissions trading system in 2017, providing the potential for carbon pricing to incentivise more rapid decarbonisation. Is there a tipping point for business, driving the board level logic of decarbonisation? As revolutions in nanotechnology drive the costs of renewable energy down further, the prospect is rapidly emerging for the levelised cost of low carbon energy sources to broach cost parity with fossil fuels. It's all to play for.



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Contents

Summary

In December, Governments meet in Paris to agree how to tackle climate change. The deal is expected to have far reaching implications, affecting energy, transport, industry, buildings and finance. It will change investment decisions made by companies and spending decisions made by consumers.

The rapid decoupling of emissions from economic growth is essential to avoid the worst impacts of climate change. Since 2009, the year of the Copenhagen Summit, our Low Carbon Economy Index tracks the progress G20 countries have made to decarbonise their economies. The results for 2014 are shown in section 1. In section 2 we analyse the targets (or Intended Nationally Determined Contributions – INDCs) that countries have proposed out to 2025 or 2030. The third section considers the implications of these targets for business, and the scale of investment required to achieve them.

Good progress in 2014

Countries have made progress in decarbonising their economies since 2000, though emissions continue to rise. The carbon intensity of the global economy has fallen on average by 1.3% each year since 2000, driven by energy efficiency improvements and the shift to less carbon intense service sectors. This is despite the growth of coal in the energy mix from 25% to 30% over that period. **The 2014 numbers suggest a turning point: carbon intensity fell by 2.7%, the steepest decline on record.** The largest EU countries showed particularly sharp reductions of over 7%, with the UK topping our Index with a 10.9% fall in carbon intensity – the highest by any country over the last six years. These may be the first signs of uncoupling of emissions from economic growth.

Despite this, there is still a big gap between current progress and what's needed to meet the Intergovernmental Panel on Climate Change (IPCC) 2°C carbon budget. On the business as usual trajectory of 1.3% (2000-14), the two degree carbon budget will run out in 2036, with projected emissions growth following the IPCC's four degrees scenario. The annual decarbonisation rate now required to limit warming to 2°C has risen again to its highest ever level, 6.3%.

Determined national contributions

In the lead up to the Paris summit, governments have proposed a range of emissions targets with different baselines and target years. PwC's LCEI calculates the implied carbon intensity pathways and assesses their ambition on a comparable basis. **South Africa, Mexico and Korea have the highest level of ambition according to our measure.** They will need to approximately triple their current decarbonisation rate to achieve their target. The US and China's targets also imply a step change in action to reduce carbon intensity.

Overall, the national targets imply a global average decarbonisation rate of 3% per year – more than double the business as usual rate of 1.3% (2000-14), but falling short of the 6.3% annual decarbonisation now needed. This INDC pathway is more closely aligned with the IPCC's three degrees scenario. To address the emissions gap, the Paris agreement will need a process to review progress and **a ratchet mechanism to raise ambition in future**. These elements in the Paris deal are critical, as the longer the delay in action the more rapid future reductions will need to be, and the costlier they become.

Although the Paris targets fall short of what's needed for 2°C, countries will have to shift into a higher gear to achieve them – reducing their carbon intensity even faster. The implications for business are clear. **Companies should anticipate both more ambitious climate policy in the near term and the prospect of physical climate impacts in the longer term**.

Increasing regulation is one of the top concerns of CEO's, according to our recent pulse survey on climate change. But this regulation is also driving action from companies, changing the way they manage risk, make investments and develop new products. The INDCs are already being translated into national regulations and will be the key to unlocking the technology and investment needed to accelerate decarbonisation.

The investment implications

The Intended Nationally Determined Contributions describe a step change in effort to address climate change and are probably the most relevant part of the Paris negotiations for companies. Many of the INDCs are explicit about goals in particular sectors (power generation, transport, steel) and the scale of investment in the low carbon transition implied is estimated to be up to $700bn per year in the EU and China alone. The private sector, as the principal delivery agent, should expect further regulation of emissions, increasing the direct or implied price of carbon, and more incentives for investment in low carbon infrastructure.

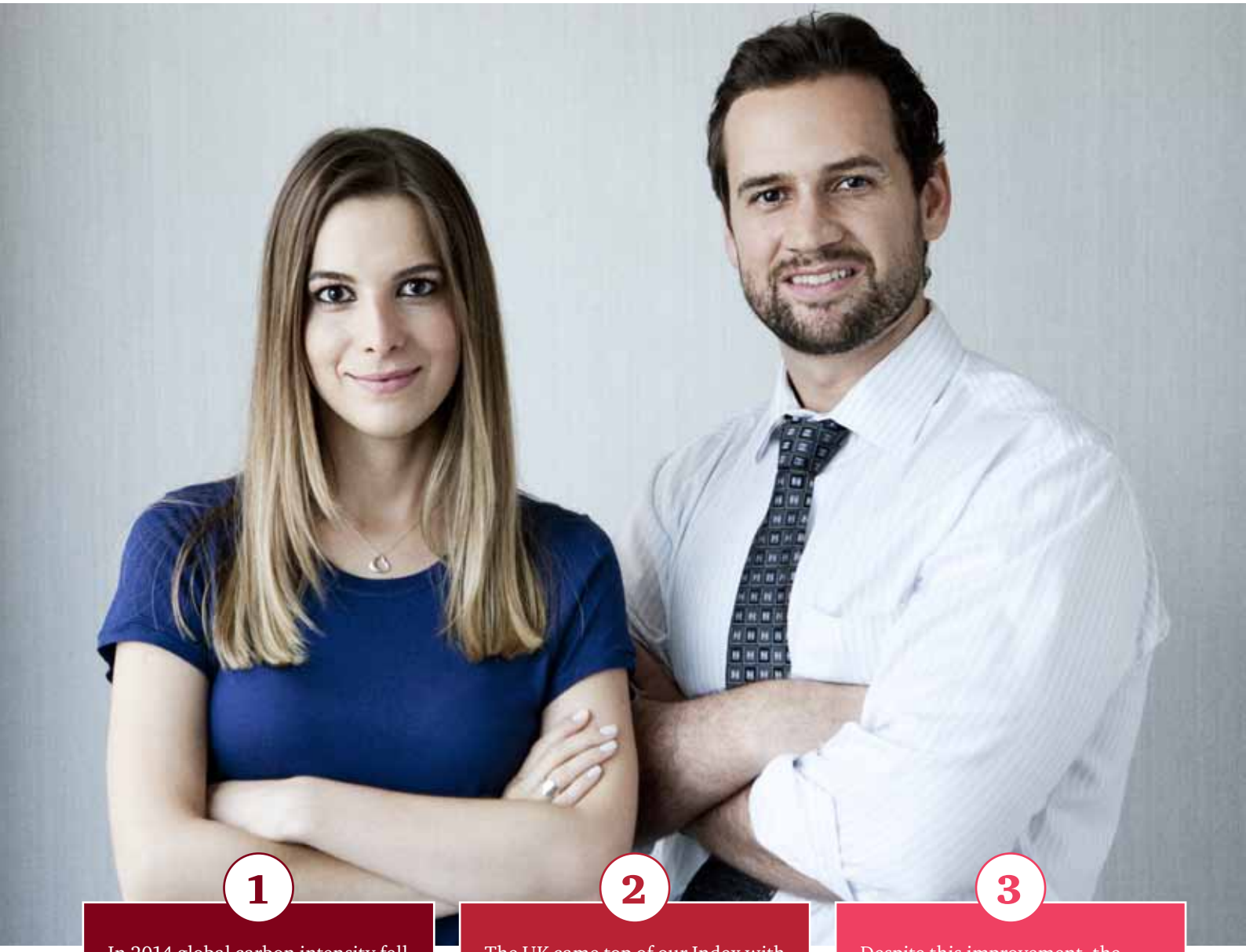
Three consistent themes emerge from the INDCs. First, they aim to increase rapid investment in renewables and its share of the energy mix. For example, the capital investment needed to achieve China's wind and solar targets is likely to add up to around $230bn. National plans describe how carbon pricing and emissions standards at power plants will drive investment into gas, nuclear and renewables. This will also support smaller scale decentralised electricity generation, for example off-grid hydro and solar, which improves access to electricity in developing countries.

Secondly, many of the INDCs will put coal under pressure. Coal fired power generation is being targeted in countries' decarbonisation pathways and many have put regulation of coal front and centre of their INDCs. But despite tightening efficiency standards and emissions standards, as well as widespread carbon pricing regulation, coal maintains cost and availability advantages in many locations and hence is still expected to be a major component of the energy system in 2030.

Thirdly, the financial services sector will play a critical role in delivering this investment. The levels of investment needed for the low carbon transition will require not just the mobilisation of investors, but also the creation and innovation of financial products to finance and insure the projects involved.

At the same time, financial institutions will need to start assessing their exposure to climate risks. This ranges from assets stranded by tightening climate policy to the implications of carbon pricing on their clients' creditworthiness and to the physical impacts of climate change on the assets that they have financed or insured. The recent announcement by the Bank of England that climate change is a threat to financial stability is a stark warning of the macroprudential risks of inaction, and should encourage financial institutions to integrate climate change into their wider risk management frameworks.

1. Conscious uncoupling in 2014?



1

In 2014 global carbon intensity fell by 2.7%, the steepest decline on record. The largest EU countries showed sharp reductions of over 7% and the rest of the EU performed well too.

2

The UK came top of our Index with a remarkable 10.9% fall in carbon intensity – the result of a strong economy, a warmer winter and lower coal use.

3

Despite this improvement, the annual decarbonisation rate now required to limit warming to 2°C has risen again to 6.3%, as falling short of the required rate means there is more to do in subsequent years. By continuing on the average trajectory since 2000, the two degree carbon budget will run out in 2036.

Potential for optimism

PwC's Low Carbon Economy Index has tracked the progress of the G20 economies against a 2°C global carbon budget for the past seven years. Throughout this period, we have seen economic growth closely coupled with growth in carbon emissions. The latest evidence from the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (AR5) reinforces the message that, without the rapid decoupling of GDP and emissions, climate change will present widespread threats to business and society.

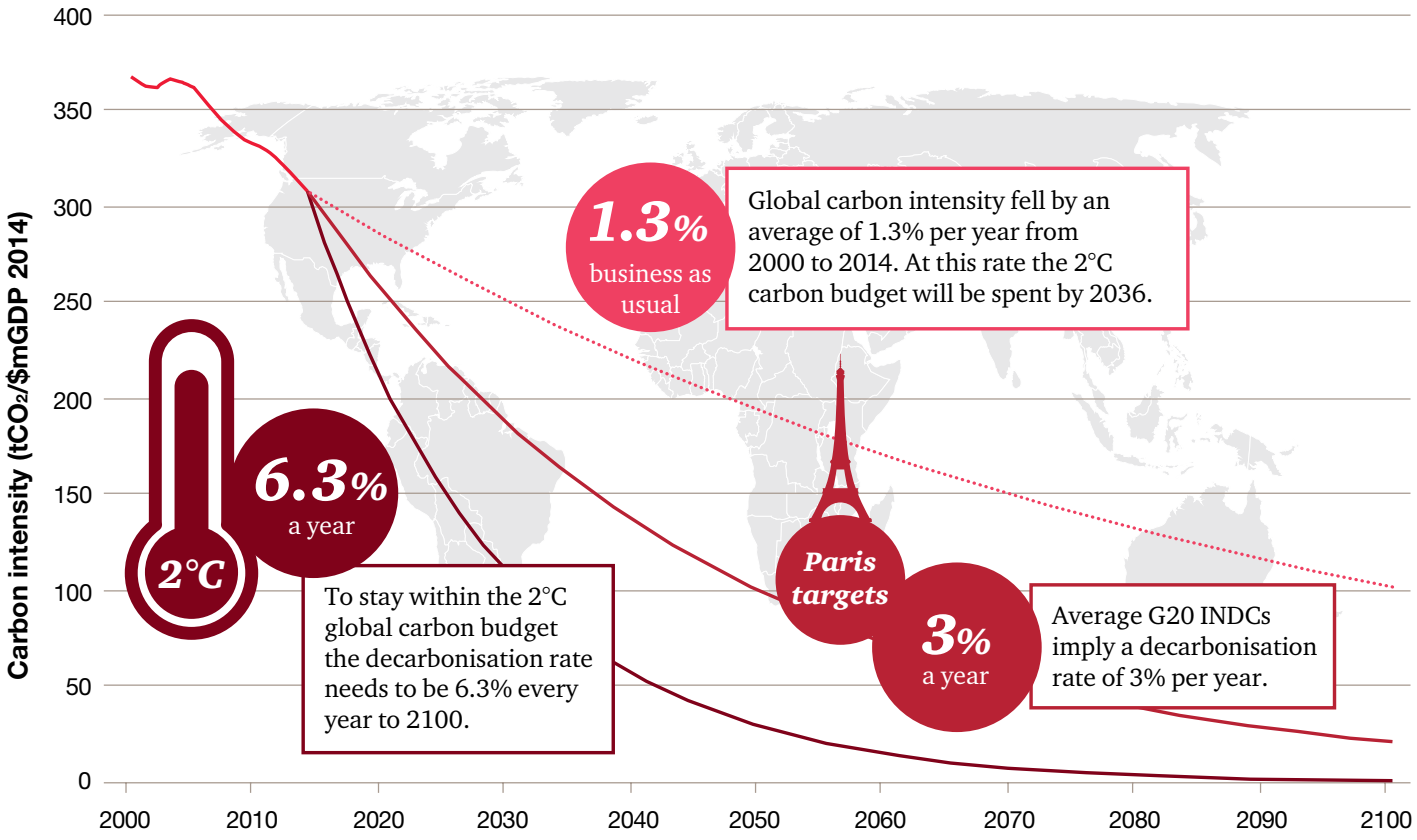
AR5 sets out four carbon budgets that correspond to different degrees of warming by the end of this century. The current consensus target by governments, convened under the UN Framework Convention on Climate Change (UNFCCC), is to limit the global average temperature increase to 2°C. The IPCC states that the physical impacts of more than 2°C of warming will be severe and in some cases irreversible. The IPCC's two degrees scenario (known as RCP2.6) gives a two thirds chance of achieving that goal and assumes cumulative fossil fuel CO_2 emissions between 2010 and 2100 of no more than 270GtC (or around 990GtCO_2).

While all parties at the UNFCCC have committed to the goal of limiting warming to 2°C, implementation has fallen well short. The current trajectory is aligned with the IPCC's highest emissions scenario which projects warming in the range of 3.7-4.8°C this century.

In December 2015, all governments meet in Paris to try to agree a deal to avoid this outcome. PwC's LCEI reviews progress made by countries since 2000. For the first time this year we have seen an apparent uncoupling of GDP and emissions. In 2014, energy related emissions increased by just 0.5%. Only in 2009, at the peak of the global recession, have emissions grown by less this century. In contrast with 2009, 2014 saw robust GDP growth of 3.3%. Combined, this has meant we have seen the fastest annual fall in carbon intensity, 2.7%, since 2000.

However, the increased decarbonisation rate seen in 2014 (2.7%) falls substantially short of what's needed for 2°C. **To prevent warming in excess of 2°C the global economy now needs to cuts its carbon intensity by 6.3% a year, every year from now to 2100.**

Figure 1: Pathway to 2°C



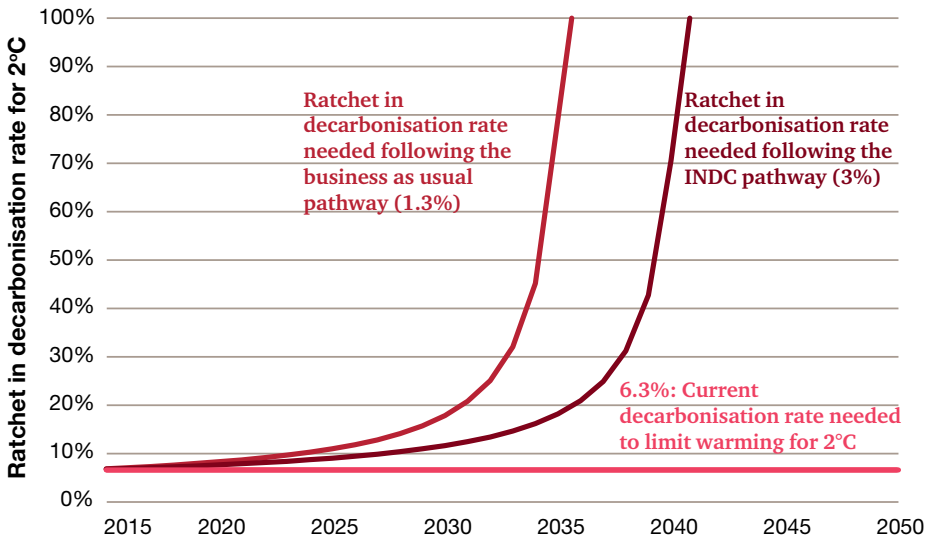
Sources: BP, Energy Information Agency, World Bank, IMF, PwC data and analysis.

Notes: GDP is measured on a purchasing power parity (PPP) basis. The INDC pathway is an estimate of the decarbonisation rate needed to achieve the targets released by G20 countries. Where countries have not released a target their Copenhagen target is used. Turkey and Saudi Arabia are yet to set any form of target and are thus excluded. INDCs only cover the period to 2030, we extrapolate the trend in decarbonisation needed to meet the targets to 2100 for comparison.

Continuing on the current business as usual trend, the 2°C carbon budget will be exhausted by 2036. We will have spent the carbon budget allocated for this century in the next 21 years. Achieving the Paris targets requires a decarbonisation rate of 3% per year (see section 2 for more detail).

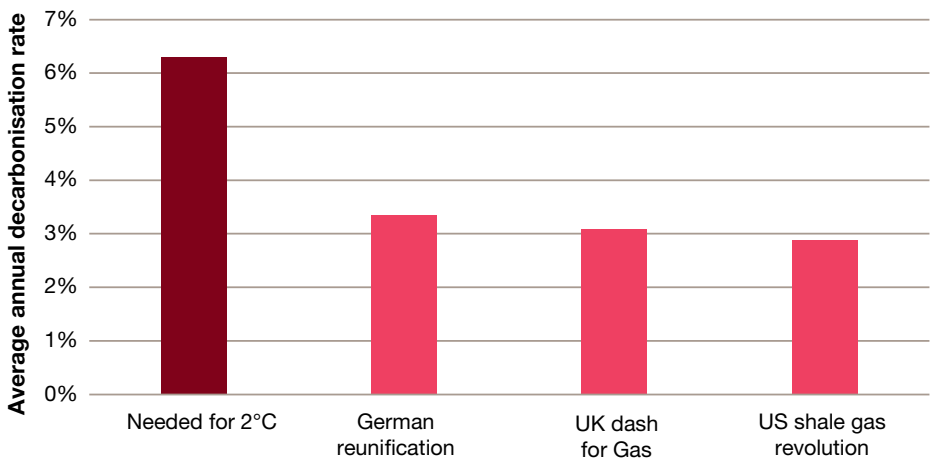
Figure 2 below shows the ratchet in the rate of annual decarbonisation that will be needed for 2°C in the future according to the three different rates of decarbonisation: 1.3%, 3% and 6.3%. Following business as usual (1.3%), by 2020, the decarbonisation rate will need to be 8% a year. By 2025 almost 11%. After 2030 the rate needed rises exponentially and by 2036 it will be too late, the budget for the rest of the century will have been completely spent. In other words, if we do not increase the rate of decarbonise soon, we will have to decarbonise at rates in future that will be at best expensive and at worst impossible.

Figure 2: Ratchet in decarbonisation rate needed for 2°C



Sources: BP, Energy Information Agency, World Bank, IMF, PwC data and analysis.

Figure 3: The challenge of 6.3%?



Notes:

German restructuring: 1991-1999
UK dash for gas: 1991-1999
US shale gas revolution: 2005-2012

Is the 6.3% decarbonisation rate achievable over a sustained period? The challenge is a large one, 6.3% is approximately double the rate of decarbonisation achieved following the restructuring of Germany's industry and power generation after reunification in 1990. The UK's shift to gas in the 1990's and the US's recent shale gas revolution also achieved carbon intensity reductions of around 3% each year.

But this year's results offer encouragement; four of the G20 countries have exceeded 6.3% in 2014 with China not far behind. The challenge is to broaden this uncoupling of growth from emissions to all countries and to maintain it for decades.

The Index: Mixed progress at the national level

Last year we estimated that the global economy needed to reduce carbon intensity by 6.2% a year to limit warming to 2°C. While 2014 saw a near doubling in the rate of decarbonisation achieved in 2013, we still fell short of this global target. Therefore, the rate required for 2°C has increased to 6.3%. This overall progress masks a wide variation in decarbonisation at the national level.

