

*Two degrees of
separation:
ambition and
reality*

Low Carbon Economy
Index 2014

September 2014

Foreword

The 2014 Low Carbon Economy Index (LCEI) shows an unmistakeable trend. For the sixth year running, the global economy has missed the decarbonisation target needed to limit global warming to 2°C. Confronted with the challenge in 2013 of decarbonising at 6% a year, we managed only 1.2%. To avoid two degrees of warming, the global economy now needs to decarbonise at 6.2% a year, more than five times faster than the current rate, every year from now till 2100. On our current burn rate we blow our carbon budget by 2034, sixty six years ahead of schedule. This trajectory, based on IPCC data, takes us to four degrees of warming by the end of the century.

This stark message comes in the run up to a critical series of climate negotiations, kicking off in New York and Lima in late 2014, then moving to Paris by December 2015 for the COP21 Summit, widely thought of as the last chance to secure a global agreement on action on climate change.

While the mood music for these climate negotiations is around two degrees – the threshold at which there is a substantial chance of avoiding climate feedback loops and runaway climate change – the sum of the pledges on the table limits warming only back to three degrees. We have got a gigatonne-gap, with global pledges falling more than 8 gigatonnes a year short of what is needed for two degrees.

But LCEI 2014 also brings two important grounds for optimism.

First, the E7 group of emerging economies appears to have woken up to the business logic of green growth, decarbonising faster than the G7 for the first recorded time, and substantially so. This, if continued, is a critical development. With ongoing manufacturing shifts to the E7, we are well past the frontier where unilateral G7 decarbonisation can get us back on track at the speed and scale required. Avoiding more than two degrees will depend on both G7 and E7 continuing to decouple growth from carbon.

Second, underpinning these improvements is not just energy efficiency but the rapid growth of renewables across both the G7 and E7. The latest IEA data now shows that renewables represent 22% of global electricity supply. Looking forwards, as some renewables approach cost parity with fossil fuels, the stage is set for a policy framework that could further accelerate the renewables roll-out.

These two emerging trends, E7 decarbonisation and the mainstreaming of renewables, run counter to the carbon rhetoric that climate action is just a cost for business and the economy– it can be complementary to growth.

On our current trajectory we are headed for four degrees, with policy pledges that currently steer us only towards three.

A business logic is emerging for turning the talk of two degrees into a concrete policy framework based not just on minimising climate risk, but on maximising the upside of long term investment.

Leo Johnson

Partner, Sustainability and Climate Change, PwC

Contents

<i>Heading for four degrees?</i>	2
<i>Promising three degrees</i>	9
<i>Delivering two degrees</i>	11
<i>Betting on Paris 2015</i>	14
<i>Appendix</i>	16

Heading for four degrees?

The PwC Low Carbon Economy Index (LCEI) calculates the rate of decarbonisation of the global economy that is needed to limit warming to 2°C. We base our analysis on the carbon budget estimated by the Intergovernmental Panel on Climate Change (IPCC) for 2°C.

Emissions per unit of GDP fell in 2013 by 1.2%, marginally better than the average decrease of 0.9% since 2000. But with such limited progress in decoupling emissions growth from GDP growth, the gap between what we are doing and what we need to do has again grown, for the sixth year running. The average annual rate of decarbonisation

required for the rest of this century for us to stay within the two degree budget now stands at 6.2%. This is double the decarbonisation rate achieved in the UK during the rapid shift to gas-fired electricity generation in the nineties.

While negotiations focus on policies to limit warming to 2°C, based on the decarbonisation rates of the last six years, we are headed for 4°C of warming in global average temperature by the end of the century, with severe consequences identified by the IPCC for ecosystems, livelihoods and economies.

The mounting challenge of decarbonisation

PwC's Low Carbon Economy Index (LCEI) has looked at the progress of the G20 economies against a 2°C global carbon budget since 2009. Currently, economic growth is closely coupled with carbon emissions and increased greenhouse gas (GHG) concentrations. The IPCC's latest assessment report (AR5) has reinforced the message that, without the rapid decoupling of GDP and emissions, climate change will present widespread threats to business and society.

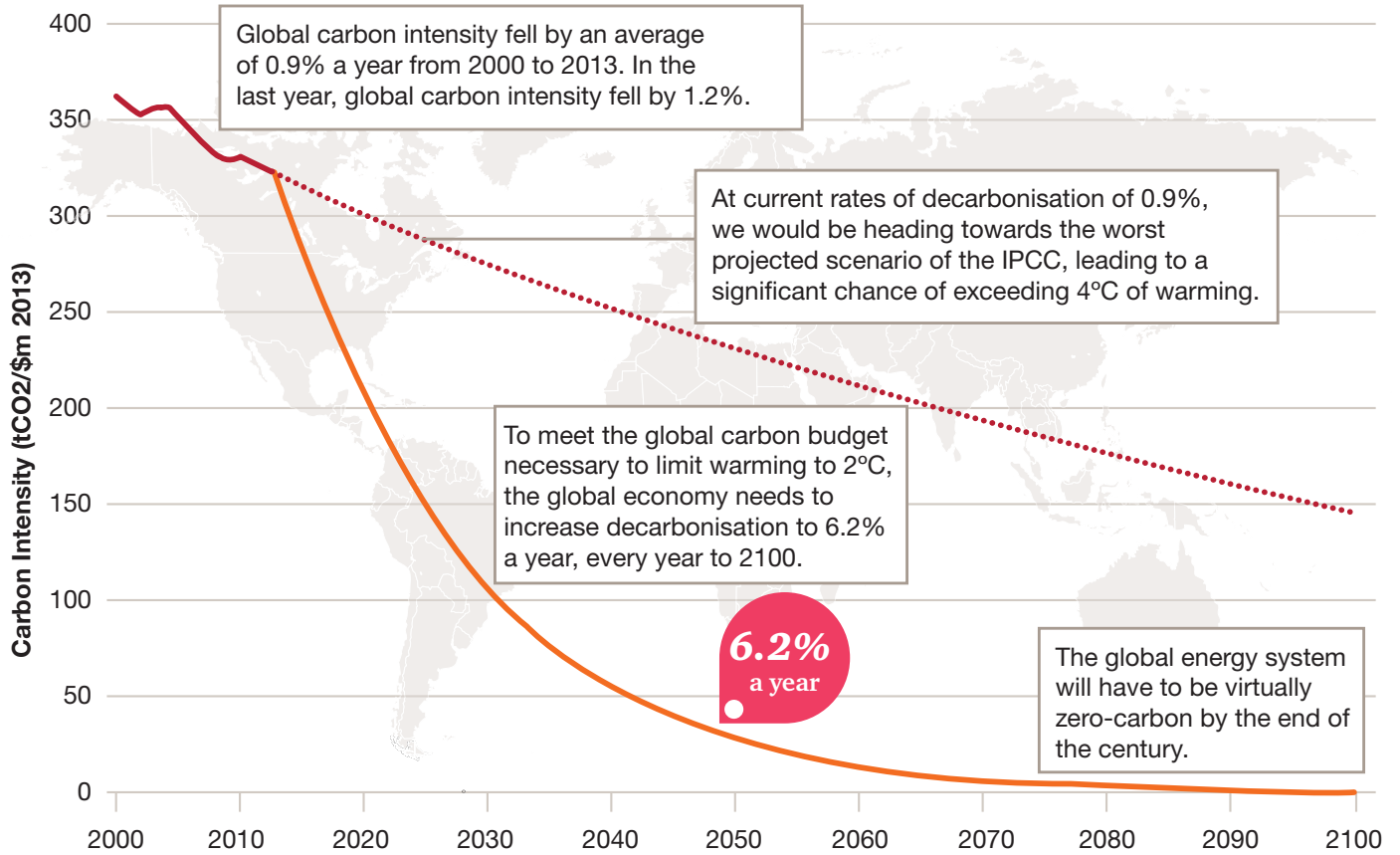
AR5 sets out four carbon budgets that correspond to different degrees of warming by the end of the 21st century. The current consensus target by governments, convened under the UN Framework Convention on Climate Change (UNFCCC), is to limit global average temperature increase to 2°C. To meet this warming scenario (known as RCP2.6 in AR5), cumulative fossil fuel CO₂ emissions between 2010 and 2100 need to be no more than 270GtC (or around 990GtCO₂).

But while all governments at the UNFCCC reiterate the goal of limiting warming to 2°C, implementation has fallen short of this goal. Current total annual energy-related emissions are just over 30 GtCO₂ and still rising, a carbon 'burn rate' that

would deplete the carbon budget for the entire century within the next 20 years. The IPCC has warned that our current trajectory will lead to warming estimated to range from 3.7 – 4.8°C over the 21st century. It anticipates severe adverse impacts on people and ecosystems through water stress, food security threats, coastal inundation, extreme weather events, ecosystem shifts and species extinction on land and sea. At the higher levels of warming, the IPCC states that these impacts are likely to be pervasive, systemic, and irreversible.

Against this backdrop of gloom, the decarbonisation results reported in this year's LCEI bring a glimmer of hope, with growth in absolute emissions of only 1.8%, the slowest rate of emissions growth since 2008-2009, when carbon emissions fell as a result of the global recession. The reduction in carbon intensity is also the highest since 2008, standing at 1.2%, compared to 0.8% in 2012. Nevertheless it is still only one fifth of the decarbonisation rate required. Currently, the LCEI shows **the global economy would need to cut its carbon intensity by 6.2% a year, every year from now to 2100**, more than five times its current rate.

Pathway to two degrees



The stakes are high

The physical impacts of climate change will vary from country to country, and some countries may find that the impacts within its own borders are relatively limited or in some cases benign. But in a highly globalised economy, no country is likely to be spared as the impacts of climate change ripple around the world, affecting interdependent supply chains and flows of people and investment.

Indirect impacts of climate change

The UK, for example, will face adverse domestic impacts in the form of extreme weather events such as flooding, storms and heat waves, as well as some negative impacts on agricultural production. It is also projected to see some benefits, through increased agricultural yields for some produce, and lower winter mortality. But the international impacts of climate change to the UK could be an order of magnitude larger than domestic threats and opportunities. The UK for example, holds around £10 trillion of assets abroad, with the flow of investment by the UK into other countries exceeding £1 trillion in 2011 alone. Physical or economic damages in the countries that the UK has invested

in will therefore flow back to the UK – and some of the sectors that the UK has invested in have already identified vulnerability to climate impacts, for example food and beverages, mining and power generation. Many of the UK's largest retailers are now conducting risk assessments of long-term climate trends and the implications for their supply chains and business operations. Other sectors, such as manufacturing and financial services, could be affected by both the physical impacts of climate change and regulatory pressures on carbon-intensive assets. Extreme weather-related events beyond UK borders in the past year alone have shown that these losses can be significant.