2014 is the first year we have seen more than one country achieve a rate of 6% or above, with five countries reaching this threshold, as well as the EU as a whole. The **UK** leads the index with a remarkable 10.9% decarbonisation. **France** was not far behind, and actually reduced carbon emissions by slightly more than the UK but experienced slower GDP growth. **Italy** and **Germany** posted very strong decarbonisation rates. Although Italy's emissions fell rapidly, its economy also contracted slightly. Germany however achieved fairly rapid emissions reductions as well as economic growth of 1.6%. **China** also recorded a rapid decarbonisation rate. And while **Australia** has slipped from the top spot, it still recorded a decarbonisation rate of 4.7%.

At the other end of the table carbon intensity actually rose in 5 countries: **South Africa, India, Brazil, Saudi Arabia** and **Turkey.**

Table 1: Low Carbon Economy Index – country summary

	2013-2014				Trend this century	
Country	Change in carbon intensity 2013 – 2014	Carbon intensity (tCO2/$m GDP) 2014	Change in energy related emissions 2013 – 2014	Real GDP growth (PPP) 2013 – 2014	Annual average change in carbon intensity 2000 – 2014	Annual average change in GDP 2000 – 2014
World	-2.7%	306	0.5%	3.3%	-1.3%	3.7%
G7	-3.1%	266	-1.5%	1.6%	-2.0%	1.4%
E7	-3.4%	378	1.8%	5.4%	-1.1%	6.7%
UK	-10.9%	173	-8.7%	2.6%	-3.3%	1.7%
France	-9.1%	124	-8.9%	0.2%	-2.7%	1.1%
Italy	-7.8%	151	-8.2%	-0.4%	-2.2%	-0.1%
Germany	-7.1%	201	-5.7%	1.6%	-2.0%	1.0%
EU	-6.7%	187	-5.4%	1.3%	-2.4%	1.2%
China	-6.0%	515	0.9%	7.4%	-2.0%	9.8%
Australia	-4.7%	342	-2.3%	2.5%	-2.4%	3.0%
Mexico	-3.5%	219	-1.5%	2.1%	-0.2%	2.1%
Korea	-3.1%	419	0.1%	3.3%	-1.3%	4.0%
Japan	-3.0%	273	-3.1%	-0.1%	-0.7%	0.7%
Canada	-2.4%	366	0.1%	2.5%	-1.7%	2.0%
Russia	-2.2%	409	-1.6%	0.6%	-3.6%	4.1%
Argentina	-1.7%	191	-1.2%	0.5%	-0.9%	3.6%
US	-1.6%	317	0.8%	2.4%	-2.3%	1.8%
Indonesia	-1.4%	193	3.5%	5.0%	-0.6%	5.4%
South Africa	0.2%	612	1.7%	1.5%	-1.6%	3.1%
India	0.7%	268	8.2%	7.4%	-1.4%	7.2%
Brazil	3.6%	155	3.8%	0.1%	0.0%	3.2%
Saudi Arabia	4.0%	386	7.6%	3.5%	0.0%	5.2%
Turkey	4.4%	224	7.4%	2.9%	-0.6%	4.0%

Key: Top 5 | Bottom 5

Sources: BP, Energy Information Agency, World Bank, IMF, PwC data and analysis

Movers and shakers: analysing the results

UK (1.3% of global energy related emissions, 2.3% of global GDP)

The UK's 10.9% reduction in carbon intensity is better than any reported in the LCEI before. It achieved this exceptional rate by lowering energy related emissions by 8.7% while delivering strong GDP growth of 2.6%. The fall in emissions resulted from both an absolute reduction in energy consumption of 6.3% (to levels lower than recorded in 1990) and a shift away from carbon intensive fuels. The biggest driver of the fall in emissions was a reduction in coal consumption of just over 20%, taking total coal consumption to less than half of its 1990 level. This was supported by a 19% increase in renewable energy consumption, taking renewables' share in overall energy consumption to 8.3%.

However, its performance may be down to circumstances rather than climate policy. Although in 2014 the Carbon Price Support mechanism reduced the differential between the marginal generation costs of coal vs gas, this remarkable decarbonisation rate is likely attributed to two other factors. Firstly, it was the warmest year ever recorded in the UK which meant lower demand for heating. On a temperature corrected basis the fall in total energy demand was less than half as steep[1]. Secondly, two coal fired power plants had unexpected closures due to fire damage, driving generation towards gas and other sources.

But the UK also holds medium term promises as the EU Large Combustion Plant Directive (LCPD) continues to influence decisions in coal-fired power plants. A number of power generation companies have announced that they are bringing forward plans to close their plants, and biomass is increasingly being used to replace coal.

France (1% of global energy related emissions, 2.4% of global GDP)

Already the most carbon efficient country within the G20, France has the highest fall in energy related emissions of 8.9% in 2014, but lost out to the UK because of slower GDP growth. It has relatively low coal use as nuclear forms a large proportion of power generation, but nevertheless France saw a large decline in coal consumption of over 20% in 2014 alongside a 16% reduction in the amount of gas consumed. The introduction of France's carbon tax on gas, heavy fuel oil and coal, which came into force at €7 per tCO2 in 2014, may have contributed to the effect.

As host country to a global deal, France is keen to show leadership. A bill was passed mid-2015 to raise the carbon tax to €56/t in 2020 and €100/t by 2030, accompanied by targets for greater renewable generation and away from nuclear.

Rest of the EU (10.4% of global energy related emissions, 17% of global GDP (EU28))

The warmer weather has benefited much of the EU, with Italy and Germany completing the top five in our index. **Italy** saw reductions in energy demand albeit against falling GDP as well. But more notable is that within the energy mix the share of fossil fuels has fallen, compensated by continued growth in renewables which now make up 19.2% of total energy consumption compared to 16.6% in 2013.

In our last report **Germany** was in the bottom two of our index with emissions rising since 2011 following the decision to reduce its reliance on nuclear. However, this year the trend has reversed and Germany is fourth in the G20 with a 7.1% fall in carbon intensity. This was driven by a reduction in total energy consumption of 4.5%, with falling demand across all three fossil fuels. Renewables' share of the energy mix continues to grow as part of Germany's large scale energy transition known as 'Energiewende', reaching 12.8% in 2014.

As the four countries make up just over half of EU's total energy use, the EU result can be largely attributed to changes within these Western Europe economies, in particular the weather effect. Indeed smaller EU members with a similar climate such as **Belgium** and **Netherlands** also saw total energy consumption falling by 5.3% and 6.1% respectively from 2013 to 2014. But the overall EU performance can also be attributed partially to the contributions from several Eastern European countries, such as **Poland** and **Czech Republic**, which saw double-digit growth in renewables, though from a low base, and falling fossil fuel use.

China (28% of global energy related emissions, 16.6% of global GDP)

China is the best performing non-EU country in the table with a decarbonisation rate of 6.0%. Energy related emissions grew by just 0.9% in 2014, less than half the rate of growth posted in any year since 1998. While GDP growth moderated slightly, China's economy still grew by 7.4% suggesting that in 2014 China was able to decouple emissions from growth.

The main cause of the slowdown in emissions growth was the stall in coal consumption. Having grown by 7.4% on average each year since 2000, coal consumption was largely unchanged in 2014, growing just 0.1%. A number of factors are likely to have played a role in this slow down. China's economy is rebalancing with the service sector growing its share of GDP to 48% (from

1. UK Department of Energy and Climate Change, Energy Consumption in the United Kingdom (ECUK)

43% in 2010). This shift has decreased the share of the energy intensive manufacturing sector to 43% (from 47% in 2010). Within this broader macroeconomic trend, there is evidence that coal reliant sectors, like steel, are starting to cool with steel consumption shrinking in China for the first time since the 1980s[2]. China also continues to invest heavily in renewable energy with investment reaching $89.5bn[3] in 2014, helping to take renewable energy consumption to 10% of total demand. The data for 2014 may also be starting to show the effects of recent government policies, such regional emissions trading schemes and emissions performance standards affecting coal consumption.

Despite this good news, China remains the world's largest emitter and has the highest carbon intensity in the G20 after South Africa. For the world to achieve its goal of limiting warming to 2°C this progress needs to be maintained.

Australia (1.1% of global energy related emissions, 1% of global GDP)

Australia unexpectedly topped the LCEI in 2014 for the second year in a row. This year, Australia slipped to 7th in the rankings, recording a decarbonisation rate of 4.7% in 2014. This was driven primarily by a 2.5% fall in energy consumption and 2.5% GDP growth and despite renewables' share of the energy mix falling from 6.5% to 6.1%. That share fell because of a 26% fall in hydropower – a reversion to the norm after unusually high rainfall in 2013 resulted in a 30% spike in hydro output that year. However, strong growth in solar and wind energy continued.

There has been significant change in the climate policy landscape in Australia over the past twelve months, with the repeal of the Carbon Tax in July 2014 and the passage through the Senate of the new Government's Direct Action policy in October. The key element of the Direct Action policy is the $1.8bn (A$2.55bn) Emissions Reduction Fund (ERF), which will provide businesses with incentives for emissions reduction activities across the Australian economy, through a system of reverse auctions for abatement commitments. The first auction in April bought 47m tonnes of abatement at $9.7 (A$13.95) per tonne. However, it remains to be seen whether it will be possible to effectively monitor and enforce the commitments secured through the ERF.

The Renewable Energy Target, state government feed-in-tariffs, and the falling price of renewable electricity technology, continued to support strong growth of solar and wind at 17.2% and 10.6% over 2013-14 respectively. Due to a recently introduced restriction on future investment into wind technology by the Clean Energy Finance Corporation, there is a degree of uncertainty as to how rapidly wind and solar will grow in the coming period; the change is likely to benefit solar, but investment in some existing wind projects may be at risk following the change.

The US (16.6% of global energy related emissions, 16.1% of global GDP)

Carbon intensity in the US has varied widely since we started the LCEI. In LCEI 2013 the US topped the Index, recording a 6% decarbonisation rate, as the shale gas revolution took hold, but last year the US was toward the bottom of the league with rising carbon intensity. This year the US finds itself in the middle of the pack with GDP growth outpacing rising emissions – resulting in a decarbonisation rate of 1.6%. Total energy consumption increased by 1.2% in 2014, in part driven by the extreme cold weather experienced at the start of the year. Emissions also rose but by slightly less at 0.8%, as the energy mix tilted marginally toward less carbon intensive fuels. Oil's share of the energy mix continued its slow decline (to 35.1%), and after an increase in 2013 coal's share in 2014 fell back (to 19.7%) to the lows seen in 2012. Gas made up the majority of the rest reaching 30.2% of the energy mix. Renewable energy continues to grow rapidly, with solar energy consumption doubling in 2014, but renewables still only make up 5.4% of total energy consumption.

Turkey (1% of global energy related emissions, 1.3% of global GDP)

Turkey finds itself bottom of the index this year, with its energy related emissions growing by 7.4%, much faster than its GDP growth of 2.9%. An uptick in the demand for coal of 14% was the primary driver of the increased emissions, a trend which looks set to continue; Turkey has committed to increase its coal production and consumption substantially in a bid to reduce the economy's dependency on imported gas, with 80 new coal plants in the pipeline. With the exception of hydroelectricity, Turkey is yet to develop its renewable sector – solar, wind and biofuels make up less than 0.5% of its total energy demand.

India (6% of global energy related emissions, 6.8% of global GDP)

India saw the highest rate of emissions growth over the year at 8.2% and contributed the most to the increase in global emissions in 2014. As with Turkey, this emissions rise was driven by double digit growth in the demand for coal at 11%, which now makes up 56% of India's total energy demand. While demand for renewable energy continues to grow, the rate of adoption is not fast enough to increase its share of the energy mix which has remained fixed at 7% since 2011. As the 4th largest emitter and the economy with the fastest expected GDP growth in our model, how India manages its carbon intensity will play an important role in determining the world's ability to limit warming to 2°C.

2. CISA

3. Bloomberg New Energy Finance

2. The national targets
A step change in ambition

1

Achieving the national emission reduction targets (INDCs) analysed by the LCEI requires an average annual decarbonisation rate of 3%.

2

The Paris targets imply a step change in effort from the 1.3% business as usual (2000-14), but fall short of the 6.3% needed for 2°C.

3

To address the gap, the Paris agreement needs to include a process to review progress on tackling emissions and a ratchet mechanism to raise ambition in future.

Defining ambition

Countries have presented their INDCs in the lead up to Paris in many different ways, and commentators have adopted a variety of methods to assess their ambition. Some have focused on the headline emissions reduction number, some look at the required change in emissions trajectory going forward and others have tried to determine whether they reflect a 'fair' contribution to the global effort to tackle climate change.

Our measure of ambition looks at the difference between a country's historic average decarbonisation rate – or business as usual pathway – and what it needs to do to meet its target. It strips out the distortion that arises from how targets are presented (what baseline and target years) and focuses on the change in effort required. In other words, if countries are runners in a marathon, we focus on the change in speed they are committing to, not where they are on the course, or how fast they are currently running. By doing so, we can infer the extent to which change is likely to happen in these countries, in terms of government policies, business practices and ways of living.

Our analysis of the national targets in this section considers the full national greenhouse gas inventory. So this analysis includes emissions from industrial process, fugitives (leaks from pipes), land use change and forestry. This is because some countries' targets focus on actions to reduce emissions in those sectors (which are outside our normal energy-based LCEI model). So although the emissions intensity numbers are not directly comparable with those in Section 1 of this report, the rate of change implied by the INDCs is comparable and is therefore also included in Figure 1.

Who is doing what?

Table 2 shows the calculated level of ambition for the major INDCs we have analysed. It is notable that three emerging economies top the table with the greatest ambition to decarbonise their economies. However, Mexico and Korea compared their targets to a baseline of projected emissions growth. The EU's relatively modest ambition may be explained by its low carbon intensity, strong historic decarbonisation since 2000 and perhaps by the increasing scarcity of low cost ways to reduce emissions.

Table 2: Targets and their ambition

Country	Ambition	Target annual decarbonisation rate 2015 – 2030	Business as usual decarbonisation 2000 – 2014	Forecast annual GDP growth 2015 – 2030	Forecast annual change in emissions to target 2014 – 2030
South Africa	3.0%	-4.5%	-1.5%	3.8%	-1.2%
Mexico	2.9%	-3.8%	-0.9%	4.0%	0.0%
Korea	2.8%	-4.4%	-1.6%	2.9%	-1.6%
Canada	2.7%	-3.9%	-1.2%	2.2%	-1.9%
Japan	2.6%	-3.2%	-0.6%	1.4%	-1.8%
Australia	1.9%	-4.4%	-2.6%	2.8%	-1.8%
US	1.8%	-4.3%	-2.6%	2.4%	-2.0%
China	1.4%	-3.5%	-2.0%	4.6%	0.9%
India	0.7%	-2.1%	-1.4%	5.5%	3.3%
EU	0.5%	-3.1%	-2.6%	2.0%	-1.2%
Brazil	-1.1%	-4.2%	-5.2%	3.1%	-1.2%
Russia	-4.4%	0.6%	-3.8%	2.0%	2.6%

Target description	
South Africa	Emissions in a range between 398 and 614 MtCO2e by 2025-30
Mexico	22% reduction against baseline scenario by 2030
Korea	37% reduction against baseline scenario by 2030
Canada	30% reduction against 2005 absolute emissions by 2030
Japan	26% reduction against 2013 absolute emissions by 2030
Australia	26% to 28% reduction against 2005 absolute emissions by 2030
US	26% to 28% reduction against 2005 absolute emissions by 2025
India	33% to 35% reduction against 2005 carbon intensity by 2030
China	60% to 65% reduction against 2005 carbon intensity by 2030
EU	40% reduction against 1990 absolute emissions by 2030
Brazil	37% reduction against 2005 absolute emissions by 2025 and indicative 43% against 2005 by 2030
Russia	25% to 30% reduction against 1990 absolute emissions by 2030

Notes: Target decarbonisation rates 2015-2030 calculated from INDCs. Ambition is the difference between the average decarbonisation rate since 2000 (or business as usual) and a country's Paris pledge. Ambition = (BAU decarbonisation)-(Target decarbonisation). Where the target year is before 2030 we extrapolate to 2030 using the annual average emissions change needed to meet target.

Turkey and Saudi Arabia are not included in this analysis.

Sources: UNFCCC national communications, national government data, BP, Energy Information Agency, World Bank, IMF, PwC data and analysis.

Key:

Top 3 | Bottom 3

Figures 5 and 6 show the historic and projected changes in carbon intensity of the major economies if they achieve their INDCs. Taken together, two aspects stand out. Firstly, although **all countries (except Brazil and Russia) are moving in the right direction, the emerging economies, Australia and Canada are projected to have higher carbon intensities in 2030 than the EU does today**. Secondly, the EU, the US and Japan appear to be on track towards the global average carbon intensity needed in 2030 for 2°C. However, unless they do better than the global average, allowing developing countries to increase emissions in the near term, they will quickly use the poorest countries' share of the carbon budget.

Figure 5: Emerging economies INDCs

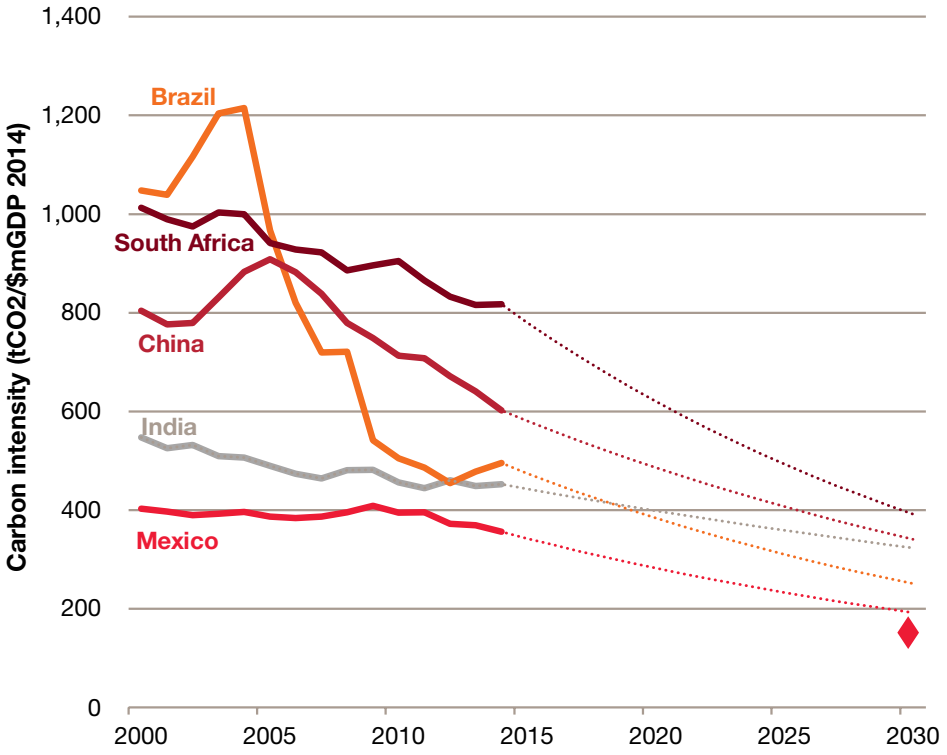
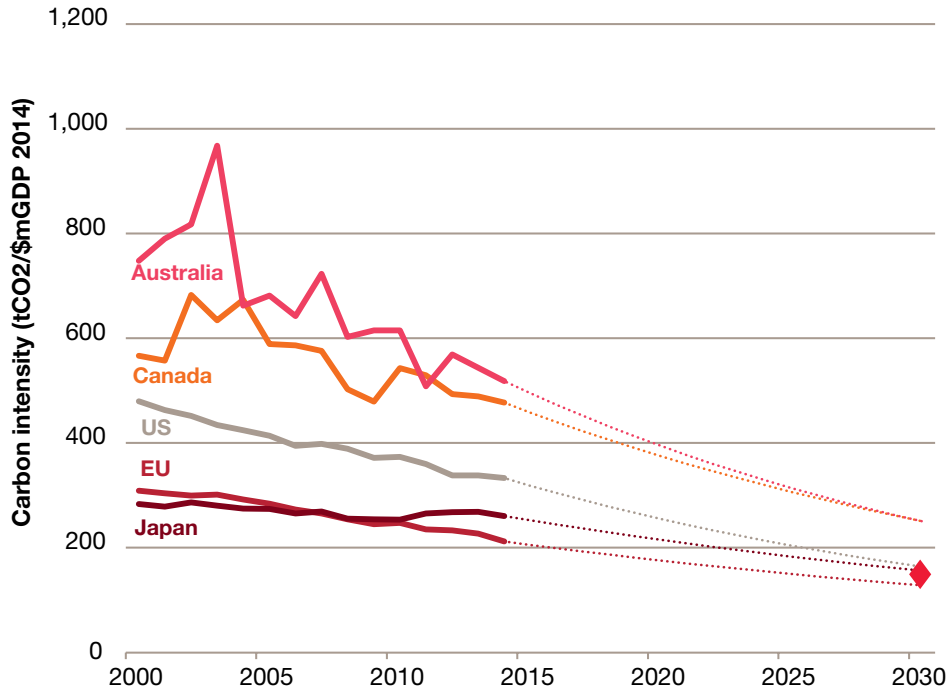


Figure 6: Developed economies INDCs



The red diamond indicates where global average carbon intensity needs to be in 2030 to be on a 2°C pathway

Notes for figures 5, 6 & 7: Target decarbonisation rates calculated from INDCs. Where target year is before 2030 we extrapolate to 2030 using the annual average emissions change needed to meet the target. Turkey and Saudi Arabia are not included in this analysis.