Top 10 region/ countries of UK investment abroad	Key sectors of investments	UK FDI international investment position abroad, 2011	Economic losses from weather-related events in the countries, 2013
		US\$bn	US\$bn
EU-28	Financial services, ICT, retail, oil and gas	343.6	34.0
USA	Financial services, oil and gas, manufacturing, ICT, food and beverages	241.7	21.8
Canada	Financial services, mining	28.3	7.1
South Africa	Financial services, oil and gas, professional services	15.5	0.8
Hong Kong	Financial services, retail	11.8	n/a
Russia	Mining, retail	11.4	1.0
Australia	Financial services, transport, oil and gas	10.6	5.1
Singapore	Financial services, ICT	10.4	n/a
China	Financial services, oil and gas, manufacturing	6.8	29.1
Japan	Financial services, ICT, manufacturing	6.3	<0.1

Sources: Investment position refers to net investment abroad in 2011, sourced from Foreign Direct Investment (FDI) Involving UK Companies, 2012, Office of National Statistics UK, Table 3.3; Economic losses estimated from 2013 Natural Catastrophe Year in Review, Munich Re and Annual Global Climate and Catastrophe Report Impact Forecasting – 2013

Source: Adapted from the findings from the International threats and opportunities of climate change to the UK, PwC 2013

Progress in 2013

In last year's LCEI we calculated that the global economy needed to reduce carbon intensity (the amount of carbon emissions per unit of GDP) by 6.0% a year to limit warming to 2°C. Overall, we have fallen far short of the global target for the sixth successive year, achieving only a 1.2% reduction in 2013. Having failed to achieve the global decarbonisation rate of 6.0%, the global challenge we face going forward is now tougher still. The path to 2100 requires an annual global decarbonisation rate averaging 6.2%. But the global result masks striking variations in performance at the national level.

An unexpected champion surpassed the decarbonisation target – **Australia** recorded a decarbonisation rate of 7.2% over 2013, putting it top of the table for the second year in a row. Three other countries – the **UK, Italy** and **China** – achieved a decarbonisation rate of between 4% and 5%. Five countries, however, increased their carbon intensity over 2013: **France, the US, India, Germany** and **Brazil**.

One glimmer of hope lies in the performance of emerging markets, with this year seeing the reversal of an emissions trend between the G7 and E7 economies. Since LCEI analysis started, the G7 has consistently outpaced the E7 in reducing carbon intensity, but in 2013, for the first time, the E7 averaged a 1.7% reduction in carbon intensity, while the G7 managed only 0.2%. This indicates the possibility of the E7 maintaining economic growth while slowing the rate of growth in their emissions. As the main manufacturing hubs of the world, the E7 economies currently have total carbon emissions 1.5 times larger than that of the G7, a figure expected to grow. This possibility of the E7 decoupling of growth from carbon is vital for global progress towards carbon targets.

Country	2012-2013				Five year trend	
	Change in energy related emissions	Real GDP growth (PPP)	Carbon Intensity (tCO ₂ /2013\$m)	Change in carbon intensity	Annual average change in carbon intensity	Average change in GDP
	2012-2013	2012-2013	2013	2012-2013	2008-2013	2008-2013
World	1.8%	3.1%	323	↘ -1.2%	-0.6%	2.8%
G7	1.2%	1.3%	281	⇒ -0.2%	-1.9%	0.6%
E7	3.5%	5.4%	404	↘ -1.7%	-0.3%	6.1%
Australia	-4.7%	2.7%	338	↓ -7.2%	-4.6%	2.4%
UK	-3.2%	1.7%	206	↘ -4.8%	-2.9%	0.1%
Italy	-5.9%	-1.9%	172	↘ -4.1%	-2.9%	-1.6%
China	3.4%	7.7%	561	↘ -4.0%	-1.6%	8.9%
South Africa	-1.1%	1.9%	635	↘ -3.0%	-3.0%	1.8%
EU	-2.5%	0.1%	209	↘ -2.5%	-2.3%	-0.2%
Canada	-0.6%	2.0%	375	↘ -2.5%	-1.9%	1.3%
South Korea	0.5%	3.0%	435	↘ -2.4%	0.2%	3.0%
Japan	-0.8%	1.5%	285	↘ -2.3%	-0.5%	0.3%
Argentina	1.7%	3.0%	190	↘ -1.2%	-2.4%	4.5%
Saudi Arabia	2.8%	3.8%	380	⇒ -1.0%	0.7%	4.2%
Turkey	3.3%	4.0%	217	⇒ -0.7%	-1.4%	3.7%
Russia	0.6%	1.3%	458	⇒ -0.7%	-0.7%	1.0%
Mexico	0.7%	1.1%	231	⇒ -0.3%	0.6%	1.6%
Indonesia	5.7%	5.8%	206	⇒ -0.1%	1.3%	5.9%
France	0.5%	0.2%	145	⇒ 0.3%	-2.0%	0.1%
US	2.5%	1.9%	326	⇒ 0.6%	-2.4%	1.0%
India	6.0%	5.0%	271	⇒ 0.9%	-0.7%	6.7%
Germany	3.3%	0.4%	224	↑ 2.9%	-0.9%	0.6%
Brazil	8.1%	2.5%	157	↑ 5.5%	1.8%	2.6%

Ups and downs: Analysing the results

Australia's 7.2% decarbonisation rate, topping the tables, is partly driven by a fall in energy demand of 1.7% against a growing economy, mostly attributed to the fall in net energy consumption in electricity generation¹. The Australian Renewable Energy target (20% of electricity from renewable sources by 2020) has played an important role in promoting renewables in recent years. The introduction of the carbon tax in 2012 meanwhile coincided with falling energy use (a decline in the iron and steel sector), and an increase in solar, wind and biomass electricity generation in the last two years. There was also a 30% increase in hydroelectric power due to unusually high rainfall in South East Australia and the improved relative cost of hydroelectric power under the carbon price. Looking to the future, just as it may be premature to attribute the impact on emissions to the carbon tax, it remains to be seen how much the decision by Australia's new parliament to repeal the tax will affect Australia's future carbon emissions profile. Emission trends beyond energy, for example fugitive emissions from oil and gas and coal mining, and agricultural emissions, are also likely to play important roles in Australia's decarbonisation pathways.

If Australia in 2013 exemplifies a decarbonising developed economy, **China** could be viewed as the poster child for developing countries, with a 2013 national decarbonisation rate of 4%. China improved its energy intensity by 3% in 2013, the third highest amongst the G20, and has a flourishing renewable energy sector². China also launched seven regional emissions trading schemes over the last year, although these are unlikely to have a dramatic impact on emissions in the short term. China's strong achievement in 2013, however, needs to be set against its role as the world's largest emitter and manufacturer, as well as its high overall carbon intensity—double that of the G7 economies. China's 3% energy intensity improvement has also fallen short so far of its own official target of 16% energy intensity improvements over the five-year plan 2010-2015. The country will need to make up for lost ground through major energy efficiency improvements in 2014 and 2015. Towards this goal, early indicators for 2014 suggest that in the first half of the year China has recorded a 4.2% fall in energy intensity³, chiefly through tougher government measures addressing coal use, and an increasing share of services within its economy.

While **Italy** has had the sharpest fall in emissions at 5.9%, it is also the only G20 economy to suffer a fall in GDP (of 1.9%). Nevertheless, the country continues to see strong growth in solar, hydroelectric and wind power. Much of its emissions reduction can be attributed to a fall in fossil fuel consumption of 5.7% from 2012 to 2013, as Italy's share of renewables (including hydro) rose from 12.8% in 2012 to 15.5% in 2013. Renewables now account for half of Italy's electricity generation.

Two countries with very similar carbon intensity levels reversed fortunes from the 2012 to 2013 league table. The **UK**, third from the bottom in the 2012 list, is now the most

improved G20 nation on carbon intensity. **Indonesia**, on the other hand, was third in the 2012 list but barely reduced its carbon intensity in 2013. In the **UK**, coal consumption was high in 2012, partly as a result of depressed coal prices, but has fallen again in 2013. Two large coal plants closed in March 2013 as they ran out of operating hours under the EU Large Combustion Plant Directive, while another plant converted to biomass. This trend is further supported by the national rise in renewable energy use, with the UK recording 33.7% growth in renewable energy consumption in 2013, the highest of the G20 economies. Improvement in energy efficiency, achieved in what is already one of the most energy efficient economies, meant that UK carbon intensity also fell significantly in 2013.

The **Indonesian** economy is very different from the UK's, but its decarbonisation challenge is also driven by trends in coal consumption. Indonesia has seen a surge in coal consumption in 2013 compared to the previous year, driven by coal-fired electricity generation by the national utility, PLN. But at the same time, while wind and solar remain nascent, PLN ramped up renewables production by 23%, mainly from hydro and to a lesser extent, geothermal. With imported crude oil prices regularly exceeding \$100/barrel, and pressures on fossil fuel subsidy reforms, the government also increased the price of heavily subsidised gasoline in June 2013. Between electricity and transport uses, overall oil consumption was tempered, and rose at a rate slower than economic growth.

Another notable development is with **Japan**. Japan has not fared well in terms of decarbonisation since the Fukushima incident in 2011, and in 2013 the country was at the bottom of the league table. This year it is middle of the pack, with falling emissions and positive GDP growth. With most of the nuclear power plants shut down, coal use continues to rise but countering this, renewable energy consumption has also surged by 15.6%.

Three countries have stayed close to the bottom of the league table in the last two years – **India**, **Germany** and **Brazil**. **India**, like Indonesia, saw coal consumption rising as domestic demand surged, and has relied more on coal imports to fuel its rapid economic growth. While renewable energy continues to grow, its speed of change has lagged behind other countries.

Germany has, since 2011, been reducing its reliance on nuclear, but at the cost of rising fossil fuel use, causing carbon intensity to rise in the last two years. The country has continued to invest in renewable energy though, with the aim of plugging the gap left by nuclear and achieving 80% of electricity from renewables by 2050. In the short term, however, carbon emissions in Germany show little sign of falling. **Brazil** faces a similar but perhaps more temporary issue. With hydropower accounting for over 30% of its energy consumption, Brazil is exposed to hydropower availability risk. In 2012-2013, with multiple droughts reducing hydropower production, the energy gap was filled through imports of liquefied natural gas.

¹ 2014 Australian Energy Statistics

² China's official government figure of energy efficiency improvement is 3.7% in 2013.