Sources for figures 5, 6 & 7: UNFCCC national communications, government statistics, BP, Energy Information Agency, World Bank, IMF, PwC data and analysis.

Figure 7: Global carbon intensity, GDP and emission growth forecast

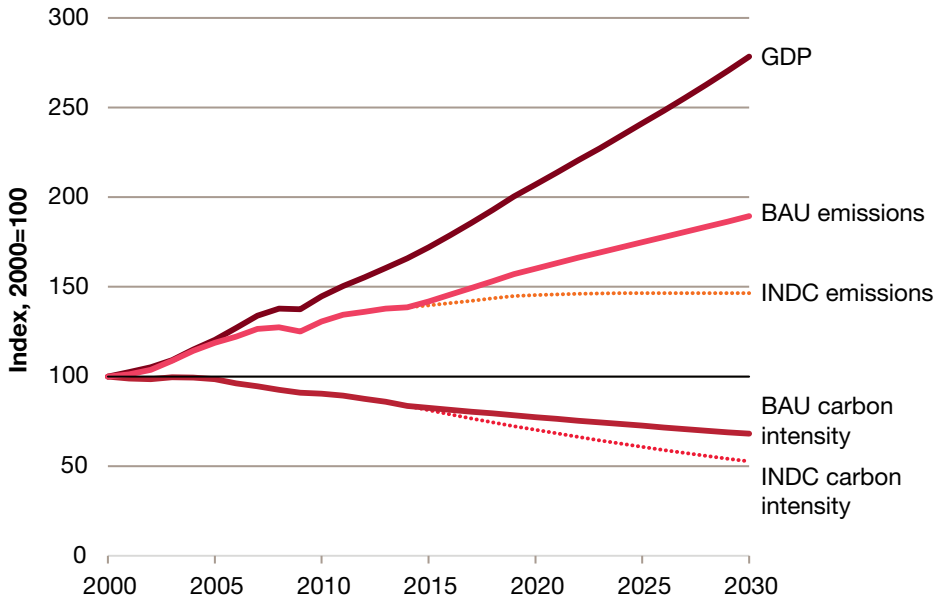


Figure 7 presents our forecast for global carbon intensity and its components (GDP and emissions), under our business as usual scenario and INDC scenario. This reveals a striking difference in the future path of emissions. Under a business as usual scenario the world's inability to decouple economic growth from emissions means that emissions will continue to rise out to 2030. Our model predicts that by 2030 annual emissions will be 37% higher than 2014 levels, and almost 90% higher relative to 2000 emissions. On that BAU pathway, we will spend the whole 2°C budget for this century over the next twenty one years.

By contrast, if we assume that all countries follow a linear or direct pathway to reach their target, our INDC scenario shows that global emissions will peak in 2025. However, this peak is unlikely to occur in 2025 as emissions are expected to grow in emerging countries in the short term before a more rapid decline further out. Overall though, if countries achieve their Paris targets, 2030 annual emissions will be just 6% higher than 2014 levels and will have only increased by 46% relative to emissions in 2000. Overall, this means that if countries achieve their INDCs, annual emissions in 2030 could be 23% below the business as usual projections.

More determination needed

Our analysis of these national emission reduction pledges suggests that they will increase the annual decarbonisation rate to 3% – if they are achieved. This is a step change from the 1.3% average annual decarbonisation rate seen this century and would buy the world an additional four years, with the 2°C carbon budget running out in 2040. By 2100 the level of emissions produced following the INDC pathway is aligned with the IPCC's scenario (known as RCP 4.5) that is expected to limit warming to 3°C.

While the Paris targets may be a step change from business as usual, they are clearly not in line with the 2°C goal. **To address the gap in required emissions reductions, the Paris agreement needs to include a mechanism to review progress on tackling emissions and a ratchet mechanism to raise ambition in future.** These process elements to the Paris deal are critical, as the longer we delay action the more rapid future reductions will need to be, and the costlier they will become.

A 3°C world is one in which the IPCC projects severe climate impacts. The IPCC's Fifth Assessment Report describes potential impacts including ocean acidification and frequent heatwaves and drought challenging global food supply and trade with knock on effects for migration and conflict. Furthermore, there is a potential that rising numbers of species face extinction, and more frequent extreme weather events will cause infrastructure damage, loss of life and business disruption.

3. What does this mean for business?

1

Coal is being targeted as major economies cap and regulate it in their INDCs. Despite this, coal is still expected to be a major component of the energy system in 2030.

2

The scale of investment in the low carbon transition implied by the INDCs is estimated to be up to $700bn each year in the EU and China alone. Finance is essential for meeting ambitious renewable energy targets and to accelerate a low-carbon transition in the transport sector. The vast majority of this is expected to come from the private sector.

3

As carbon pricing is increasingly adopted in developed and major developing countries, it's time for industry to build carbon costs into investment decisions.

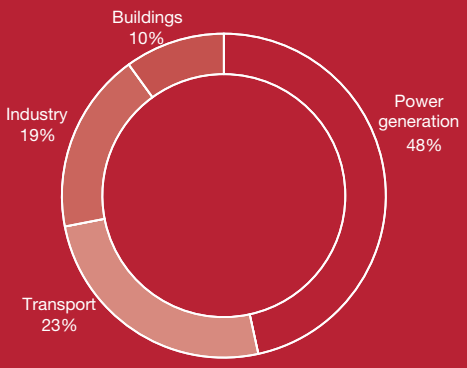
The step change ahead

The sum of INDC commitments represents a step change in decarbonisation, more than doubling the global rate of decarbonisation achieved to date, with far reaching impacts for business. Longer term ratchet mechanisms, designed to raise decarbonisation levels further beyond Paris, will present a series of further business risks and opportunities.

Business is responding. Although a binding deal in Paris is not the main driver of action for many, the regulation that follows is. Together with rising energy prices, this was cited as the top short-term concern by business in our recent CEO Pulse Survey on climate change. Companies are also motivated by improving growth opportunities, managing risk and costs, increasing shareholder value and rebuilding trust and reputation. Nearly all businesses (89%) reported making energy efficiency improvements, and over half (54%) are changing strategic investments in light of climate change opportunities. They are also changing how they manage risks (61%) and partnering with suppliers (58%) and consumers (55%) to address opportunities.

In the short term, the majority of INDCs have focused their emissions reduction efforts on the power, industry and transport sectors which account for 90% of energy related emission (the remaining 10% comes from buildings, while non-energy related land use change and forestry is important in Canada and Brazil). In this section we focus on the impacts the INDCs will have for **power, industry and transport**. We also look at the implications for the **renewables and finance sectors**.

Figure 8: Global energy related CO2 emission by sector



Source:
IEA, WEO 2014
PwC analysis

For each of these sectors we examine:

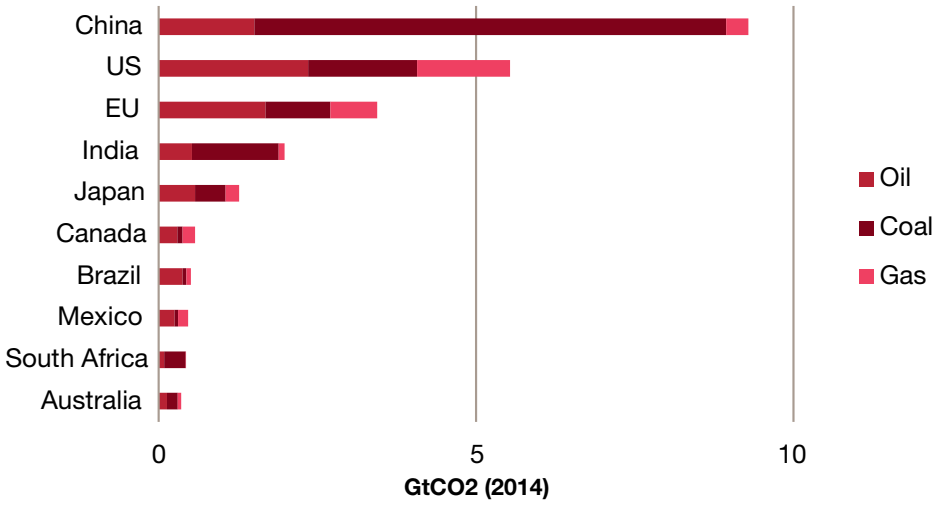
1. **Key countries**: Which countries are driving sectoral commitments?
2. **Main policies:** What are the main policies embedded in the INDCs?
3. **Implications**: What are the implications for business?

Power

Coal is under pressure

For all the focus on decarbonisation over the last decade, coal remains the dominant source of energy for the power sector (oil is a feedstock in the petrochemicals and chemicals sectors and some diesel is used for power generation, but oil is mostly used as a transport fuel – see next section). As Figure 9 indicates, China, the US and the EU top the table for global coal use, but India's emissions from coal, gas and oil have increased twice as much as China's over the past five years. Japan's coal consumption has risen since Fukushima. The energy mix in South Africa and Australia is dominated by coal and low on natural gas.

Figure 9: Emissions from coal, oil and gas in focus countries



Source: BP 2015

Policies to tackle coal in power are front and centre of the big players' INDCs

Table 3: Snapshots from INDCs that impact coal

China	National carbon market planned for 2017 and the National Development and Reform Commission rules that coal-fired power plants should engage in carbon capture and storage (CCS) pilot projects.
US	Clean Power Plan encouraging shift from coal to gas and renewables, and encouraging energy efficiency by electricity consumers across all states.
EU	EU Emissions Trading System (EU ETS) sectors to reduce emissions by 43% compared to 2005, equivalent to 2.2% a year from 2021 onwards, and the Large Combustion Plant Directive targets pollutants.
India	The carbon tax has doubled and applies to coal, lignite and peat.
Japan	Carbon tax targets coal and capping of coal fired generation now being considered.
Canada	Regulations under the Canadian Environmental Protection Act set emissions intensity levels for new power plants equal to Natural Gas Combined Cycle (NGCC) technology, ruling out new coal from 2015 without CCS.
Australia	Emissions Reduction Fund for carbon abating projects and new renewable energy targets.

Coal fired power generation is being targeted

Coal is potentially the most important part of a global decarbonisation pathway in the medium term. Most of the countries have made coal reductions front and centre of their INDCs, even though Australia and South Africa will need more time for the transition away from coal. This revolution is pushing investment into gas, nuclear and renewables and also smaller scale decentralised electricity generation, for example off-grid hydro and solar that improve access to electricity in developing countries.

Coal demand plateaued in 2014

2014 marked the first year this century where growth in China's coal consumption was curbed. China accounts for over half of global coal consumption so its climate and clean air policies can affect the global coal market. China's INDC specifically targets a shift to non-fossil fuels in primary energy consumption and an increase in the share of natural gas. China will also set coal consumption standards for new coal power stations 'to around 300 grams of coal equivalent (gce) per kilowatt-hour (KWh). This effectively pushes it towards the best in class coal units, CCS and gas for new power. China's coal fleet currently averages 335 gce/KWh with the most modern ultra super critical units achieving less than 280 gce/KWh. With roughly two-thirds of energy coming from coal, curbing emissions from existing coal-fired power plants depends on the success of CCS deployment in China, another focus area of its INDC.

The US is the second largest coal consumer, and the Clean Power Plan, specifically targets reducing emissions from the country's most carbon intensive power plants

Coal heavy Wyoming and Kentucky currently offer the lowest average retail electricity prices in the US[4], so policy changes that either charge or push them to switch fuels will affect their competitive advantage. It is no surprise that several states are hoping to overturn the Clean Power Plan, in spite of the potential emissions reductions that it offers.

But the progress in China and the US could be offset by coal growth elsewhere

India's energy consumption has more than doubled this century to 638 Mtoe, and 63% of the increase came from the addition of 216 Mtoe of coal. Indonesia is another growth market for coal with 2014 consumption over four times its 2000 level.

4 State Electricity Profiles for 2013, EIA as of July 2015, http://www.eia.gov/electricity/state/

Industry

Momentum on carbon pricing for industry is building

Table 4: Snapshots from INDCs that support carbon pricing

China National carbon market planned for 2017.

US and Canada Ontario has joined the Western Climate Initiative's (WCI) cap-and-trade scheme, the largest North American carbon market led by Quebec and California.

EU EU Emissions Trading System (EU ETS) sectors to reduce emissions by 43% compared to 2005, equivalent to 2.2% a year from 2021 onwards.

Korea The Republic of Korea launched its national ETS (KETS) in January 2015.

Today there are 62 carbon pricing programmes in force or planned worldwide

Some 13 years after the UK implemented the first scheme in 2002. The World Bank estimates that approximately 12% of global emissions are covered by some form of carbon pricing initiative. Big emitters such as China are now starting to introduce carbon pricing, disarming some of the competitiveness concerns from the EU. A series of regional pilot programs has been the pre-cursor for China to implement a national carbon market from 2017 which would cover the largest volume of emissions in the world. The EU would then be put in second place for emissions coverage and Korea third.

The majority of the world's most carbon-intensive industrial products are made in a small number of countries. Crude steel production is dominated by China (50% of 2014 global total), followed by Japan (6.7%), US (5.4%) and India (5.3%)[5]. Similarly in cement, the top 2014 producers include China (60%), India (6.7%) and the US (2.0%)[6].

The business impact will vary

Under carbon pricing schemes, industry passes carbon costs on to consumers where they can. This is easier in less competitive markets, or if everyone in a sector is facing the same carbon price and takes similar action. If the cost is passed on it does not mean the policy has been ineffective. Increasing the price of carbon intensive options should ultimately shift demand away from these products and open up opportunities for alternative or recycled materials.

It will bring forward investments in best in class technologies

In the EU, separate PwC analysis indicates a carbon price of US$30 in 2030 would form at least 15% of the cost structures of energy intensive industries such as refineries and over 10% for petrochemicals. Where this carbon cost is not passed through entirely, or a conservative CFO does not want to rely on passing carbon costs through in prices, it will incentivise industries to bring efficiency investments forward.

5. Based on PwC analysis from Crude steel production 2014-2015, World Steel Association, as of August 2015, https://www.worldsteel.org/statistics/crude-steel-production.html
6. Based on PwC analysis from U.S. Geological Survey, Mineral Commodity Summaries for Cement, January 2015, http://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2015-cemen.pdf
7. Source: Figure 8.1 Direct GHG emissions of the transport sector, Chapter 8 Transport, IPCC AR5 Working Group 3

What to watch out for in power and industry

Likely tensions in the short term

- Slow action from countries prioritising short term growth to take advantage of cheaper coal.
- Limits to the emissions from power plants that equate to 'no new coal' without CCS, for example in the UK and Canada and now being considered in Japan.
- Risk of carbon leakage and lobbying from energy intensive sectors such as cement, aluminium and paper on concerns about competitiveness.
- Knock on impacts through coal's supply chain.
- The level of the carbon price and the complex mechanisms (such as free allocation and tax rebates) used by countries to protect different sectors.

Some opportunities

- Increased incentives for energy efficiency measures (with higher carbon price levels).
- Focus on CCS deployment.

Shifts in markets longer term

- A non-binding initial statement on carbon pricing in Paris and slow uptake in important industrial countries such as the US, India and Russia could protract carbon leakage and competitiveness debates.
- Diversification of supply chains to lower carbon intensive or recycled materials.
- CCS technological advances made by the power sector supporting CCS deployment in heavy industry.
- Potentially rapid shifts in competitive advantage as fuel subsidies are removed and carbon pricing comes in.
- Potential for more domestic gas production and consumption to reduce reliance on imports.

Transport

Under scrutiny

Road emissions make up 72% of global transport emissions, followed by aviation (10.6% for both domestic and international) and shipping (9.3%)[8]. Given their international nature, the aviation and shipping emissions are being addressed (albeit slowly) by the International Civil Aviation Organisation (ICAO) and International Maritime Organisation (IMO) respectively. INDCs focus on ground transport emissions from cars, freight and rail.

8. Source: Figure 8.1 Direct GHG emissions of the transport sector, Chapter 8 Transport, IPCC AR5 Working Group 3

Transport: under scrutiny

Table 5: Snapshots from INDCs and international transport policy updates

EU	Carbon content of transport fuel to be reduced by 10% by 2020. Vehicle manufacturers will have to meet more stringent efficiency targets for their new fleets (95gCO_2/km for cars by 2021 and 147gCO_2/km for vans by 2020).
Japan	50-70% next-generation vehicles by 2030. Road infrastructure investment will also improve efficiency using technology to manage traffic flows.
Korea	Investing in infrastructure, providing tax breaks for hybrid and electric vehicles and setting similar emissions standards to the EU.
India	Hybrid and electric vehicles will receive a $12.5m boost according to the 2015-2016 Union Budget.
Maritime	The International Maritime Organisation (IMO) Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) will address energy efficiency in shipping.
Aviation	International Civil Aviation Organisation (ICAO) plans to propose a global carbon offset scheme in 2016 for implementation in 2020.

Emissions standards under scrutiny

Manufacturers have consistently met their emissions targets, but concerns about the validity of emissions performance tests have now cast doubt over policy effectiveness. The US and Canada plan to roughly double vehicle efficiency by 2025; the EU is aiming for 95gCO_2/km for cars by 2021 and 147gCO_2/km for vans by 2020 and Korea has very similar targets. New and improved technologies are expected to contribute to these improvements, including vehicle light-weighting, hybrid drive trains, and electrification of the vehicle fleet. With this electrification comes the need to upgrade local grids to support the demand and provide charging points.

Japan and Korea provide hope with focus on electric and fuel cell vehicles

Electric and hydrogen powered vehicles have zero emissions from the exhaust pipe and so emissions standards do not apply. Japan is committing $400m into vehicles and infrastructure for energy efficiency improvements, targeting 50-70% next-generation vehicle (within which there is a focus on electric and hydrogen fueled vehicles) sales by 2030. Korea has made next-generation vehicles a similar priority, though without stating targets. Both also specify more efficient traffic flow management technology.

Biofuels remain stagnant or niche

Concern in the EU in 2012 about the implications of land use change for the production of first generation biofuels and a cap of 5% for their contribution to renewable fuels tempered investment with immediate effect; no capacity was added in 2013 compared to a high of nearly 4bn litres in 2008. The 2030 climate and energy package of the European Commission has no new targets for biofuels, and no adoption of rules for accounting for indirect land use change by the European Parliament. Investment today therefore focuses on demonstration-level second generation biofuels, supported by grants. The European Biofuels Technology Platform aims to issue a new policy framework for advanced biofuels in the future.

Brazil's biofuel outlook remains strong

Its $50bn per year sugar-ethanol market will continue to be significant for the transport sector and will be helped by the removal of petrol subsidies.

Need for more clarity on public transport, shipping and aviation ambitions

India's smart cities programme will look for efficient modes of public transport, but details are not yet available. The International Maritime Organisation (IMO) has a strong focus on efficiency and pollution but measures use CO2 per capacity mile, leaving total CO2 targets and climate ambition unclear. The Energy Efficiency Design Index (EEDI) imposes energy efficiency standards on new ships, while the Ship Energy Efficiency Management Plan (SEEMP) addresses energy efficiency in all ships. ICAO plans to propose a global carbon offset scheme in 2016 for implementation in 2020, but will need to convince the EU of its stringency if it is to avoid protracted political delays.

What to watch out for in transport

Likely tensions in the short term

- Low oil prices leading to increasing transport demand and emissions.
- Differences in national emissions standards.
- Concern over indirect impacts of first generation biofuels on land use change, e.g. EU investment remaining stagnant since 2012 and introduction of a cap of 5% for their contribution to renewable fuels.
- ICAO's carbon offsetting scheme for aviation will compete with the EU's, and there will likely be disagreement over stringency and implementation rules.
- Demographic changes in developing countries, such as Brazil, increasing the consumer population and demand for car ownership.
- Recent controversies within some automotive makers on manipulating emissions tests leading to distrust in vehicle improvements.

Some opportunities

- Investments into road vehicle technologies including vehicle design and materials and electrification.
- Smarter planning, such as India's smart cities.
- Technological developments for traffic management, such as Japan and Korea's smarter infrastructure
- Investments into low carbon public transport projects in countries such as China.
- Continued growth in biofuels market and further research and development opportunities.