³ Source: http://www.gov.cn/xinwen/2014-08/12/content_2733668.htm

Can renewables compete with coal by the 2020s?

A mixed set of results then, but there are signs that momentum is building in critical areas. Most notable is the growth in renewable energy – and its emergence as a core part of the national energy mix. Across the world, the use of renewable energy excluding hydroelectricity grew this year at 16%.

While renewables growth has been a consistent trend across the last decade, with double digit growth in renewables every year, its absolute share of the global energy mix remains small, rising only from 1.9% to 2.2% (8.6% to 8.9% when hydroelectricity is included). This is partly because the rapid growth in renewables is dwarfed by moderate growth in coal and gas-fired generation, but also because transport fuels and energy intense industrial processes (such as steel or chemicals production) are harder to shift away from fossil fuels than electricity generation.

Largest rates of renewables growth are observed in solar and wind energy. Wind energy witnessed strong growth, particularly in **Africa, Latin America, and Asia**. These regions had trailed the Western economies in the uptake, where in most countries wind power has only been adopted in the last decade, but they now account for one-third of global wind energy generation.

Solar energy generation doubled in the **US and China**. Both countries have also surpassed the 10GW capacity milestone in 2013, along with **Japan**. Nevertheless, solar generation remains the highest in Europe, with **Germany, Italy and Spain** accounting for more than half of global solar use (a total of 65TWh). In Italy, the high renewable energy supply is considered a contributor to falling margins at gas-fired plants, even as solar subsidies have been scaled down⁴.

While there has been strong growth globally in renewable energy, in absolute terms, this increase is small scale compared to the increased use in coal in 2013; the absolute increase in coal consumption is three times the increase in renewables consumption. Again, though, there are glimmers of hope. The latest IEA data estimates that renewables generation represents 22% of the electricity mix today and that this could rise to 26% by 2020.

While coal use in **China** rose by 3.7% in 2013, it is at a much slower rate than in previous years. China has made public efforts to curb coal use to manage its air pollution problems, for example a limit on coal use to 65% of its energy mix, and more recently a proposed ban on coal-fired power in Beijing by 2020. Nevertheless a trend towards coal gasification plants has stoked another concern. These plants produce a synthesis gas which can be used more cleanly in a gas turbine but the gasification process is much more carbon intensive than thermal coal plants and is also highly water-intensive. China's future energy emissions will depend on how it manages its coal consumption and the alternative fuels that will replace it.

A revival of coal in the **US**, driven by a combination of falling coal prices and rising gas prices, has also been a major factor in the low US position in the G20 decarbonisation league table. Coal in the US has regained some market share from natural gas in the generation mix since its low in April 2012, causing an increase in emissions, and dispelling the myth that a shale gas revolution will necessarily result in emissions reductions. In June 2014, however, the Environmental Protection Agency released a Clean Power Plan proposal that will aim to reduce the US power sector carbon dioxide emissions by 30% from 2005 levels by 2030 through targeting emissions from coal fired power plants as well as fostering incremental energy efficiency improvements and continued growth in renewables.

Can the Clean Power Plan deliver the US climate ambition?

The US Environmental Protection Agency (EPA) Clean Power Plan proposes to achieve emissions reduction by requiring individual states to meet state-specific targets. States will have the flexibility to establish their own approach for meeting the proposed limits, including pursuing options 'outside the [power plant's] fence' such as demand side management through energy efficiency and support of distributed renewable energy.

The proposal's timeline for implementation is long and uncertain. The EPA is working to finalize its rules by June of 2015, at which point states will have a year or more to develop their plans to meet the targets. The first compliance year is 2020. It's also certain that there will be legal and political challenges. To date, 12 states have declared their intention to oppose the rule. The US Supreme court has upheld the ability of the EPA to regulate GHGs so it is hard to predict the rule's ultimate shape, timing, and enforceability.

If the rule goes forward as it is currently conceived, this proposal, combined with the reductions to date and those that will be driven by prior executive actions addressing the transportation sector, would, in approximate terms, put the US on a path to achieve Obama's 17% by 2020 pledge. However, putting the proposed rule in context of the global de-carbonization challenge, it will achieve a small portion of the reductions required to stay within 2°C carbon budget. The EPA estimates it will result in reductions from the business as usual case of 545 MM tonnes of CO₂ in 2030*. This plan would contribute a cumulative 5.9% reduction in US carbon intensity or an average annual additional intensity reduction of 0.39%.

* <http://www2.epa.gov/sites/production/files/2014-06/documents/20140602ria-clean-power-plan.pdf> – page 12

⁴ Source: <http://www.icis.com/resources/news/2014/01/03/9739341/italian-ccgts-call-for-capacity-payments-as-spark-spreads-fall/>

Looking forward, the pattern of investment flows into renewable energy and coal suggests that renewable energy will continue to grow in market share. Over the period 2000 – 2013, investment in coal has averaged US\$55 billion a year, while investment in wind and solar PV averaged US\$80 billion a year⁵.

But the investment in renewables has thus far been concentrated in OECD countries, where the share of total power generation investment in renewables rose from 14% in 2000 to over 60% in 2012.

On the other hand, in non-OECD countries, investment in coal, nuclear and hydro power accounted for 68% of investment in that period, with gas and non-hydro renewables accounting for a further 12% and 18% respectively.