Shifts in markets longer term

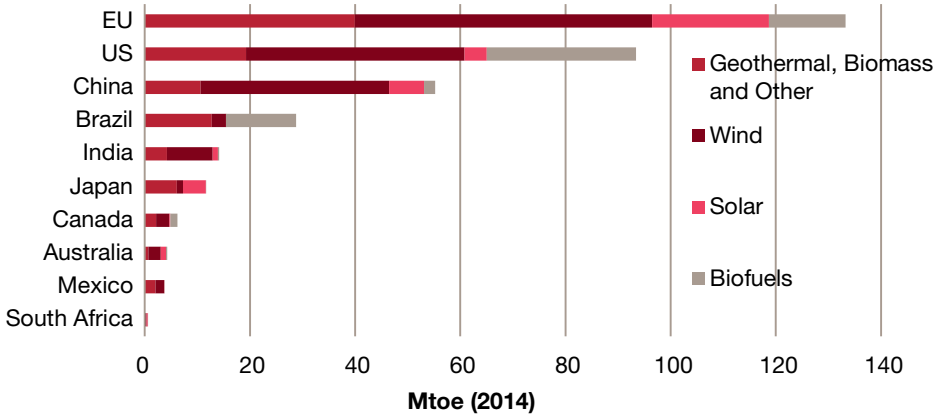
- Reduced oil demand as alternative fuels take hold.
- Increased demand for alternative fuel powertrain technologies and parts as well as traffic management systems.
- Increased cost of flying due to carbon offsetting scheme, unless biofuels can sufficiently reduce carbon emissions.

Renewables

Big targets and big funding gaps

The EU leads on energy generation from wind, geothermal, biofuels and solar, but including hydro would put China at the top. The EU strides ahead with a better quantity and balance in the renewable resources it is using.

Figure 10: Energy consumption from renewable sources, excluding hydro



Source: BP 2015

Renewables: big targets and big funding gaps

Table 6: Snapshots from INDCs that impact renewables

China	Targets of installing 104GW of wind capacity and 72GW of solar.
EU	Increasing the share of renewables in energy consumption from 12% today to at least 27% by 2030.
India	175 GW of renewables are expected by 2022, including 100GW from solar PV and 60GW from wind.
Australia	Renewable Energy Target (RET) aims for 23.5% of electricity to be generated by renewables by 2020, revised down by a fifth after amendments made earlier this year.
South Africa	Renewable Energy Independent Power Producers Procurement Programme (REI4P), launched by the Department for Energy, the National Energy Regulator of South Africa and Eskom in 2011. It has approved 5GW of renewable energy capacity and is considering a further 6GW.
Mexico	Targets for 35% of electricity to be from clean energy sources by 2024

Policies from the EU, US, China and India could drive global demand on solar and wind

Currently the EU is the largest market for renewables (excluding hydro), accounting for approximately 35% of global renewable energy consumption. This is followed by US (24%), China (14%), Brazil (8%) and India (4%). All INDCs from this group suggest growth in the wind and solar sectors, and Brazil in its biofuels sector.

The majority of the 'clean trillion' will come from the EU, the US, China and India

A recent buzzword in the renewable sector is the 'clean trillion', suggesting the level of annual financial investments (in US dollars) needed to deliver the renewable energy required for the 2°C target. In China alone, approximately 104GW of new wind energy capacity is expected to be installed by 2020 – equivalent to 35,000 3MW turbines or close to the current installed onshore wind capacity in the EU. Including the 72GW of solar and 60GW of nuclear capacity, investment in the Chinese renewable sector could add up to an estimated investment of US$230bn or 2% of one year of its GDP. The EU targets at least a 27% share of renewable energy by 2030. The cumulative investment needed to reach this target is likely to add up to at least $400bn, three quarters of which is for 200GW of solar. India's renewable targets imply an increase in investment ($210bn) that is similar to China's. But India is starting from a far lower base[9].

5 S's (sun, subsidies, silicon, skills and storage) will drive solar growth, and all but the sun need money

Solar PV has already reached grid parity in some sunny countries or states with generous subsidies. Technology improvements in solar cells are forecast to drive down costs per kWh by 20-25% between 2015 and 2030. But to speed installations the right skills are needed to build and fit the units. And over the longer term better energy storage systems will be required to integrate solar as a main power source.

9. Renewable Power Generation Costs in 2014, IRENA, 2015. European Wind Energy Association: Wind in power 2013 European statistics

What to watch out for in renewables

Likely tensions in the short term

- Conflicting policy incentives between feed-in tariffs to boost renewables and fossil fuel subsidies that reduce fuel poverty.
- Investment trade-offs between encouraging proven technologies and further research and development.
- Generating sufficient private sector investment to reach targets.
- Creating feed-in tariffs that give predictability and certainty to business.
- Avoiding fossil fuel technology lock in by encouraging electricity market reforms that improve renewable connectivity.
- The rate of build required to achieve targets could lead to implementation risks, e.g. skills, manpower and time.
- Some types of renewables could present economic and non-economic impacts, e.g. biofuel compete with cash crops in some markets, hydro power can raise other local environmental concerns.

Some opportunities

- Huge capacity extensions planned in China, EU, US and India.
- Reverse auction feed-in tariff policies becoming more widespread and provide better certainty for investors, for example in South Africa.
- Increased use of renewables generates demand for supporting technologies and supply chains.

Shifts in markets longer term

- Improvements in renewables transition over longer distances and battery storage.
- Diversification or shifts of focus from energy producers from fossil fuels to renewables could affect the market for coal and gas.

Financial services and governments: Need to tread new ground

Itself a low emissions sector, financial services are not mentioned in any of the INDCs. But the INDCs, if well implemented, could present opportunities for finance. The EU and China alone have estimated that the low carbon transition will require annual investments of $300bn and $400bn respectively. These levels of investment will require not just the mobilisation of investors, but also the creation and innovation of financial products to finance and insure the projects involved. The sector is responding, as can be seen most visibly with a recent surge in the use of 'green bonds' and the emergence and expansion of 'green investment banks'.

Momentum can be built if policymakers and public institutions are able to **catalyse private investment with public money**, creating larger-scale and more sustainable impacts especially in developing countries. **The sector needs to experiment and innovate with new instruments** to help generate deal flows into sectors such as renewables and energy efficiency, and reduce or insure the risk associated with new technologies. Bank loans are still the primary source of finance to enterprises in China, accounting for more finance than from issuing stocks or bonds in the capital market. As a lever to promote growth, the Green Credit Guidelines in China encourage banking institutions to promote 'green credit'. This credit is intended to support the low carbon economy and improve the environmental and social performance of banking institutions.

However, there is a limit to the amount that can be financed with bank debt, given increasingly stringent capital requirements that financial institutions face. Capital markets finance in this area will need to scale up if the missing 'clean trillion' is to be funded. For that to happen, financial structures will need to be created that meet the risk-return requirements of capital markets, and that means more innovative public-private financing. There will also need to be more concerted efforts to build domestic capital markets in emerging economies that can efficiently recycle savings there into low carbon assets.

Financial institutions will also have to address increasing levels of risk associated with high carbon assets. As the level of public awareness of the threat of climate change increases, there will be greater public pressure for financial institutions to take a position on their funding of carbon intensive activities. For example, the G20 has called upon the International Financial Stability Board to open an inquiry into the systemic risks of stranded assets. Financial regulators are also starting to take action: the recent report by the Bank of England and speech by its governor cites climate change as a threat to financial stability, and although it falls short of recommending regulation, states that it will seek appropriate inclusion of climate change risks in its ongoing supervisory activity. Financial institutions will need to start assessing their exposure to climate risks. This ranges from assets stranded by tightening climate policy to the implications of carbon pricing on their clients' creditworthiness and to the physical impacts of climate change on the assets that they have financed or insured.

Voluntary action also has its place, and the financial services sector has a long history of incorporating environmental and social issues into its business. The Montreal Carbon Pledge – a pledge by investors to measure and disclose the carbon footprints of their portfolios annually – is also gaining traction, with nearly 70 signatories so far.

Detailed national analysis

Australia

Emissions targets and implications for business

Australia has committed to reduce emissions by 26 to 28 per cent below 2005 levels by 2030

What is Australia's contribution...

1. The **Emissions Reduction Fund** (ERF) introduced in December 2014 replaced the carbon tax that was repealed in July 2014.
2. The ERF includes a '**Safeguard Mechanism**' which monitors big emitters to ensure that investments are not undone out by increases in emissions elsewhere.
3. A range of discretionary, graduated enforcement options will be open to the Clean Energy Regulator for facilities that exceed their baselines, calculated based on the high point of their last five years' emissions.
4. The **Renewable Energy** Target (RET) aims for 23.5% of electricity to be generated by renewables by 2020, down by a fifth after amendments made earlier this year.
5. Individual State governments continue to pursue their own emissions reductions targets, e.g. through energy efficiency trading schemes.
6. A 2017-18 consultation is planned to determine future abatement targets and policies.

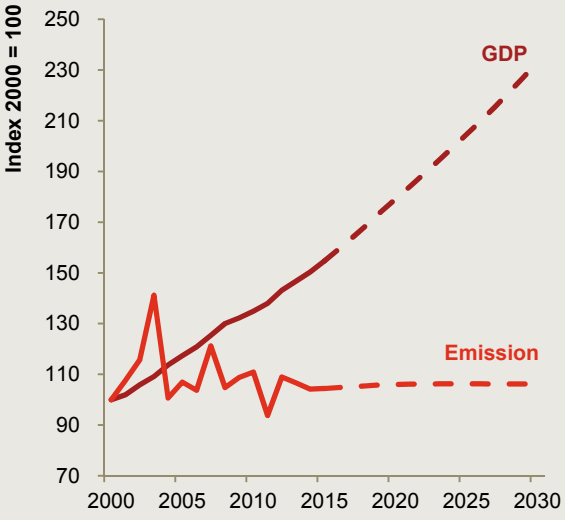
...and what are the implications for business

- 47 million tonnes of abatement commitments were auctioned at around **$10 per tonne of CO2** under the ERF in April 2015, using up nearly $0.5bn of the $1.8bn pot. Funds are not disbursed until emissions are abated.
- **Emerging technologies** are now the focus for $1.4bn of investment per year up to 2017 after the Abbott Government moved the mandate away from more established solar, wind and energy efficiency technologies.
- **Solar** is still attractive with falling technology costs and state level feed in tariffs of 3.5¢ – 5.7¢/kWh (lower than UK rates of 5¢ – 9¢/kWh which may be cut due to high uptake).
- New restrictions on **wind financing** by Clean Energy Finance Corporation (CEFC) could be damaging and put large scale projects in doubt.

(All dollars are US dollars)

GDP, energy and related emissions

GDP forecast: 2.8% per year
Emissions forecast: 0.1% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Australia has maintained a 24 year unbroken run of economic growth since 1992. Since 2000, GDP has increased by 56%, growing at an average of 3% per year. However, GDP growth has slowed since the global financial crisis, averaging 3.4% from 2000-08 but just 2.5% from 2009-14. PwC's World in 2050 forecasts Australia to continue to grow at 2.5-3.0% per annum over the coming years to 2030.

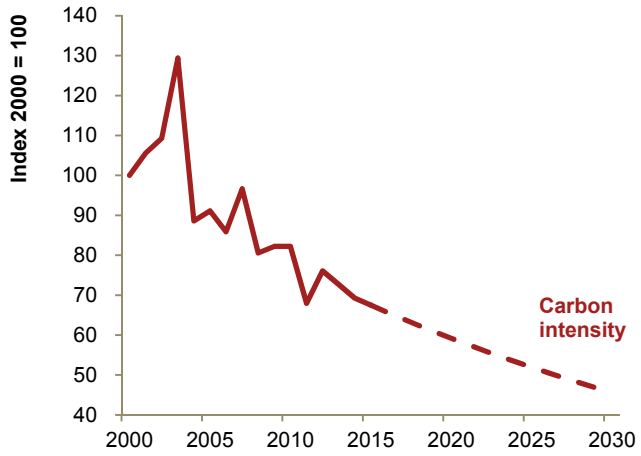
Energy: Australia's total energy consumption has risen by 14% since 2000. However, after a peak in 2012, total energy consumption has been falling. Energy consumed from oil, coal and gas sources fell by 2.9%, 2.3% and 0.1% respectively across 2013-14. This trend continued the slide for energy consumed from coal sources, which is down 18% since 2009, and contrasts with increasing trends for oil and gas over the same period (up 6.1% and 15.8% respectively). Coal, oil and gas still meet 94% of total energy demand in Australia.

Renewable energy: Australia's 6% of renewable energy has witnessed fast growth from a low base the past five years, with energy consumed from renewable sources increasing by 72% since 2009. This has been led by wind and solar collectively increasing their share of the energy mix from 1% to 3%. Solar energy consumption increased by 17.4% over 2013-14, with wind up by 10.6%.

Emissions: Australia's emissions breakdown by industry sector in 2013 was power and utilities 35%, agriculture, forestry and fishing 18%, manufacturing 13%, mining 12%, residential 10%, commercial services 5%, transport 5% and construction 2%.

Carbon intensity

Carbon intensity forecast: -2.6% per year



- Australia's decarbonisation rate has averaged 2.6% since 2000.
- For half of the years this century, Australia's carbon intensity has actually increased, driven by emissions rather than changes in GDP (which has increased steadily).
- Relatively volatile sectors such as forestry and agriculture are influential for emissions, causing large variations in carbon intensity. The spike in 2003 and 2004 reflects a 18.3% increase followed by a 31.6% decrease.
- In 2013 and 2014 Australia showed similar decarbonisation rates of 4.5% and 4.7%.
- Since 2005 there has been a steady shift of emissions away from agricultural, forestry and fisheries sources towards mining, transport and residential sources in particular, which may steady carbon intensity.
- We use the average decarbonisation rate since the turn of the century, 2.6%, for our business as usual forecast opposite and below.

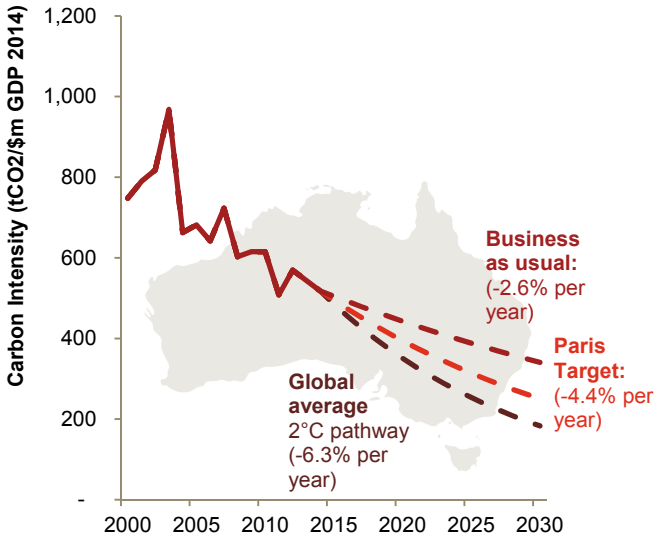
How ambitious is Australia's 26-28% target?

To meet its target, Australia needs to decarbonise by an average of 4.4% per year until 2030, including limiting fugitive emissions from mining and land use emissions. Compared with the average rate of decarbonisation achieved this century, 2.6%, this implies that a significant increase in effort is required. So business can expect a step change in climate policy and regulation in the short term to achieve this goal.

For comparison, the EU has also been decarbonising at an average rate of 2.6% per year since 2000, but on a steadier path. The EU's target only requires a decarbonisation rate of 3.1%. Canada has achieved less this century decarbonising at 1.2% a year but its target requires an increase to 3.9% per year. By our measure of ambition Australia's target appears to be more ambitious than the EU's but less than Canada's. That is, Australia requires a greater shift in the pace of decarbonisation than the EU but less than Canada.

However, Australia's absolute carbon intensity is above the G7 average. Even if Australia meets its target, its carbon intensity in 2030 is estimated to be only just below that of the UK in 2014. And like all of the INDCs the rate of decarbonisation needed falls short of the global average rate required to limit warming to below 2°C of 6.3%.

How ambitious is Australia's 26% to 28% target?



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Sources:
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Brazil

Emissions targets and implications for business

Reduce emissions by 37% by 2025, with an indicative extension to 43% by 2030, both against 2005 levels

What is Brazil's contribution…

1. **Deforestation levels should be 80% below the 1996-2005 average in the Amazon and 40% below 1999-2008 average in the Savannah by 2020**. 12 million hectares of forests should also be restored or reforested by 2030. Details on implementation are in the Forest Code, the Action Plan for Deforestation Prevention and Control in the Legal Amazon (PPCDAm) and the Cerrado (PPCerrado).
2. **Biofuels, ethanol and biodiesel is estimated to form 18% of the energy mix by 2030.**
3. **45% of energy mix should be from renewables**, up from 40% today.
4. In the electricity sector, the **non-hydro renewables share should double** to just under a quarter and an improvement of a tenth in the efficiency of electricity generation is expected.
5. International support is welcomed but not required, other than for REDD+ activities[1].

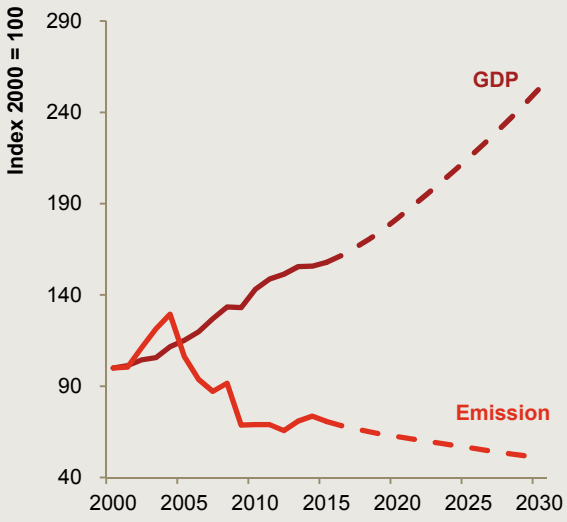
[1] The creation of financial value, or credits, for Reducing Emissions from Deforestation and Forest Degradation (REDD+)

...and what are the implications for business

- **$150m will be invested by government to avoid deforestation and burning in Cerrado by 2020**, after $460m was spent between 2011 and 2014.
- ABC or 'Low Carbon Agriculture' programme **loans for agroforestry reached $1.3bn in 2013**, investing in low carbon technologies and practices, soil uptake of nitrogen and rehabilitating degraded pastureland.
- **Clean energy sources are likely to benefit from $46bn targeted government investment** in generation and transmission lines by 2018.
- Hydro potential may be limited by dwindling untapped resource and droughts and investment incentives for other renewable energy sources are discussed.
- The Northeast and South regions offer high potential for **$10bn of planned investment in wind energy by 2020**, up from $6bn invested between 2004 and 2011.
- **Banks' interest in solar may return,** with 400 solar projects adding up to 10GW of potential solar capacity registered in 2014 and auction ceiling prices 25% higher in 2015 than the previous year (Brazil uses auctions to find willing suppliers at or below set consumer ceiling prices).
- **Industry has shown little sign of a focus on energy efficiency** for reducing emissions, particularly as Brazil hits recession.
- The $50bn per year Brazilian sugar-ethanol market will continue to be significant for the transport sector.
- Petrol and diesel price increases aid incentives for lower carbon fuels but increased energy costs for households by around **50%**.

GDP, energy and related emissions

GDP forecast: 3.1% per year
Emissions forecast: -2.3% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

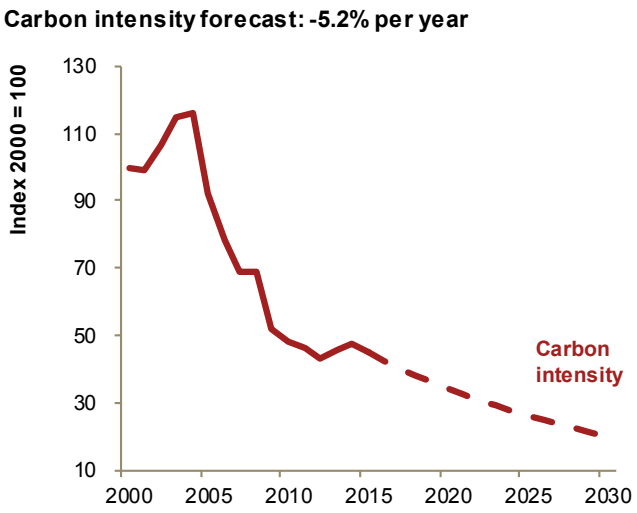
GDP: Since 2000, GDP has grown 56% to US$3,264bn in 2014 and at an average of 3.2% per year. It was strongest in the five years leading up to the global recession where it achieved above 3% each year and a high of 6% in 2007, but shrank just once before the current recession by 0.2% in 2009. The last three years have all been under 3%, the lowest of which 0.1% last year. But things are set to return to normal – PwC's World in 2050 forecasts a return to over 2% growth in the next five years and a 3.1% per year average up to 2030.

Renewable energy: Renewables make up 38% of the total energy consumption in Brazil, helped by hydro's 28% share and biofuel's 5%. However, despite increasing hydro power generation, recent droughts has affected output. Geothermal increased from 1% to 4% and wind now contributes 1%, but solar remains on zero despite government incentives.