In 2013, total renewable investment amounted to US\$214 billion worldwide. This is slightly lower than in 2012, which is attributed to the falling cost of solar photovoltaic systems, and also concerns about policy support⁶. Falling costs, especially in PV, have in recent years triggered a withdrawal of financial incentives offered by government. But institutional investors have filled the space. In particular there has been increasing involvement by long-term investors such as pension funds, insurance companies, wealth managers and private individuals in the equity and debt of wind and solar projects.

In 2013, several multilateral lenders, including the World Bank and the European Investment Bank, announced new rules intended to reduce lending for new coal-fired power plants. Divestment campaigns away from fossil fuel investments have also led to several high profile commitments to withdraw from fossil fuels by university endowments, professional and religious organisations, as well as public pension funds. Whether these materially affect future investments in coal-fired power plants remains to be seen – ultimately unless there is a financial disincentive to coal investments, divested entities or projects are likely to find their way to new investors⁷.

Longer term trends also appear to support the growth of renewables. Analysts such as the IEA have suggested that, through falling costs, it would not be long before on-shore wind and large solar PV plants can be competitive against fossil fuel generation⁸, in particular if subsidies to fossil fuel are also taken into account.

Investment in renewables including hydropower is estimated by Bloomberg New Energy Finance (BNEF) to form two-thirds of the US\$7.7 trillion projected investment in new generation capacity globally by 2030⁹. The same analysis shows that there are regional variations. In the Americas, onshore wind and rooftop solar PV are expected to account for about a third of the predicted USD\$1.3 trillion of total investment, with other renewables and gas accounting for about 30% and 26% respectively, while investment in coal generation is expected to fall. Meanwhile in Asia-Pacific, the absolute amount of investment in fossil-fuel generation is predicted to continue to grow, but the majority of growth in investment will be in renewables, particularly rooftop solar PV – an estimated US\$2.5 trillion out of overall investment of US\$3.6 trillion. In China, 72% of overall investment is expected to go to renewables, compared to 63% in India and almost 93% in Japan. Europe is expected to spend nearly US\$1 trillion on renewable generation, much of which will go to small-scale solar and wind power.

While there are grounds for optimism on the transition to renewables, there are still reasons for caution; as renewables share of the generation mix grows, the challenge of managing intermittency and storage costs increases. And, of course, electricity is only one part of the energy mix – switching transport systems and industrial processes to zero carbon is likely to be even more challenging.

⁵ World Energy Investment Outlook 2014, International Energy Agency.

⁶ Global Trends in Renewable Energy Investment 2014, Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance, the United Nations Environment Programme (UNEP) and Bloomberg New Energy Finance

⁷ For further analysis on the divestment campaign see Stranded assets and the fossil fuel divestment campaign: what does divestment mean for the valuation of fossil fuel assets? University of Oxford's Smith School of Enterprise and the Environment.

⁸ RE-COST, Study on Cost and Business Comparisons of Renewable vs. Non-renewable Technologies, IEA – Renewable Energy Technology Deployment

⁹ Bloomberg New Energy Finance's (BNEF) 2030 Market Outlook

Promising three degrees

How the pledges currently stack up

Through past international UN climate negotiations, a number of countries have already put forward carbon reduction plans for 2020. These voluntary pledges formed part of the Cancun Agreements concluded in 2010 the year after the Copenhagen summit.

These plans include quantified economy-wide emission reduction proposals from 42 developed countries with and some form of quantified targets for 16 developing countries¹⁰. Many of these countries submitted their targets as a range, and some have included conditions for the more ambitious end of their range.

However, the UN Environment Programme has estimated that, even if the current pledges are fully implemented, the emissions gap with the two degrees scenario in 2020 will be 8–12GtCO₂e or two to three times the EU's current emissions compared with projected global emissions of 44GtCO₂e at that date¹¹.

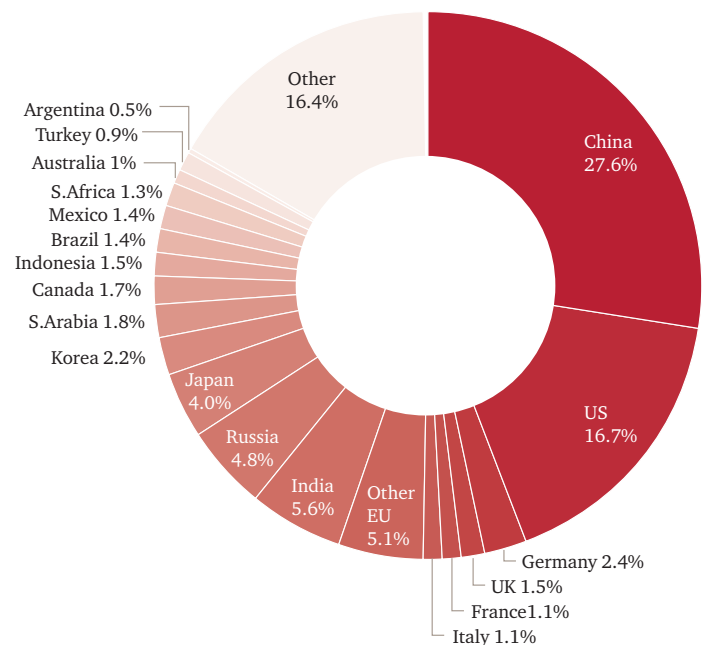
Extending that trajectory forward, most estimates conclude that the sum of the pledges, if implemented, will take us to a three degrees scenario. For all the talk of two degrees, the policy pledges thus far appear to commit to a future impacted by three degrees of warming.