Energy: Similar to GDP, energy consumption has increased 58% since 2000 to 296 Mtoe. Oil, at 42% of the energy mix, increased the most in absolute terms providing an extra 42Mtoe, supporting Brazil's biggest emitting sector after LULUCF, transport. Gas also increased in absolute terms (27 Mtoe) and more than doubled its share of the fuel mix from 5% to 12% this century. Coal absolute consumption remained stable and so its share of the growing total fell from 7% to 5%, while nuclear increased its absolute contribution to maintain its small 1% share.

Emissions: In 2005, total emissions were 1,637 MtCO2. LULUCF contributed 77%, energy contributed 18%, agriculture 1% and industry and waste made up 4% of emissions. Of the energy related emissions, transport contributed more than half and industry a quarter, the rest relates to power and buildings.

Carbon intensity

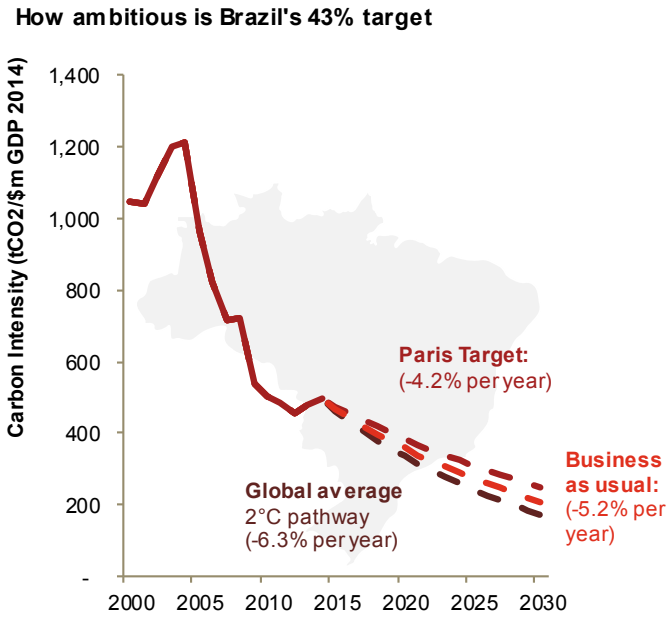


- Brazil's carbon intensity has seen the most dramatic trend this century, partly due to its sizeable LULUCF sector.
- It has averaged a decline of 5.2% per year, but has risen by 7.9% in 2003 and fallen by as much as 20% and 25% in 2005 and 2009. This change has been largely attributed to emissions reduction in deforestation.
- By contrast, when considering energy only Brazil's carbon intensity remained flat, although it did fall by 6% during the 2009 global recession.
- We use the average since the turn of the century, including LULUCF, 5.2%, for our business as usual forecast opposite and below.

How ambitious is Brazil's 43% target?

Brazil's BAU trajectory, decarbonising at 5.2% a year on average since 2000, is the closest country to the LCEI two degree trajectory. However by our measure of ambition it has become a victim of its own success because we look at the shift away from BAU, and its 43% implied an average decarbonisation rate of 4.2% per year.

While Brazil underperforms in our measure of ambition, its Paris Target should not be dismissed. Reducing deforestation has significantly contributed to carbon intensity reduction in the last decade, and continuing that trajectory, albeit slightly slower, will be essential in reducing land use emissions.



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
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Canada

Emissions targets and implications for business

Canada will reduce emissions by 30% on 2005 levels by 2030

What is Canada's contribution...

1. Regulations under the Canadian Environmental Protection Act set emissions intensity levels for new power plants equal to Natural Gas Combined Cycle (NGCC) technology, **ruling out new coal from 2015 without CCS**.
2. The Specified Gas Emitter Regulation under **Alberta's Climate Change and Emissions Management Act charges $11 ($15 CA) for each tonne of CO2 over 100,000 tonnes emitted in a year. The price will double to $22/tonne ($30 CA) in 2017.**
3. Under the same regulation, **Alberta companies are required to reduce emissions intensity by 20% by 2017.**
4. **Ontario has joined the Western Climate Initiative's (WCI) cap-and-trade scheme,** the largest North American carbon market led by Quebec and California.
5. **Ontario's aviation fuel tax is increasing** from 3.6¢ to 5¢ (4.7¢ to 6.7¢ CA) per litre by 2017.
6. **Vehicle emissions standards are proposed** at US Environmental Protection Agency levels.

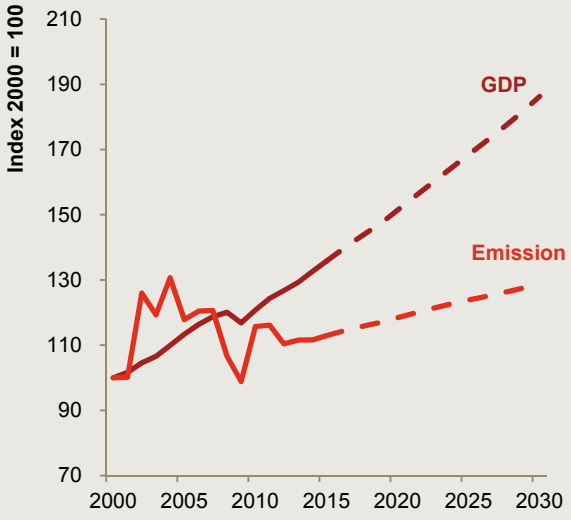
...and what are the implications for business

- The **WCI cap-and-trade scheme's eight auctions so far have generated $570m.** The August 2015 auction alone generated $150m for Quebec. This money is reinvested by the Green Fund in projects to reduce emissions, with a **focus on transport electrification**.
- **Auction revenues from Ontario's introduction to the WCI are estimated at $1.5bn in 2020.**
- The Climate Change and Emissions Management Corporation's (CCEMC), funded by the Alberta Specified Gas Emitter Regulation, has **$265m to spend on clean technologies.** When this funding is leveraged the total projects are estimated to be valued at $1.6bn.
- The Alberta government estimates that legislative burden and the planned increase in **Alberta corporate tax rate could add 30-40 cents to the cost of producing a barrel of oil sands by 2017.**
- Further exploitation of oil sands, primarily for the US market, will continue to suffer because of relatively high breakeven oil prices – Rystad Energy and Morgan Stanley estimate breakeven oil prices of $65 per barrel in Canada compared to $27 in the Middle East.
- **Alberta is looking to invest nearly $1bn between now and 2030 in two large oil sands CCS projects**: the Alberta Carbon Trunk Line and Quest Projects.

(All dollars are US dollars unless 'CA' stated for Canadian dollars)

GDP, energy and related emissions

GDP forecast: 2.2% per year
Emissions forecast: 0.9% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Apart from early 2015 when it entered slight recession, Canada has managed a steady 2% per year average annual GDP growth rate this century, suffering in the 2009 recession with a -2.7% change but bouncing back in 2010 with a 3.4% increase. 2014 saw an above average increase of 2.5%, taking GDP to $1,567bn. In the coming 15 years, PwC's World in 2050 predicts a 2.2% average annual GDP growth rate.

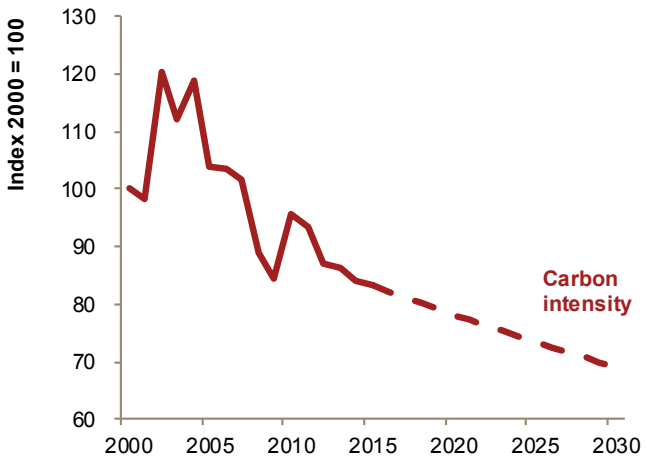
Renewable energy: The proportion of renewable energy in the energy mix has remained relatively steady since 2000, fluctuating between 27% and 28%. Hydro's large share, 26%, is supported by negligible contributions of 1% of wind and geothermal and biomass. Solar and biofuels remain at 0%.

Energy: Canada's electricity production is varied by province, from Quebec being second only to Iceland in terms of its renewable share for electricity (97.3%) to Alberta, where electricity generation is largely dominated by coal and natural gas (89.7%). At a national level, after a drop in 2009, energy consumption now totals 333Mtoe - a 10% increase on 2000 levels. Oil at 31%, gas at 28% and Hydro at 26% in 2014 have powered most of Canada consistently this century, fluctuating by only 1 to 2 percentage points (pp) each over the century. Coal declined from 10% in 2000 to 6% in 2014, balanced by nuclear increasing from 5%-7%, wind adding 1% since 2010 and a 1pp increase from oil.

Emissions: By Sector, electricity contributed to 12% of emissions, the oil and gas sector and industry 35%, transport 23%, buildings 12%, and agriculture, waste and others contributed 18% in 2013.

Carbon intensity

Carbon intensity forecast: -1.2% per year



- Canada's steady GDP and energy trends would provide for a virtually straight line carbon intensity decline, but land use emissions adds some variety.
- There were sharp increases in the early 2000s (22% in a single year in 2002) and a large drop in the 2009 recession (17% over two years since 2007).
- On average, carbon intensity fell by 1.2% per year this century.
- We use this 1.2% trend as our business as usual forecast below.

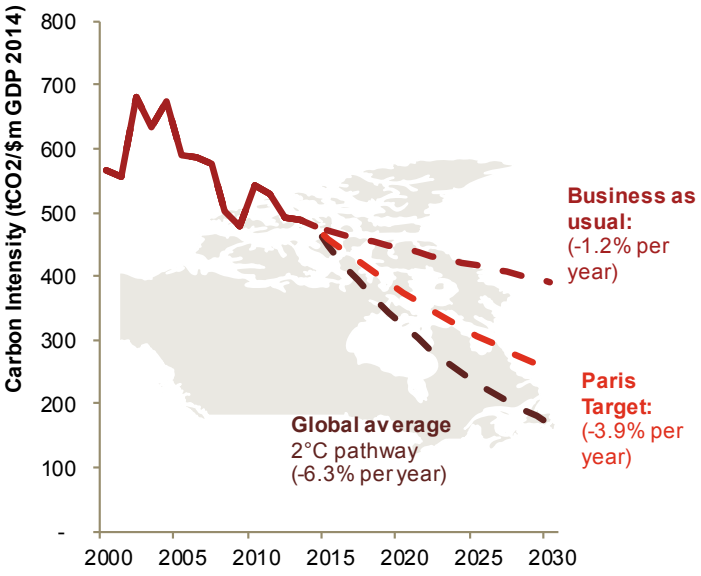
How ambitious is Canada's 30% target?

Contrary to other commentary, our Low Carbon Economy Index model shows that Canada's target is more ambitious than the EU and US targets. This is because it requires a greater shift from its business as usual carbon intensity reductions than the shift required by the EU and US to achieve their targets.

Canada's carbon intensity, or emissions per million dollars of GDP, has fallen by 1.2% per year on average since 2000. Adopting the 30% target (and sticking to it) will require a cut in carbon intensity of 3.9% per year given our GDP growth projections for Canada. This is close to what France achieved when it switched to nuclear power in the eighties. The shift in decarbonisation required to meet the EU and US targets is less than 2% compared with Canada's 2.7% change. But the targets proposed by countries fall far short of the 6.3% average decarbonisation rate needed globally to limit warming to two degrees.

Canada will need a significant shift in effort to tackle emissions if it is to more than double its current decarbonisation rate. So business can expect a step change in climate policy and regulation in the short term to achieve this goal.

How ambitious is Canada's 30% target?



Sources:
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China

Emissions targets and implications for business

China has committed to reduce its carbon intensity by 60-65% compared to 2005 levels by 2030, and increase the share of non-fossil fuels in primary energy consumption to around 20%

What is China's contribution...

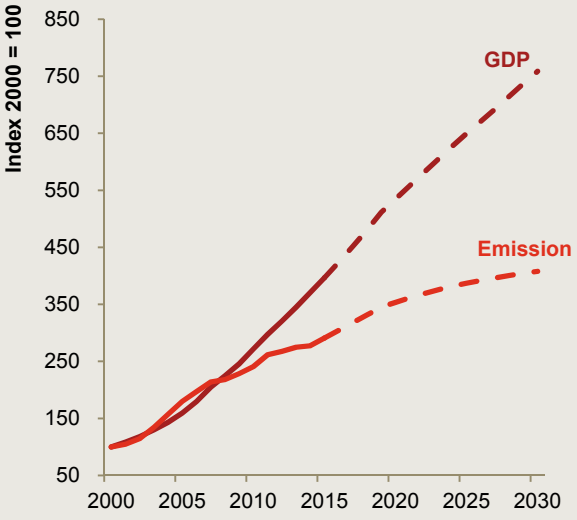
1. To peak CO2 emissions by around 2030, part of the U.S.-China Joint Announcement on Climate Change of November 2014.
2. To increase the share of non-fossil fuels in primary energy consumption to around 20%, installing 104GW of **wind** capacity, 72GW of **solar** and over 60GW of **nuclear** capacity.
3. To increase the **forest** stock volume by around 4.5 billion cubic meters on the 2005 level.

... and what are the implications for business

- At the UN Sustainable Development Summit in September 2015, China announced it will contribute **US$3 billion** for setting up a South South Cooperation fund to support developing countries to combat climate change and enhance their capacity to access the Green Climate Fund.
- The National Strategy Centre for Climate Change estimates that China will need to invest **US$6.3 trillion in the low carbon transition** including energy efficiency improvements, development of renewables, nuclear and CCS technology over the next 16 years. This equates to $400bn per year.
- The National Development and Reform Commission ruled that priority industries like coal-fired power plants, chemicals, steel, cement and oil and gas actively engage in CCS pilot projects to improve China's experience in the technology.
- China plans to implement a national carbon market in 2017 which would cover the largest volume of emissions in the world. For illustration, a modest **carbon price of US$20 per tonne in 2030 would form at least 10% of the cost structures** of energy intensive industries such as petrochemicals.
- The scale of investment to meet China's **wind and solar targets is likely to add up to around $230bn** (or 2% of one year's GDP).
- Approximately **US$130bn of investment will be needed to install the 104GW of wind capacity** by 2020 – equivalent to 35,000 3MW turbines or close to the current installed onshore wind capacity in the EU.
- We estimate **US$100bn will be required to add the 72GW of solar capacity** covering an area the size of London. Nearly 8GW of solar capacity, or roughly US$12bn of investment, was introduced in the first half of 2015.

GDP, energy and related emissions

GDP forecast: 4.6% per year
Emissions forecast: 2.4% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Since 2000, GDP has almost quadrupled, averaging growth of 10% per year. However GDP growth has slowed recently, falling from 9.3% in 2011 to 7.4% in 2014; the lowest GDP growth rate since 1990. PwC's World in 2050 forecasts this to slow to 4.6% per year on average between now and 2030.

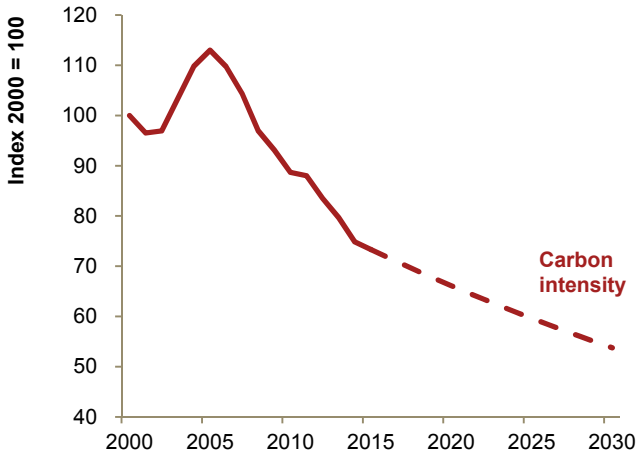
Energy: China's energy consumption has almost tripled in the last 15 years. Rapid coal increases in consumption in the early century have slowed in recent years, increasing by just 2.0% and 0.1% in 2013 and 2014 respectively. However coal still contributes 66% of total energy. The share of oil in China's energy mix has decreased from 22% in 2000 to 18% in 2014, whilst natural gas has increased from 2% in 2000 to 6% in 2014. Nuclear's contribution to the energy mix still remains negligible at just 1% in 2014.

Renewable energy: China's commitment to cleaner energy is growing, with just under 10% of the energy mix now supplied by renewable energy. This has risen from just 5.4% in 2000, with investment in renewable energy reaching $89.5 billion in 2014, and $431 billion since 2005. Rapid growth in hydroelectricity means that it now provides four fifths of this 10% share. Wind, biofuels, geothermal, biomass and solar have been growing at an exponential rate, but from a very low base.

Emissions: By Sector, Power contributed 57% of emissions in 2012, Industry 27%, Transport 9% and Buildings 7%.

Carbon Intensity

Carbon intensity forecast: -2.0% per year

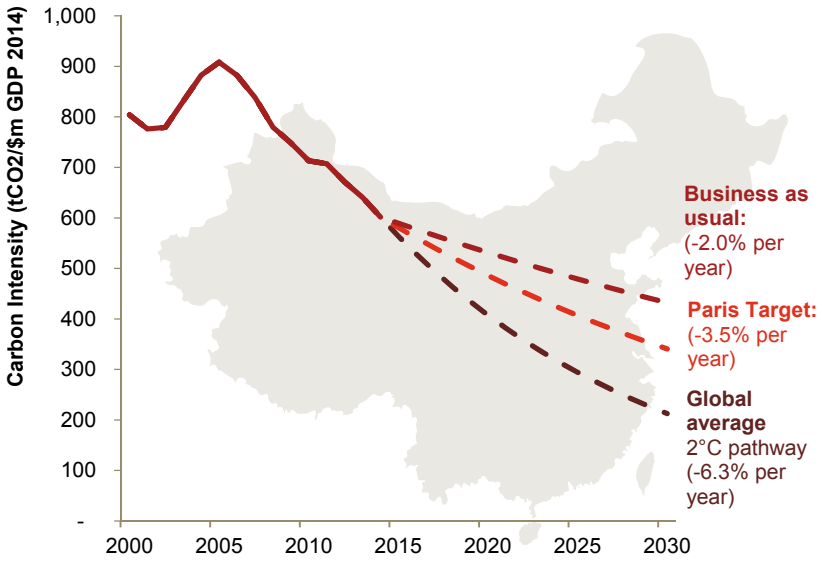


- China's decarbonisation rate has averaged 2% since the turn of the century.
- The average masks wide variations in annual rates from a 7% decarbonisation high in 2008 to carbon intensity increases of 6.7% in 2003.
- Since 2005, China has consistently decarbonised each year. Since 2011, the decarbonisation rate has risen from 1% to 6% in 2014.
- We use the 2% average decarbonisation rate so far this century for our business as usual forecast opposite and below.

How ambitious is China's 60-65% target

- Compared with its business as usual decarbonisation rate of 2.0% this century, China's target is relatively ambitious as it will require annual decarbonisation of 3.5% per year. However, against the 6.0% decarbonisation rate China achieved in 2014 the target looks like it could be achieved comfortably.
- Assuming the target is met, China's carbon intensity in 2030 will be roughly the same as the US' in 2014. Like the EU and US targets, China's falls short of the 6% annual reduction needed to limit warming to two degrees.

How ambitious is China's 60% to 65% target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
Historic emissions data: International Energy Agency, 2014, World Energy Outlook and UNFCCC
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EU

Emissions targets and implications for business

The EU has committed to at least a 40% reduction compared to its 1990 level by 2030 without the use of international carbon credits

What is the EU's contribution...

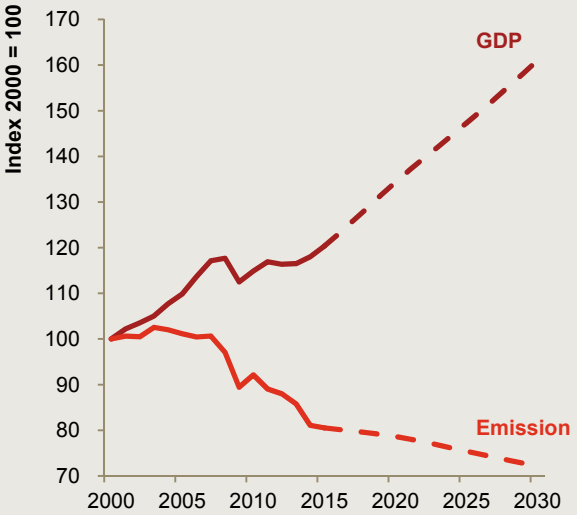
- The detail is in the EU Climate and Energy Package launched in October 2014.
- Increasing the share of **renewables** in energy consumption from 12% today to at least 27% by 2030.
- Reducing **energy consumption** by 27% against projections by 2030 through energy efficiency (this may be revised upwards in 2020 to 30%).
- **EU Emissions Trading System** (EU ETS) sectors to reduce emissions by 43% compared to 2005, equivalent to 2.2% a year from 2021 onwards, up from 1.74% between 2013 and 2020.
- Non-EU ETS sectors, such as **non-energy intensive businesses** and the residential sector, to cut emissions by 30% below 2005 levels.
- Intra-EU **aviation** to follow the EU ETS emissions targets notwithstanding International Civil Aviation Organisation plans to propose a global carbon offset scheme from 2020.
- **Transport fuel** carbon intensity to be reduced by 10% by 2020. Vehicle manufacturers will have to meet more stringent efficiency targets for their new fleets (95gCO2/km for cars by 2021 and 147gCO2/km for vans by 2020).