The outcome has been limited by two inconvenient realities:

- Confronted with the choice between an economic calculation (what a country believes it can afford) and a scientific calculation (what the science determines as needed) a tendency has been to prioritise the former, basing targets on national economic and technical capabilities.
- Meeting the carbon budget is a zero sum game – a shortfall by any one country has to be made up by increased ambition by others¹².

Commitments vs. progress by the largest emitters

Energy-related emissions breakdown 2013



In 2013, the G20 economies made up about 85% of global energy-related emissions. Their role in reducing emissions will fundamentally determine whether we are successful in tackling emissions growth at the global scale. This does not diminish the vital role of other countries' actions on emissions: all countries will need to work together towards zero net carbon globally by 2100, but the G20 are critical in determining the carbon pathway.

There are of course, though, significant variations, within the G20. In particular, the G7 and E7 groups have fundamentally different economic structures driving how and when they can reduce emissions.

The pie chart shows the share of each G20 country's emissions relative to the total global energy-related CO₂ emissions. China is the largest emitter (at 27.6%), followed by US (at 16.7%) and India (at 5.6%). The four EU countries, Germany, UK, France and Italy, are part of the G20 group, and the remaining emissions by the other countries within the EU are aggregated in 'Other EU'.

¹⁰ Source: UNEP Emissions Gap Report 2013

¹¹ Source: UNEP Emissions Gap Report 2013

¹² The carbon budget is fixed to a certain extent, as the climate is a variable system and there is still a range of cumulative CO₂ emissions that will meet within the two degrees target with varying probabilities.

Weak G7 progress towards 2020 targets

In 2010, the G7 countries (with the whole of EU-27, not just Germany, France, UK and Italy, considered as part of the G7 in this analysis) made up 46% of global energy-related emissions.

Collectively, achieving the ambitious end of their Cancun pledges would reduce **G7** emissions in 2020 by 19%, relative to 2010, when the pledges were made. This is equivalent to a decarbonisation rate of 3.7% per annum and would mean a carbon intensity across the G7 of around 200 tCO₂/\$m by 2020. This is compared with 209 tCO₂/\$m in the EU, and 326 tCO₂/\$m in the US today.

Though short of what is needed for two degrees, meeting these pledges would represent substantial progress. However, the **G7's** progress has not come close to meeting these pledges. Current projections for the EU, for example, show that it is on track to meet its 20% reduction target from 1990 levels by 2020, but not the conditional 30% target it has put forward¹³. Following the Fukushima incident in 2011 and the shutdown of nuclear power, **Japan** has had to revise its carbon emissions target for 2020 to 3.8% below 2005 levels, or 3.1% above 1990 levels, instead of the target pledged at Cancun of 25% reduction below 1990 levels.

Collectively, the **G7** group has achieved an average decarbonisation rate of 2.3% between 2010 and 2013. To be able to meet their voluntary Cancun pledges, the **G7** needs to raise this to 3.8% per year between 2013 and 2020. A step change in performance, in other words, is required, almost doubling the rate of decarbonisation achieved to date.

Continued rising carbon emissions from E7

The **E7** group of economies has fared little better. The **E7** countries took widely different approaches to target setting for 2020. While **China** and **India** set specific decarbonisation targets; Indonesia and **Brazil** set targets below a business-as-usual baseline. **Mexico** and **Russia** set absolute targets below a base year, and **Turkey** did not put forward a target. Since 2010, however, across the countries, only **Russia** came close to meeting their carbon intensity reduction pledge.

The overall carbon intensity of the **E7** would need to fall by 3.1% each year under their collective pledges between 2010 and 2020. But only 0.6% has been achieved between 2010 and 2013. For the E7, meeting their pledges will require a steepening of their decarbonisation rate to 4.2% between 2013 and 2020.

Politically not scientifically driven

For both G7 and E7, the conclusion is clear. We face a twofold challenge of both intent and implementation. The sum of the current pledges is insufficient to meet the global decarbonisation targets needed for two degrees. At the level of implementation, the results since 2010 reflect the on going failure of key economies to meet their pledges, even if insufficient to achieve 2°C.

¹³ The EC estimated that total EU-28 emissions in 2020, including international aviation, will be 22% below the 1990 level. Source: European Commission Climate Action, http://ec.europa.eu/clima/policies/g-gas/index_en.htm

Delivering two degrees

So what is needed?

The international negotiations leading up to Paris 2015 are a critical chance to ensure collective agreement on targets to keep temperature increases within 2°C. The foundation of a successful deal will be a set of emissions pledges that are adequate to maintain global temperature increases below 2°C.

The IPCC, and others such as UNEP, have estimated the required carbon emissions levels under the different concentration pathways. The IPCC's latest report on mitigation has also put forward, based on a range of models, a possible breakdown of the carbon budget by regions¹⁴. The UN initiative referred to as the Deep Decarbonisation Pathways Project also considered plausible decarbonisation pathways for 15 countries¹⁵.

What does this look like in more detail?

The LCEI takes these breakdowns as a basis to outline the potential reductions required by these countries, and their ongoing decarbonisation rates. The challenge is considerable.