...and what are the implications for business

- The EU pledged around half ($4.8bn) of the initial $10bn capitalisation of the **Green Climate Fund** in Lima in 2014.
- The EU's **energy and transport systems will require over $300bn** of additional public and private investment per year for the next 40 years, or around 1.5% of EU GDP. In July 2015, the EU approved around $15bn of European Commission money for transport infrastructure investment, said to unlock an additional $33bn of public-private co-financing. This is estimated to create up to 10 million jobs and increase Europe's GDP by 1.8% by 2030.
- The cumulative investment needed to reach the EU's 2030 **renewable energy target is likely to add up to at least $400bn**, three quarters of which is for 200GW of solar which dominates capacity additions compared to 70GW of onshore wind.
- **Horizon 2020 offers $90bn** between 2014 and 2020 for research and development.
- Recent EU ETS reforms (backloading allowances and the market stability reserve) are designed to reduce the oversupply in the EU market and raise the **price of EU carbon credits (EUAs) from €8/tCO2 today to €29/tCO2 in 2020.**
- For illustration, a **carbon price of US$30 per tonne under the EU ETS in 2030 would form at least 15% of the cost structures** of energy intensive industries such as refineries and over 10% for petrochemicals.
- Upgrades and transformations to refineries are needed to remain profitable. For example Total invested €400 million to upgrade a refinery to produce new low-sulphur fuels and €200 million to transform a refinery into a biorefinery.
- The **NER300 programme raised $2.4bn** from the EU ETS from new entrants to the scheme and invested in 38 renewable energy projects and a **carbon capture and storage** (CCS) project. The successor in 2021, **NER400, could generate over $10bn** for investment in low carbon innovation in industrial sectors as well as renewables and CCS.
- Investment in **biofuels** has remained stagnant since 2012 owing to concerns about the indirect impacts of first generation biofuels on land use change and a cap of 5% for their contribution to renewable fuels. No new targets or rules for accounting for land use change have been adopted by the European Parliament. Investment today focuses on demonstration level second generation biofuels supported by grants.

GDP, energy and related emissions

GDP forecast: 2.0% per year
Emissions forecast: -0.7% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: The European economy is 18% bigger than it was in 2000, averaging 1.2% per year growth in spite of falls of 4.4% and 0.5% in 2009 and 2012 respectively. Last year it grew at 1.3%. According to our latest 'World in 2050' report, 2.2% yearly growth is expected over the next five years, falling to 1.9% on average in the 2020s. By 2030, the EU economy is projected to be 60% bigger than it was in 2000.

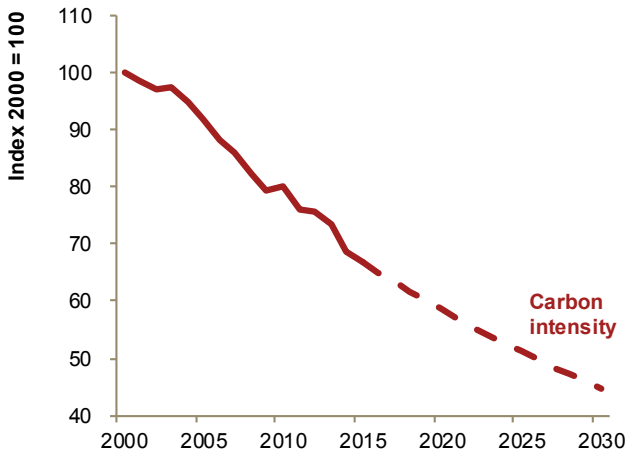
Emissions: Emissions in the EU fell from 4.1GtCO2 in 2000 to 3.4 GtCO2 today. The biggest contributor to emissions is the power sector with 40%, followed by emissions from transport at 29%, buildings contributed 19% and industry 13%.

Energy: Energy demand is 7% lower than it was in 2000. It followed the pattern of the economy, dipping in 2008 and 2009 and increasing in 2010. Over the last four years however it has come down at an average of 2%, with a 4% fall last year aided by a warm winter. In terms of fossil fuel energy, the five EU countries most reliant are the UK (85%), Greece (88%), Lithuania (93%), Poland (95%) and the Netherlands (96%). But in absolute consumption terms the biggest energy consumers are Germany (253 Mtoe), the UK (159), Italy (121), France (118) and Spain (95). Since 2000, total demand for oil has fallen by 18%, reducing its share of consumption to 36% in 2014. Only Poland, the Czech Republic and Austria increased oil consumption over the period. Nuclear, coal and gas changed negligibly between 2000 and 2014: nuclear remained at 12% of the mix, more than half of which is from France, coal changed from 18% to 17% of the mix and gas from 23% to 22%. There are more interesting changes at the country level: gradual nuclear phase out in Germany – responding to Fukushima - reduced its share of nuclear from 10% in 2010 to 7% in 2014 (aiming for zero by 2022, equivalent to roughly 30Mtoe in 10 years) and pushed a small return to coal during 2012 and 2013. France has comparable goals for phasing out 30Mtoe of nuclear over the next 10 years, replacing one third of its nuclear with renewables. In response to the EU ETS, there may have been some fuel switching from coal to gas since 2005, but overall this century only Poland, Sweden, Spain, Portugal and Greece increased total gas consumption.

Renewable energy: Since 2000, the share of renewables in the EU's energy mix has risen from 6% to 13.5% in 2014, mainly through additional wind capacity (3.5 percentage points). Renewables displaced coal and gas by 1 percentage point each and oil by 4 percentage points in the fuel mix. With nuclear, this leaves the EU at around a quarter of energy from zero-carbon sources consumed in 2014, having started the century at 18%. Half of hydro energy is produced in France, Italy and Sweden. Sweden also tops the renewable energy tables consuming 38% of its energy from hydro, wind, geothermal and biomass, with Austria (31%) and Portugal (30%). The Netherlands foots the table with only 3% of energy consumption from renewable sources.

Carbon intensity

Carbon intensity forecast: -2.6% per year



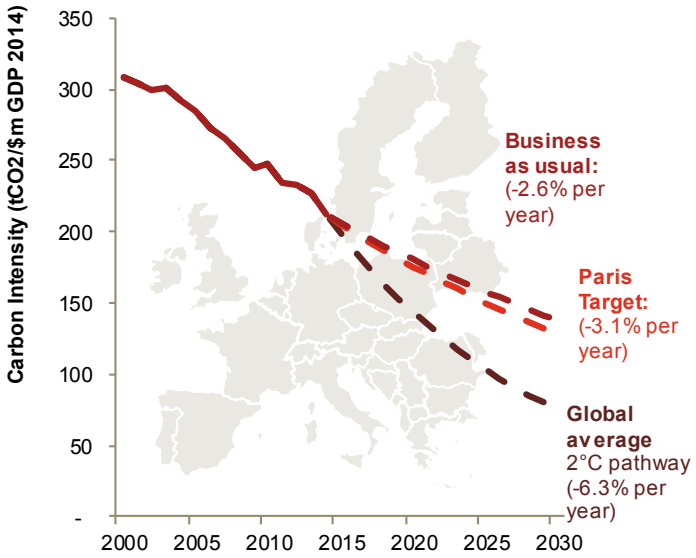
- The EU's carbon intensity has fallen by 2.6% on average since 2000 and remains amongst the lowest of the major economies.
- In 2014 the EU's decarbonisation rate picked up to its fastest rate this century of 6.7% - a combination of 1.3% GDP growth and a 5.4% reduction in energy related emissions. This partly the result of a switch away from coal, but it was also helped by a warm winter.
- We use the average decarbonisation rate since the turn of the century, 2.6%, for our business as usual forecast opposite and below.

How ambitious is Europe's 40% target?

The EU will need to decarbonise at 3.1% per year to reach its 40% reduction target by 2030. This is faster than the UK's 'dash for gas' in the 1990s or Germany's restructuring after reunification.

The 40% target looks quite close to business as usual, but despite the EU's existing policies to tackle climate change, it will still need to find another gear. However, the EU's recent pick up in decarbonisation rate to 6.7% suggests that this target could be achieved. It is also supported by a raft of European Directives that are transposed into national legislation. But, the EU's Paris target falls short of the emissions pathway to its own long term target of 80%-95% by 2050. This 2050 target is more closely aligned with a 2 degrees pathway and would require average annual decarbonisation of 6.9%.

How ambitiouos is the EU's 40% target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
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India

Emissions targets and implications for business

India intends to reduce the emissions intensity of its GDP by 33 - 35% by 2030 below its 2005 level

What is India's contribution...

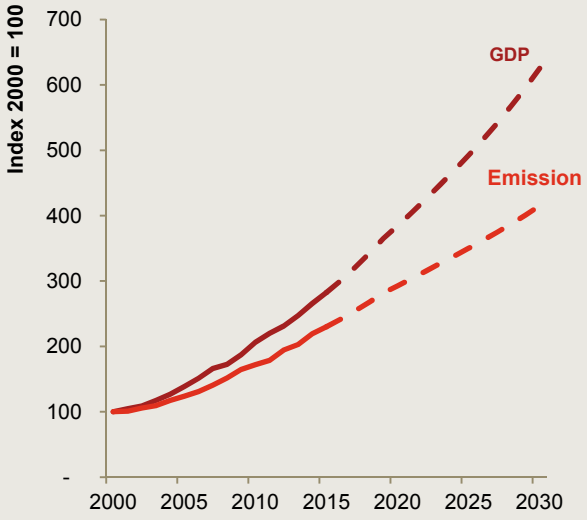
1. Stringent emissions standards and mandatory efficiency targets have been placed on all **coal** fired power stations.
2. 175 GW of **renewables** are expected by 2022, including 100GW from solar PV and 60GW from wind among others. By 2030, non-fossil fuel sources are expected to make up **40% of electric power installed capacity**.
3. A nationwide energy conservation programme will try to save 10% of today's energy consumption by 2018 and 2019. Over the longer term, **industry, transportation, buildings and appliances** will be targeted for further energy efficiency savings.
4. The **carbon tax** has recently increased four-fold to roughly $6 per tonne of CO_2 and applies to coal, lignite and peat. Carbon tax revenue is redistributed through the National Clean Energy Fund and contributes up to 40% of project costs.
5. Perform Achieve Trade (PAT) will enter its second phase of **energy intensity targets** (which has achieved a 4-5% decline in between 2012 and 2015 for eight sectors, iron and steel, cement, fertilizers, textiles, aluminium, pulp and paper, and chlor-alkali).
6. 98 of 100 **smart cities** have been chosen for grant support.
7. Additional **forest and tree cover saving 2.5 to 3 billion tonnes of CO_2 equivalent** by 2030

...and what are the implications for business

- **An opportunity the size of China's**: we estimate that the investment required for solar and wind is comparable to China's at US$210bn.
- Around **$40bn is required by 2017 to achieve the government's solar mission of** 22 GW installed capacity, the government has started with a $1.4bn investment.
- Tax-free **infrastructure bonds of $794mn** are being introduced for funding of renewable energy projects during the year 2015-16.
- Grants of $8bn, or **$15m per smart city per year for the next five years** has been earmarked for 100 smart cities. Private sector investment will be required to substantiate this funding.
- India has **relaxed FDI rules** as part of its Make in India campaign to encourage private sector funding for local manufacturing.
- **Businesses need efficiency measures** to reduce their PAT exposure. Certificates bought to make up for missed targets in phase 1 are estimated to cost business $5.4bn.
- The Faster Adoption and Manufacturing of **Hybrid & Electric Vehicles** (FAME India) will receive a **$12.5m** boost from the 2015-2016 Union Budget.
- Funding of **clean energy technologies may exceed $2bn** which was provided in 2014 as a result of recycled revenues from the doubled carbon tax.
- **$6 billion a year for forest conservation** has been allocated in the Union Budget.

GDP, Energy and related emissions

GDP forecast: 5.5% per year
Emissions forecast: 4.1% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: India's GDP of US$7,393bn in 2014 is over two and a half times what it was in 2000 having grown by 7.2% per year on average. The pattern has been of relentless positive growth, hitting 'lows' of 3.8% in 2002 and 3.9% in the 2008 recession but was averaging 9.5% in the three years leading up to 2008 and bounced back with 10.3% in 2010. PwC's World in 2050 forecasts growth of 6.4% over the next five years but a lower average of 5.5% for the whole period between now and 2030.

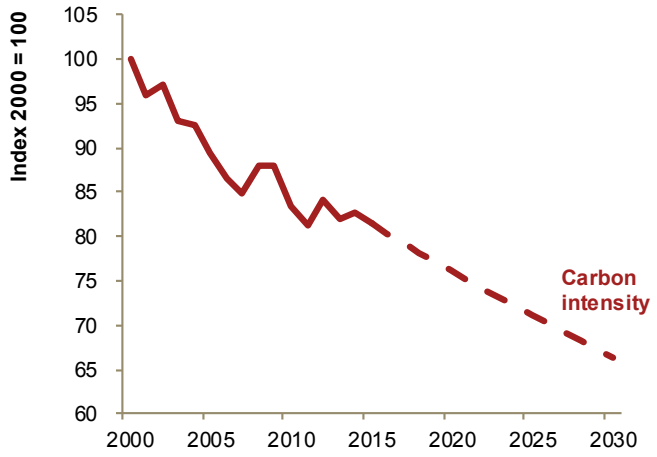
Renewable energy: Renewables made up just 7% of total energy consumption in 2014. Hydro increased from 17 to 30 Mtoe to contribute 5pp of the 7% and wind and geothermal comprise 1pp each. Wind generation's share has been constant since 2006 and geothermal since 2010.

Energy: India's energy consumption has more than doubled this century to 638 Mtoe, and 63% of the increase came from another 216 Mtoe of coal. Oil consumption increased by two thirds to comprise 28% of the energy mix, second to coal's 56%. Gas and nuclear may have roughly doubled absolute consumption levels, but still only contribute 7% and 1% respectively to the mix.

Emissions: By Sector, power contributed 59% of emissions in 2012, industry 22%, transport 12% and buildings 7%.

Carbon intensity

Carbon intensity forecast: -1.4% per year



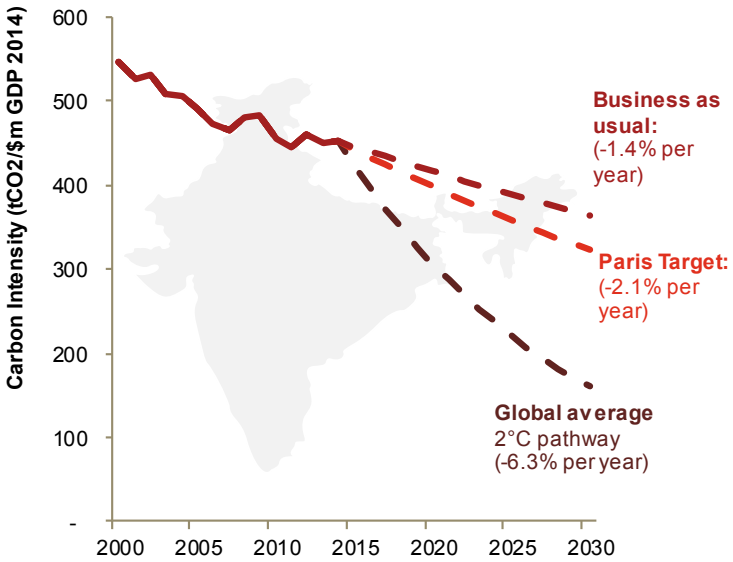
- India's decarbonisation rate has averaged 1.4% since the turn of the century.
- Carbon intensity followed a mostly downward trend in the early 2000s, but since the 2008 recession it has fluctuated. This is primarily driven by fluctuations in emissions rather than GDP.
- We use the average since the turn of the century, 1.4%, for our business as usual forecast opposite and below.

How ambitious is India's 33-35% intensity target?

Using our measure of ambition – the 0.7% gap between BAU and the target lines below – India's level of ambition is behind China (1.4%) and only just ahead of the EU (0.5%) who are coming from a far lower carbon intensity. China has been decarbonising at a relatively respectable 2% compared to India's 1.4%. From this perspective it is a detailed but unambitious INDC. Indeed compared to its Copenhagen target of 22-25% intensity reduction by 2020, the revised 2030 target means that the pace of decarbonisation between 2021 and 2030 will be slower.

Coal and oil are large parts of India's energy consumption and GDP growth is expected to slow. This will make it hard for India, but it has still left a large gap between its target and the decarbonisation rate needed to achieve two degrees.

How ambitious is India's 33-35% intensity target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
Emissions by sector: International Energy Agency World Energy Outlook, 2014
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Japan

Emissions targets and implications for business

What is Japan's contribution...

1. To reduce emissions by 26% on 2013 levels by 2030.
2. To reduce the emissions and energy intensity of GDP by 20-40% by 2030.
3. To reduce energy-related CO2 by 25% by 2030.
4. To reduce methane emissions by 12.3% on 2013 levels by 2030.

Prime Minister Abe recognises the significance of his term post-Fukushima - Japan's 4th Strategic Energy Plan released in April, 2014, 'rebuilds the energy strategy from scratch'. But positive messages may be countered by uncertainty from electricity market reforms, nuclear's future and the feasibility of meeting the targets. The Environment Ministry and the Ministry of Economy, Trade and Industry also disagree on plans for 45 coal power plants with estimated annual CO2 emissions of 120 million tons.

...and what are the implications for business

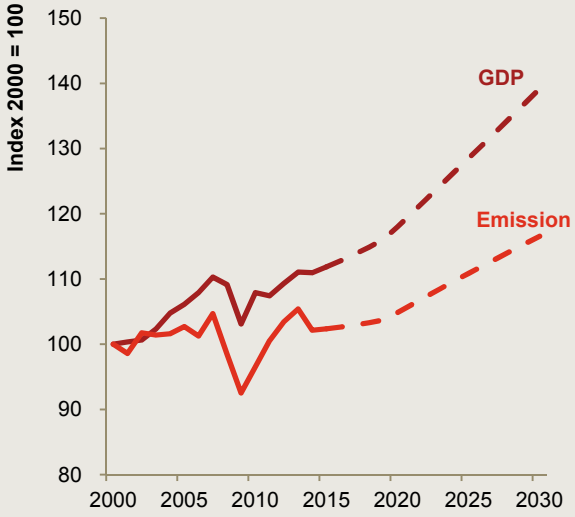
- 9 major industry sectors have voluntarily pledged emissions reduction targets as part of Keidanren's (Japan's Business Federation) commitment to a low carbon society. A long list of **energy efficiency** and technology improvements are detailed for industry to reduce emissions and showcase Japanese technology.
- With **electricity market reform** new entrants will be allowed to enter the market from 2016. The number of new entrants may also increase in 2020 when generation and distribution functions are split up.
- A **low carbon tax of around $2-3 applies** to coal and oil which raises approximately $2.2bn per year. This is coupled with government subsidies aimed at the promotion of a low carbon society.
- Approximately $2.3bn has been earmarked to support renewable energy generation and achieve a target of 10% of total primary energy supply by 2020. The **feed-in tariffs** vary by technology ranging from $0.10-0.33 per KWh for biomass to $0.18-0.45 per KWh for wind.

...and what are the implications for business

- Japan restarted the first **nuclear** reactor in August 2015, after a 23 month interval and there are plans to restart additional reactors following completion of safety inspections.
- Over $400m will be invested in the transport sector (vehicles and infrastructure) which is expected to be the main driver of energy efficiency improvements as it targets **50-70% next-generation vehicles by 2030.** Low carbon transport provides a significant demand for high-tech parts and automobile manufacturing. Road infrastructure will also improve efficiency using technology to manage traffic flows.
- Over $90m will be directed to research and development of **carbon capture and storage**, and further funding is available for batteries.
- Gas prices in Japan are expected to rise as cheap long term **Liquefied Natural Gas** contracts with Middle Eastern suppliers expire in the next few years.
- Solar prospects beat wind and geothermal in the short term due to easier installation and grid connection, but interest in geothermal is growing with Softbank announcing plans for its first **geothermal** investments. Restrictions and regulations on safety and the environment on wind and geothermal are hurriedly being reviewed and so may improve prospects for investors in the medium term.
- Reducing CO2 emissions from the **iron and steel** sector by 9 million-tons compared to BAU by 2030 creates new market opportunities for efficient technologies. The steel industry – the world's second largest after China – will continue servicing domestic automobile manufacturers and construction and is internationally competitive due to the weak yen.
- A **Joint Crediting Mechanism** may create a $90m opportunity for low carbon investment if it obtains international consensus.

GDP, energy and related emissions

GDP forecast: 1.4% per year
Emissions forecast: 0.8% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Japan started the century with a year of significant GDP growth at 11.9%. Since then however, GDP growth has struggled to surpass 2%, with the economy contracting for four years from 2010-2014.

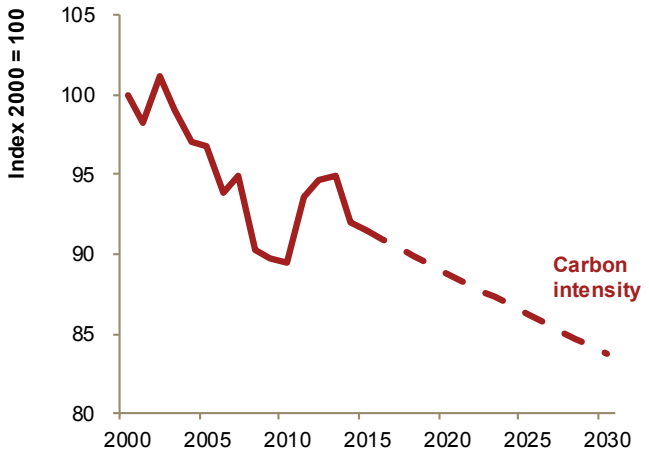
Renewable energy: For such a technology rich nation, the 6% share of energy from renewables in 2014 is surprisingly low. Wind still registers a 0% contribution and Solar and Geothermal and Biomass provide 1% each in 2014. Hydro provides a steady 3-4%.

Energy: Between 2000 and 2010, 14% of Japan's energy came from nuclear power. But following the disaster at the Fukushima Dai-ichi power plant in March 2011, this fell to 8%, 1% and zero in subsequent years. This 14% gap was filled by gas (5%), coal (4%), oil (3%) and hydro and solar (2%) having a significant impact on Japan's carbon intensity. Absolute oil consumption was declining and probably would have continued to decline without the accident, but use of the other fuels were increasing anyway and just had to step up the pace.

Emissions: By Sector, Power contributed 46% of emissions in 2012, industrial emissions were 14%, transport 17%, buildings 13%, the remaining 10% came from agriculture, others and non-energy use.

Carbon Intensity

Carbon intensity forecast: -0.6% per year

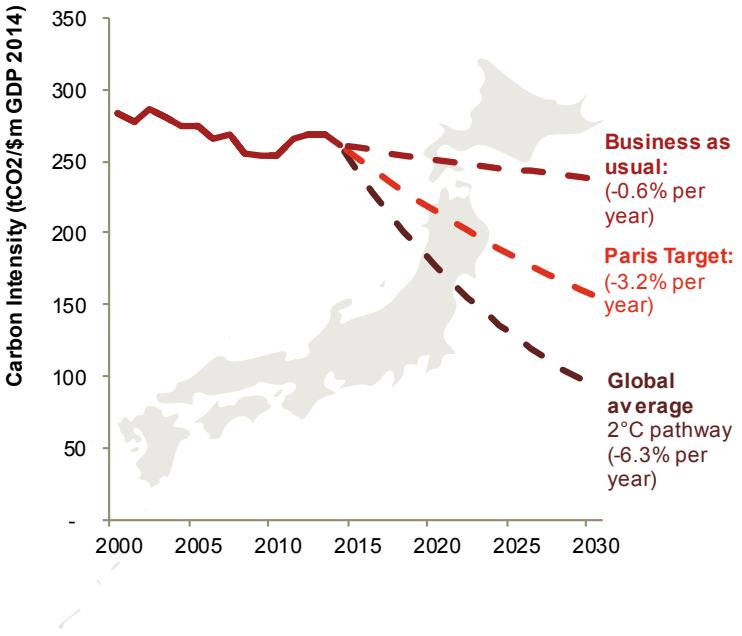


- Before the Fukushima disaster and shutdown of nuclear generation in 2011, carbon intensity in Japan was falling by 0.9% on average each year (2000-2010).
- Unsurprisingly, 2010-2012 saw a 2.6% average increase in carbon intensity, but the overall average trend for the century is a 0.6% reduction per year.
- Japan is decoupling GDP growth and carbon emissions at a very modest rate compared to other developing countries.
- We use the 0.6% trend as our business as usual forecast opposite and below.

How ambitious is Japan's 26% target?

- To meet its target, Japan needs a 3.2% decarbonisation rate assuming our economic growth forecast of 1.4% each year to 2030. Given Japan's average intensity reductions of only 0.6%, this target implies a significant shift in policy for carbon or energy intensive businesses in Japan.
- For comparison, carbon intensity in the US and EU has been falling at 2.6% each year on average since 2000. Achieving their emissions targets will require the US and EU to decarbonise at 4.3% and 3.1% respectively. Like the US and EU, Japan's target falls short of what's needed to reach two degrees (a global average 6.3% decarbonisation every year). Overall, Japan's current and target decarbonisation rate is still significantly lower than the US or EU's. This slow decarbonisation rate (even before Fukushima) suggests there may be plenty of opportunities for low carbon investment in Japan.

How ambitious is Japan's 26% target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
Historic emissions data: UNFCCC
The Steel Industry of Japan, 2015, Review
International Energy Agency, 2014, Policies and Measures database

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Mexico

Emissions targets and implications for business

Mexico has committed to reducing emissions by 22% by 2030 against its business as usual projection or 36% conditional on an agreement in Paris

What is Mexico's contribution...

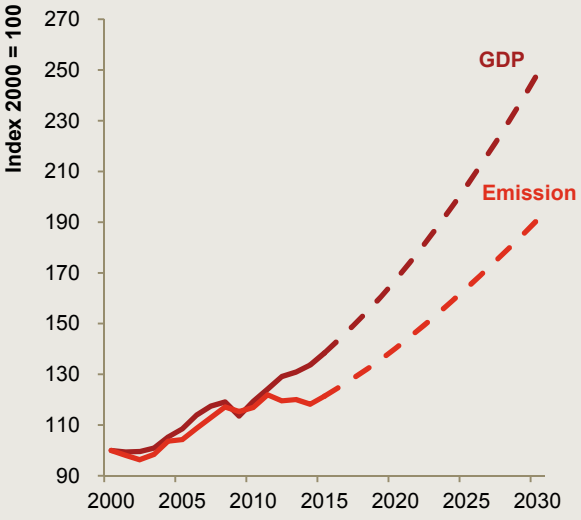
1. The General Law on Climate Change of 2012 was the first of its kind in the developing world, and has since been substantiated by specific policies and targets.
2. **A target for 35% of electricity to be from clean energy sources by 2024** is stated in the Special Programme on Climate Change (PECC 2014-2018).
3. **A carbon tax of $3.50/tCO2** was introduced in 2014.
4. **Reporting obligations** for emitters of over 25 thousand tCO2 - National Emissions and Emissions Reductions Registry – also came into force in 2014.
5. It is the only country so far to set targets for reducing black carbon emissions: 51% and 70% (conditional on an agreement in Paris) against BAU.
6. Targets for **deforestation rates of zero by 2030**.
7. Adaptation measures are aiming to protect strategic infrastructure and communities from the adverse impacts of climate change.

...and what are the implications for business

- In the next three years, **renewable energy targets could stimulate $6bn of investment in wind and $2bn in solar PV.**
- In the next five years, M**exico may become the strongest solar PV market in Latin America**.
- But grid connection issues, unclear rules of the wholesale electricity market reforms and continuing retail electricity subsidies create uncertainty for investors.
- Although unlikely to be a significant proportion of business costs, **the carbon tax will raise $1bn in government revenue.**
- Mandatory reporting, coupled with the carbon tax, may enable a carbon market in the near future.
- Private sector compliance with emissions reporting needs to be increased.
- Air quality, traditionally a greater concern than greenhouse gases, will remain a priority issue for government and industry.

GDP, energy and related emissions

GDP forecast: 4.0% per year
Emissions forecast: 3.0% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Since 2000, Mexico's GDP has grown at 2.1% per year on average and currently stands at $2,125bn. The economy shrank by 4.7% in 2009, but this was followed by solid growth of 5.1% and 4.0% in subsequent years. Recently, growth has slowed to 1.4% and 2.1% in 2013 and 2014 respectively.

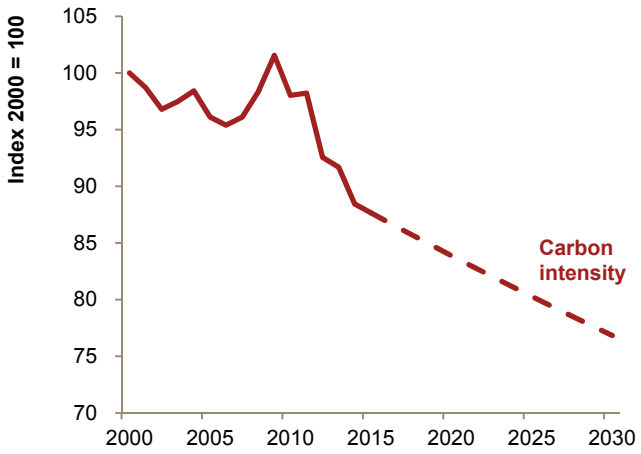
Energy: Energy consumption has risen by 31% since 2000, growing rapidly between 2000 and 2005 and more steadily since. Oil remains the largest part of the energy mix, but has fallen from a 62% share to 45%. Gas has been increasingly used to meet growing demand, rising from 26% of the energy mix to 40% in 2014. Coal is currently 8% of the energy mix, peaking at 10% in 2011 and Nuclear continues to contribute 1%.

Renewable energy: Currently renewable energy makes up 6% of Mexico's energy consumption. Hydro dominates this and consumption increased by 39% between 2013 and 2014. Geothermal and Wind contribute small additional amounts.

Emissions: Mexico's emissions are 68% from power generation, 8% from industry, 12% from agriculture and 6% each from LULUCF and waste.

Carbon intensity

Carbon intensity forecast: -0.9% per year



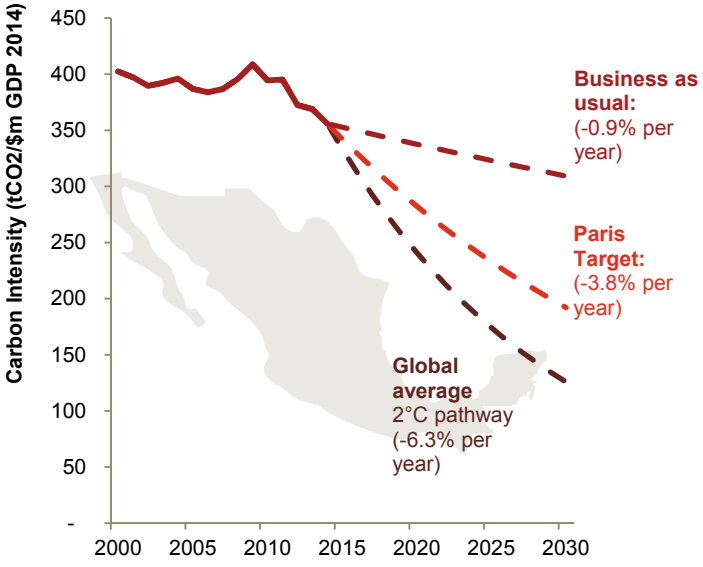
- Mexico's decarbonisation rate has averaged 0.9% since the turn of the century.
- Recent trends have been promising, decarbonising at 6% in 2012 and 4% last year, the highest rates this century.
- The 2009 global recession saw a 3% increase in Mexico's carbon intensity.
- We use the average 0.9% decarbonisation rate for our business as usual forecast opposite and below.

How ambitious is Mexico's 22% target?

Mexico's target is undoubtedly ambitious. It will have to decarbonise 2.9% faster per year than its rate this century, similar to the change required by Korea's target (2.8%). For comparison, this is also roughly the change the US achieved in its recent shale gas revolution.

Mexico also says it will peak its emissions in 2026 (not shown by our analysis of the target). This implies that in the last few years to 2030 it will move away from carbon quicker than the US did using shale gas. While 6% in 2012 and 4% in 2014 suggest it is possible, the smaller 1% decarbonisation in 2013 reveals the unpredictability of achieving the target.

How ambitious is Mexico's 22% target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
Historic emissions data: International Energy Agency, World Energy Outlook, 2014
International Emissions Trading Associate, The World's Carbon Markets: Mexico, 2015
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South Africa

Emissions targets and implications for business

Emissions estimated to be within a range of 398 and 614 MtCO2e by 2025-30. Emissions will peak, plateau and decline (PPD) between 2020 and 2030

What is South Africa's contribution...

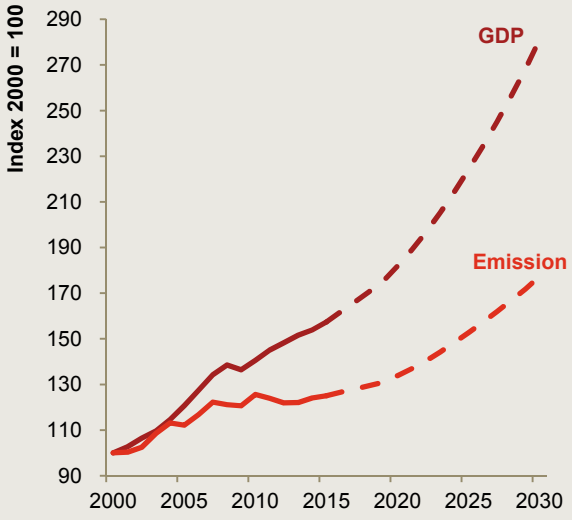
1. The Integrated Resource Plan envisages additional capacity of **10GW of nuclear and 2GW from gas by 2030** to help decarbonise the energy mix.
2. Existing inefficient fleet of ageing coal-fired power plants will be replaced with **renewable energy and high efficiency coal plants.**
3. **6GW of renewable energy capacity** is being considered under REI4P.
4. **Energy intensive sectors may pay a carbon tax of $1 - $3.50 per tonne of CO2 in the near future** (compensation and reliefs bring the price down from an initial prices of $9).
5. **Company level carbon budgets** are being drafted, termed Desired Emission Reduction Outcomes (DEROs).
6. **Reporting on emissions will be mandatory** by South African businesses emitting over 100 thousand tonnes of CO2. The Draft National Greenhouse Gas Emission Reporting Regulations (No. 38857 of 2015) under the Air Quality Act was submitted by consultation in May this year.
7. Investment is estimated for key adaptation programmes: Working for Water, Working for Fire, Working on Wetlands, Water Conservation and Water Demand Management, and LandCare.

...and what are the implications for business

- The INDC proposes significant investments that require international support up to 2030, for example:
  - Over **$40bn per year would be required in next generation vehicles**, split three quarters for hybrid electric vehicles and one quarter electric vehicles. Just under half a billion per year would also be required for public transport infrastructure.
  - **$8bn per year would be needed in renewables and nuclear**, including beyond 2030.
  - the estimated **cost to expand REI4P is $3bn per year.**
- **Renewable power capacity equivalent to all of the offshore wind turbines in Europe today is expected** from the Renewable Energy Independent Power Producers Procurement Programme (REI4P) launched in 2011 by the Department for Energy, the National Energy Regulator of South Africa and Eskom.
- The **SA Green Fund received a $66m initial injection**, set-up by the Development of Bank of South Africa (DBSA) on behalf of Department of Environmental Affairs.
- 284 companies and investors have committed to low-carbon initiatives as part of the 'We Mean Business' initiative.
- **Adaptation programmes require nearly $7bn of short term investment** over the next five years, for example:
  - Water Conservation and Water Demand Management estimated: $5.3bn
  - Working for Water (WfW) and Working on Fire: $1.2bn
  - Working on Wetlands: $0.12bn
  - LandCare: $0.07bn

GDP, energy and related emissions

GDP forecast: 3.8% per year
Emissions forecast: 2.3% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: South Africa's GDP in 2014 was US$704bn having grown by 54% since 2000. On average the economy grew at 3.1% per year with only one year of decline; 1.5% in the 2009 recession. Looking forward, South Africa is forecast to grow faster averaging 3.8% growth annually to 2030.

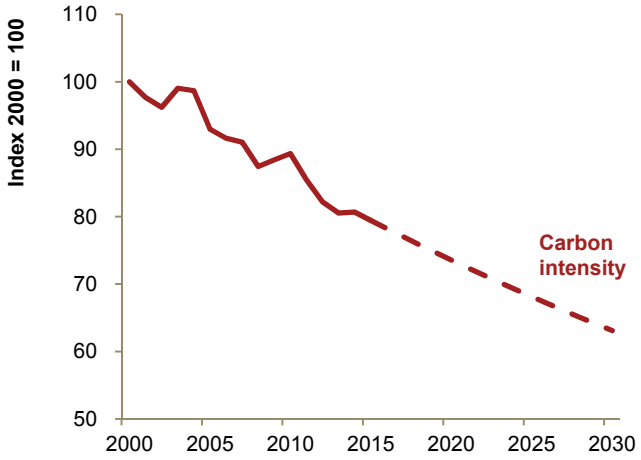
Renewable energy: Wind and solar contributed half a Mtoe or just under half a percent to South Africa's energy mix in 2014, and the same came from hydro and geothermal.

Energy: South Africa's energy consumption of 127 Mtoe in 2014 is comparable to fellow coal giant Australia's 123 Mtoe and only one seventh of India's. The mix of fuels has been roughly stable for a while: 71% coal, 23% oil and 3% each for gas and nuclear.

Emissions: By Sector, Power contributed 59% of emissions in 2012, Industry 22%, Transport 12% and Buildings 7%.

Carbon intensity

Carbon intensity forecast: -1.5% per year



- South Africa's has decarbonised at an average of 1.5% since the turn of the century, similar to that of India.
- It may be one of the most carbon intensive country, more so than China and India, but in absolute terms its emissions are twenty times smaller than China and five times smaller than India.
- Its carbon intensity follows an erratic pattern ranging most abruptly between 2003 and 2005 where it increased by 2.3% and then fell 5.8%. This is pattern is influenced more by emissions than GDP.
- We use the average since the turn of the century, 1.5%, for our business as usual forecast opposite and below.

How ambitious is South Africa's PPD target?

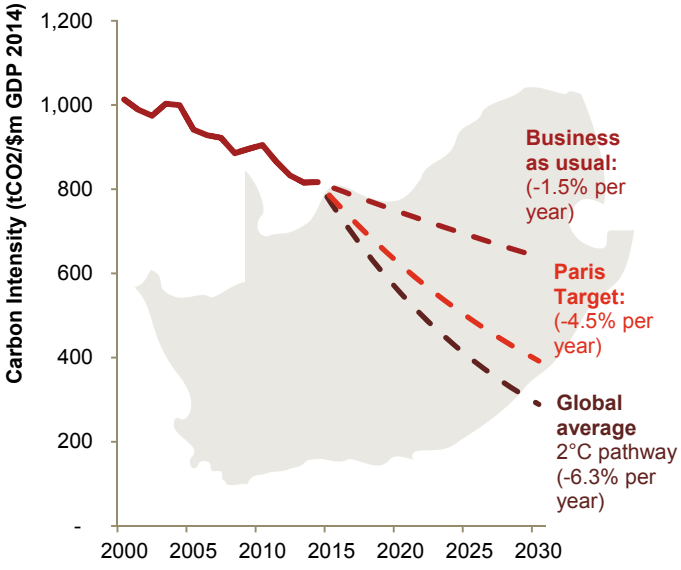
The range of 398 and 614 MtCO2e by 2025-2030 is a wide one, so its implied decarbonisation rate could be anything between 3.3% to 5.9% a year. This could bring some uncertainty to businesses in South Africa expecting carbon regulations, as the room for manoeuvre is significant.

Notwithstanding the uncertainty, the more ambitious target of 398 MtCO2 would mean a decarbonisation rate close to the global rate required of 6.3%, making South Africa's INDC an ambitious one, but even at 3.3% it will be decarbonising marginally faster than the average of the INDC targets we have examined. In our chart we have illustrated the Paris target as the average of this range by 2030.

But it is starting from a very high base (the highest of the G20). As a result, the ambitious rate of change would only take South Africa from its current carbon intensity to just above India's carbon intensity today.

This is challenging but also present an opportunity, particularly in the power sector as the current fleet of coal plants gets replaced by renewable energy or other low carbon technology.

How ambitious is South Africa's PPD target?



Sources:
Historic GDP: World Bank, 2014
GDP Forecasts: PwC World in 2050, 2015
Energy data: BP, Statistical Review of World Energy, 2015
Emissions by sector: International Energy Agency World Energy Outlook, 2014
Government of the Republic of South Africa, 2011, National Climate Change Response White Paper
Department of Energy, 2011. Integrated Resource Plan for Electricity 2010 to 2030

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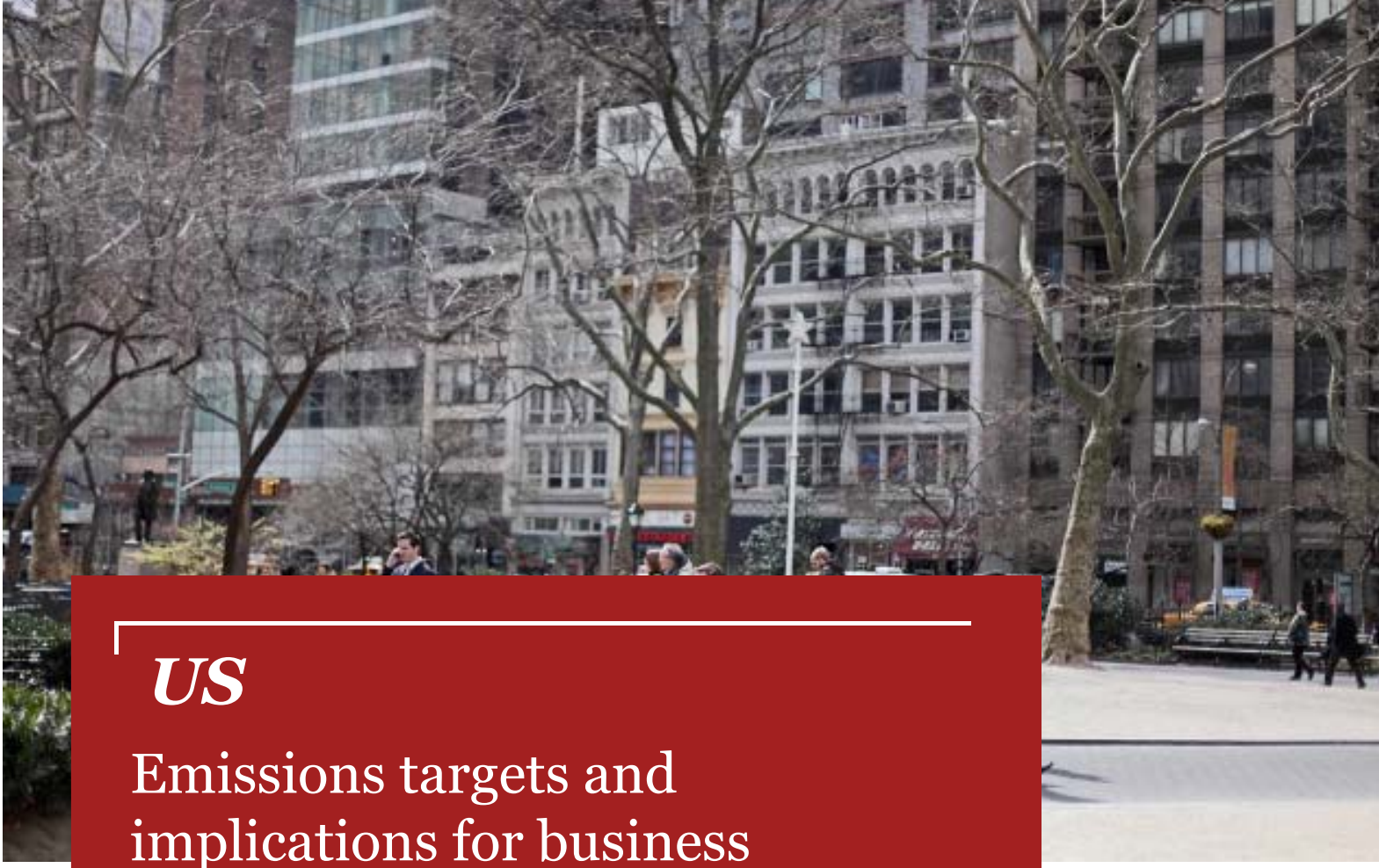


US

Emissions targets and implications for business

What is the US's contribution…

The US has committed to reduce emissions by 26-28% by 2025 compared to 2005 levels

1. 60% of the reductions will come from the US President's Climate Action Plan that addresses the largest GHG producing sectors of the economy—power generation, transport, and buildings—as well as federal government operations and major sources of two potent GHGs, hydrofluorocarbons (HFCs) and methane.
2. Potential areas for further reductions include energy efficiency and fuel switching in the industrial sector (bulk chemicals, petroleum, refining, metals, cement), and changes in the forestry, agriculture, and other land use areas.
3. The Clean Power Plan (CPP) - the largest single contributor to GHG reductions from the Climate Action Plan is - focuses on emissions from the nation's power plants (electricity generation). The CCP is forecast to reduce overall emissions by 7.3%, approximately a third of the total 2014-2025 reduction commitment.
4. The CPP requires all 50 states to develop state-level plans to reduce GHG emissions by improving power plant efficiencies, shifting from coal to natural gas and renewables, and encouraging energy efficiency by electricity consumers.
5. The US adopted fuel economy standards for light-duty vehicles in 2012 and for heavy-duty vehicles this year.
6. The Energy Policy Act and the Energy Independence and Security Act dictate a number of energy conservation standards and building codes that will generate reductions from the building sector and from Federal Government operations, primarily through energy efficiency improvements and the adoption of renewable energy.
7. Significant additional reductions will come from new federal regulations on HFCs and methane from coal mines, landfills, and oil and gas production.

...and what are the implications for business

The Clean Power Plan:

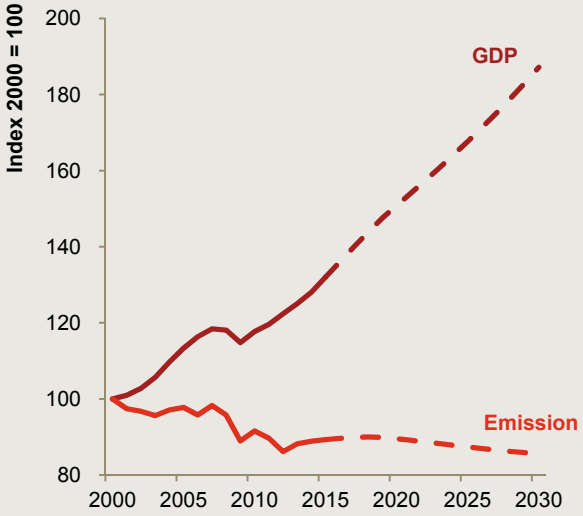
- **Current demand and fuel mix trends** are transforming the US power sector already, so it's helpful to separate the impact of the plan itself from the projected continuation of existing trends. The two most important existing trends are:
  1. moderation of electricity demand growth due to conservation and efficiency measures, and
  2. the falling carbon intensity of electricity due to the ongoing shift away from coal.
- In terms of demand, the base case projects a continued moderate growth rate of 0.6% per year or total growth from 2014 to 2030 of 9.6%.
- Falling carbon intensity is driven by projected continued low natural gas prices resulting from shale gas production and the improving economics of wind and solar. Continued regulations and incentives also continue to support renewables. The 2030 'Base Case' shows that coal will drop 6 percentage points as a portion of the electricity generation mix by 2030, to 33% from 39% in 2014. Concurrently, natural gas and renewables (wind and solar) will both improve their share of the energy mix by 2 and 3 percentage points respectively, to 30% and 10%.
- The CPP will cut total electricity demand by 8% through conservation and energy efficiency, and will further reduce coal's share by 5 percentage points. Renewables and natural gas will each gain an additional 2 percentage points of the post-CPP fuel mix, all compared to the base case.
- **Industry costs and electricity prices** will be affected. The EPA projects the CPP will cost $8.4 billion per year to implement. The EPA further projects average electricity price increases in the early years will be on the order of 3%, with some regions of the country facing up to 6% price increases. As the sectors transition, renewables costs fall, and new infrastructure and capability comes on line, these price increases will be mitigated By 2030, average cumulative price increases from the plan will be in the range of 1%. While no 3rd party analyses of the final rule are currently available, many in the utility industry contest these cost projections and believe that resulting prices increases will be more significant than the EPA estimates.
- **Utilities** will face limited aggregate demand growth paired with the requirement to ramp up generation through gas and renewables. The plan could significantly impact coal-dependent merchant generators. Vertically integrated and distribution-only utilities should be able to pass transition costs on to customers, but they will likely need to mitigate the potential regulatory consequences of higher customer bills.
- **Fossil fuels and mining sector** will see an increase in the current pressures. The plan reduces domestic demand for coal and increases demand for natural gas producers. This feeds through into pipeline development companies that will provide the supply and infrastructure for the shift to natural gas.
- **Large users of electricity** including those with manufacturing operations, data centers, distribution centers or big commercial real estate portfolios will face incrementally higher electricity prices if their current supply is carbon intensive. These users can also expect a new suite of energy efficiency and renewable energy programs to become available that could mitigate cost impacts.
- **Renewables and cleantech** will grow as the plan is projected to result in growth of renewables' share of the generation mix from 10% in the base case to 12% by 2030 amid falling demand. The plan has the effect of 'locking in' the growth on top of already rapid growth in the base case (projected 2014 – 2030 growth in the base case is 30%) to protect the sector from dips in demand. However, because the CPP is based on individual plans for all 50 states, it will complicate rather than harmonize the marketplace, exacerbating the complexity of state incentives and implementation programs that cleantech firms face.
- **Employment** may suffer in electricity, coal, and natural gas sectors: the US EPA estimates approximately 25,000 to 30,000 job losses. It also estimates employment growth in renewables of approximately 21,000, and in the energy efficiency sector of approximately 50,000.

The Vehicle Emission Regulations

- By 2025, the average fuel efficiency of new US cars will be 54.5 miles per gallon as compared to 24.1 mpg in 2014, accelerating the transition to higher fuel efficiency vehicles. This improvement, to be achieved through vehicle lightweighting, the adoption of new technologies such as hybrid drive trains, and moderate increases in the electrification of the fleet, equates to a projected cut in US oil consumption in 2025 of 2 million barrels per day, or roughly 10% of daily consumption today.
- The EPA estimates these efficiencies will cost the consumer an average of $985 in the initial vehicle cost, but save owners $4,000 in fuel over the life of the car.
- Electric vehicles as a fraction of total vehicle sales are projected to reach 3% by 2025 from less than 0.3% today.
- The EPA estimates that 700-3,200 jobs will be added, primarily in the auto parts sector.

GDP, energy and related emissions

GDP forecast: 2.4% per year
Emissions forecast: -0.2% per year



Our absolute emissions trend is based on combining the GDP forecast above with the average decarbonisation rate so far this century

GDP: Since the turn of the century, GDP has grown by an average of 1.8% per year in real terms. This average includes the two consecutive years of contraction in 2008 and 2009 following the financial crisis. Since then, growth has picked up, reaching 2.4% in 2014. PwC's 'World in 2050' forecasts that this rate will continue to rise over the next 3 years, before moderating, leading to an average annual growth rate of 2.4% from now until 2030.

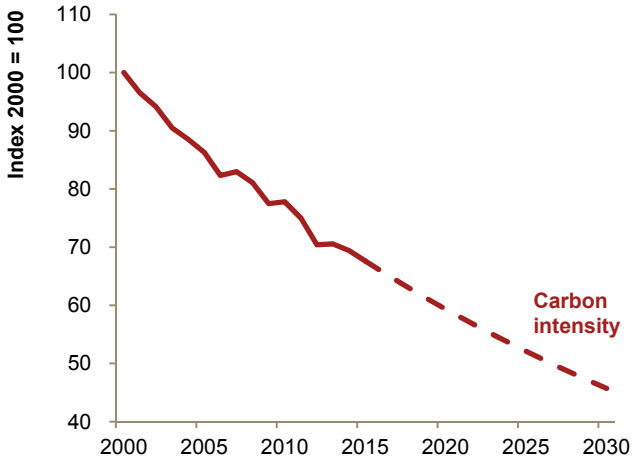
Energy: Overall energy consumption has remained largely unchanged, with total consumption in 2014 less than 1% below that in 2000. However, the steady consumption totals mask significant changes in the underlying mix of fuels. The shale gas boom has seen gas consumption surge by 24% since its low in 2006, and it now makes up 30% of total energy consumption. Oil fell from 38% to 36%, and coal from 25% to 20% since 2000.

Renewable energy: The share of renewables in the energy mix has increased from 4% in 2000 to 6% in 2014. This rise has been driven largely by wind, which has increased from 0% to 2% in 2014. Solar power has increased rapidly but from a very low base and still contributes less than 1% to total energy consumption.

Emissions: By sector, power contributed 44% of emissions in 2012, transport 37%, buildings 11% and industry 8%.

Carbon intensity

Carbon intensity forecast: -2.6% per year



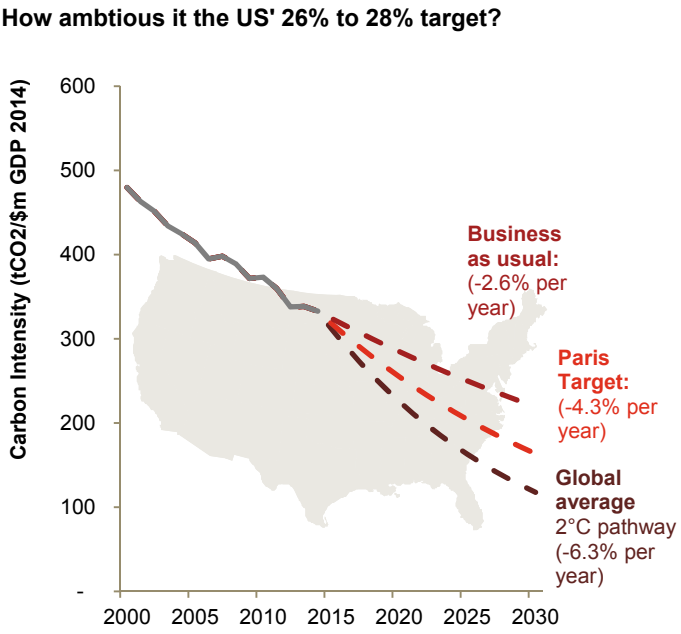
- Carbon intensity follows a steady trend of decline this century.
- Apart from two dips in the global recession, GDP and emissions have been steady. Growth didn't exceed 3.8% and emissions have did not fall by more than 3.9%.
- At its worst in 2009, the recession saw the economy contract by 2.8% and emissions fall by 7.1%.
- We use the 2.6% trend so far this century as our business as usual forecast opposite and below.

How ambitious is the US's 26-28% target?

To meet its target, the US will need to decarbonise its economy at a 4.3% per year to 2030. Doing so will require two-thirds more effort than today's decarbonisations rate of 2.6%. This reflects the significant shift in policy under the Climate Action Plan for carbon or energy intensive businesses in the US.

This level of change from BAU is higher than the EU's but lower than Canada's. Carbon intensity in the EU has also been falling at 2.6% each year on average since 2000, but its target rate is only 3.1%. Canada has been declining at 1.2% but its target rate requires a jump to 3.9%.

Overall the US target appears to be middle of the pack in terms of ambition. Moreover, like all other countries, the US' target does not come close to what's needed to reach two degrees (an average of 6.3% decarbonisation every year).



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Sources:
Historic GDP: World Bank, 2014
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Energy data: BP, Statistical Review of World Energy, 2015
Historic emissions data: UNFCCC and Australian Greenhouse Emissions Information System, Australian Department of Environment, 2015
Department of the Environment, 2015, Renewable Energy Target, Emissions Reduction Fund
Energy Matters, 2015, feed-in tariff for grid-connected solar power systems
Ofgem, 2015, UK Feed in tariff levels
International Emissions Trading Association, 2015, The World's Carbon Markets

Appendix A – Methodology

A.1. Our approach

The Low Carbon Economy Index

The purpose of our model is to calculate carbon intensity (tCO_2/$m GDP) for different countries and the world, and the rate of carbon intensity change needed in the future to limit warming to two degrees by 2100.

The countries the study focuses on are individual G20 economies, as well as world totals. The G20 is also portioned into 3 blocks: G7 economies (US, Japan, Germany, UK, France, Italy, Canada), E7 economies which covers the BRICs (Brazil, Russia, India and China), and Indonesia, Mexico and Turkey and other G20 (Australia, Korea, EU, South Africa, Saudi Arabia, Argentina).

For GDP data, the study draws on World Bank historic data. For long-term GDP projections the study draws on the latest version of PwC's 'World in 2050' model, which is based on a long-term GDP data are taken from the World Bank. Long-term GDP projections are drawn from the latest versions of PwC's 'World in 2050'. This was last published in February 2015 and details and a methodology summary can be found here: http://www.pwc.com/world2050.

For emissions, the study considers energy-related carbon emissions drawn from the BP Statistical Review (2015). For biofuels we adjust BP Statistical Review (2015) data from production to consumption using US Energy Information Administration data.

We use Intergovernmental Panel on Climate Change data for the energy related emissions associated with limiting warming to two degrees by 2100.

The National Targets

Our analysis of the national targets in this report considers the full national greenhouse gas inventory. So this analysis includes emissions from industrial process, fugitives (leaks from pipes), land use change and forestry. This is because some countries' targets focus on actions to reduce emissions in those sectors (which are outside our normal energy-based LCEI model). So although the emissions intensity numbers are not directly comparable with those in Section 1 of this report the rate of change implied by these INDCs is representative of what's required in Figure 1.

INDC targets were taken from the UNFCCC portal.

Where available national greenhouse gas inventory data was taken from the UNFCCC for 1990 to 2012. This was supplemented with national government department data where gaps existed in UNFCC data. Where there were still missing years we used the rate of change in energy related emissions from the BP Statistical Review (2015) and applied this to the UNFCCC or national government department data.

Where INDCs mention emissions from Land Use, Land Use Change and Forestry (LULUCF) we assume a net-net approach has been used. If LULUCF is not mentioned in INDCs we assumed it is not included in the target.

A.2. The challenges of counting carbon

A tonne of carbon is a tonne of carbon, regardless of where in the world it is emitted. But there are still challenges in the world of accounting for carbon. Typically, carbon dioxide emissions from factories and power plants are calculated; they are not directly monitored in the way natural gas volumes are monitored by flow meters. These calculations are based on the quantities of fuel consumed and the carbon content of those fuels.

Statisticians collect energy consumption data which, just like GDP data, are subject to revisions as better information becomes available. Unlike GDP data, which in many countries are reported quarterly, emissions data are available a year late in most countries, and often subject to revisions later.

The LCEI estimates are based on energy consumption data from the BP Statistical Review that has been released annually for over 60 years. Often there are revisions to the data compared to previous reports, and not just to the prior year – occasionally they go back more than a decade. This is not unique to BP. Other data sources such as the IEA and government statistical offices also update their historic data regularly.

For example, BP revised total energy consumption and coal consumption globally for 2011 upwards by 1.4% and 4% respectively in 2015 compared to figures reported in 2014. These revisions mean that reported global emissions would be nearly 2% higher for 2011 based on 2015 data relative to 2014, the equivalent of Canada's annual emissions.

The other part of the equation in calculating emissions is the use of 'emissions factors' – the amount of emissions produced per unit of fuel consumed. This varies by fuel, with coal generally being most carbon intensive, followed by oil then gas. But coal emissions also vary by rank (given the differing carbon content of anthracite, bituminous, subbituminous, or lignite) or geographic origin. In the US itself, the EIA uses different emission factors for different states and coal rank.

An article in Nature reported that the amount of carbon in a tonne of coal consumed in China is much lower than the global average. This means that the amount of carbon dioxide emissions produced when burning that (or oxidising the carbon) coal in China could have been overstated – possibly by as much as 10% of annual global emissions.

The two examples above showed revisions in opposite directions, so the net effect remains unclear. These pose challenges to anyone, including us, trying to count carbon. In addition to calculating energy-related CO2 national inventories include emissions from industrial processes – such as steel and cement production – and land use change and forestry, as well as the other non-CO_2 greenhouse gases. Each of these bring additional complexities and uncertainty to the challenge of counting emissions.

Data revisions are part and parcel of reporting, and generally do not raise issues that become causes of concerns. A consistent approach to monitoring, reporting and verifying emissions is one of the desired outcomes of the Paris summit, as governments need to have confidence in the numbers. Such a system will require time, money and regulations to develop. The large energy users monitoring and reporting emissions already are probably better prepared for new reporting regulations. Others will need to catch up.

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The megatrends – join the debate

We've been working with clients to understand the big changes that are disrupting their organisations – and the economy and society as a whole. We've distilled what we've learned down into five global shifts that we've seen have a major influence today and that we believe will still be important over the coming decades. These five 'megatrends' are: demographic and social change, shift in global economic power, rapid urbanisation, climate change and resource scarcity and technological breakthroughs.

We want to encourage a debate around how these megatrends and the collisions between them are reshaping the economic and commercial landscape. How are the megatrends affecting the world today and what does it mean for the future? What can business leaders and policy makers do to prosper?

For perspectives on the implications, challenges and opportunities of the megatrends visit: www.pwc.co.uk/issues/megatrends

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