Overall, to stay within the global carbon budget, annual energy-related emissions by the G20 bloc need to fall by one-third by 2030 and just over half by 2050. Much of the debate in climate negotiations has centred on responsibility and how to share the burden between developed and developing countries, as defined in 1992 in the UNFCCC. Regardless of how the carbon budget is split, it is clear that both developed and emerging economies face the challenge of growing their economies whilst radically curbing emissions.

The timeline is also unforgiving. The IPCC and others have estimated that global emissions will need to peak around 2020 to meet a 2°C budget. This means that emissions from the developed economies need to be consistently falling, and emissions from major developing countries will also have to start declining from 2020 onwards.

Specifically, to stay within a 2°C budget, the G7 needs to further reduce its absolute carbon emissions by 44% by 2030 and 75% by 2050 compared to 2010 levels. Even if the 2020 pledges are met, this means its carbon intensity needs to fall by 5.9% from 2020 to 2030, and by 6.0% from 2030 to 2050.

For the E7 economies, meeting the 2020 pledges is just the first step. The required carbon emissions reduction from 2020 to 2030 will have to be sharp and immediate, equivalent to a carbon intensity reduction of 8.5% per annum. If this is achieved, then further carbon intensity reductions of about 5.3% a year to 2050 could take the E7 to emission levels compatible with limiting climate change to a 2°C warming. In this case, carbon intensity levels will be comparable to those of the G7 by 2050.

¹⁴ See Chapter 6 – Assessing Transformation Pathways from the AR5 Working Group III – Mitigation of Climate Change, specifically Section 6.3.2 on regional roles on the emission pathways.

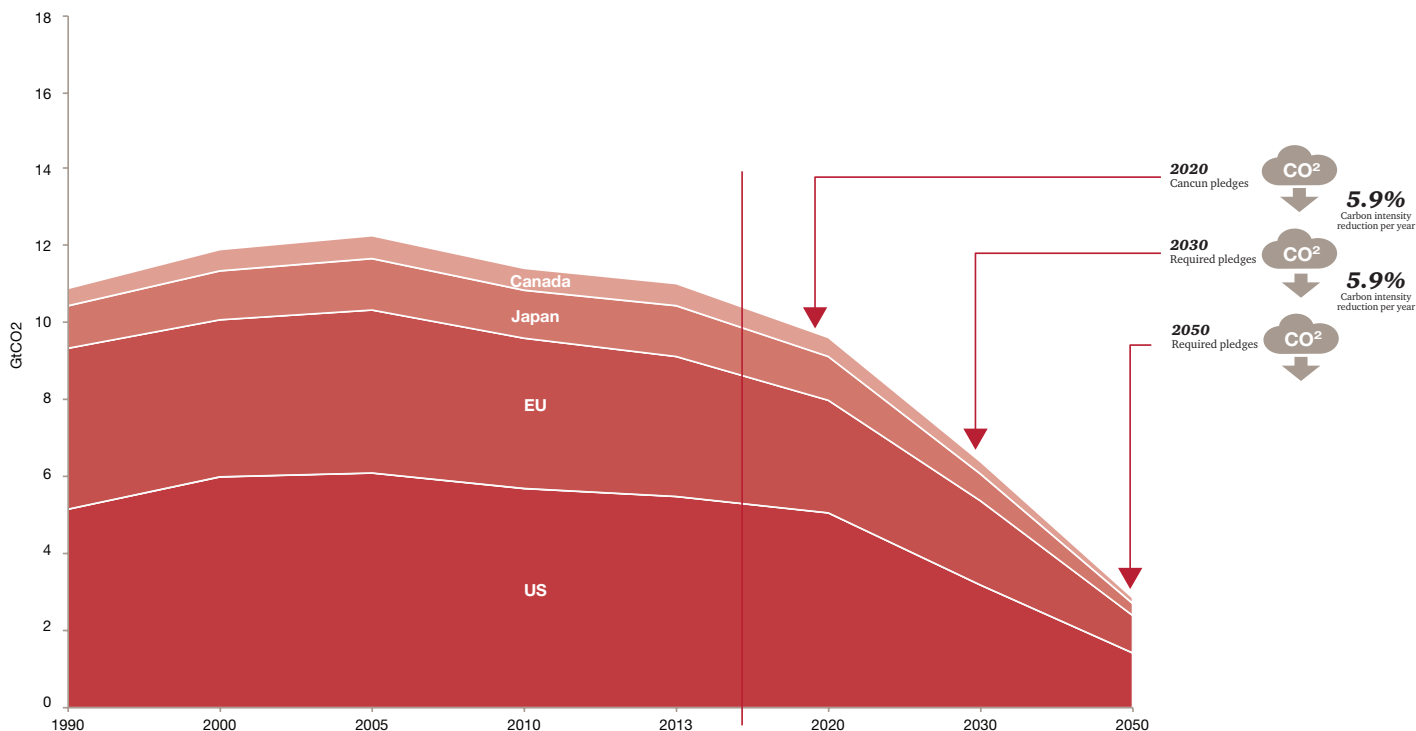
¹⁵ Our analysis looks at the interim 2014 report of the Pathways to Deep Decarbonisation, http://unsdsn.org/wp-content/uploads/2014/07/DDPP_interim_2014_report.pdf

G7 (incl EU) historical energy-related emissions and targets

The chart shows the historic and required targets on emissions for the G7 (including EU) countries from 1990 to 2050. The countries represented in this analysis are US, Japan, Canada and EU.

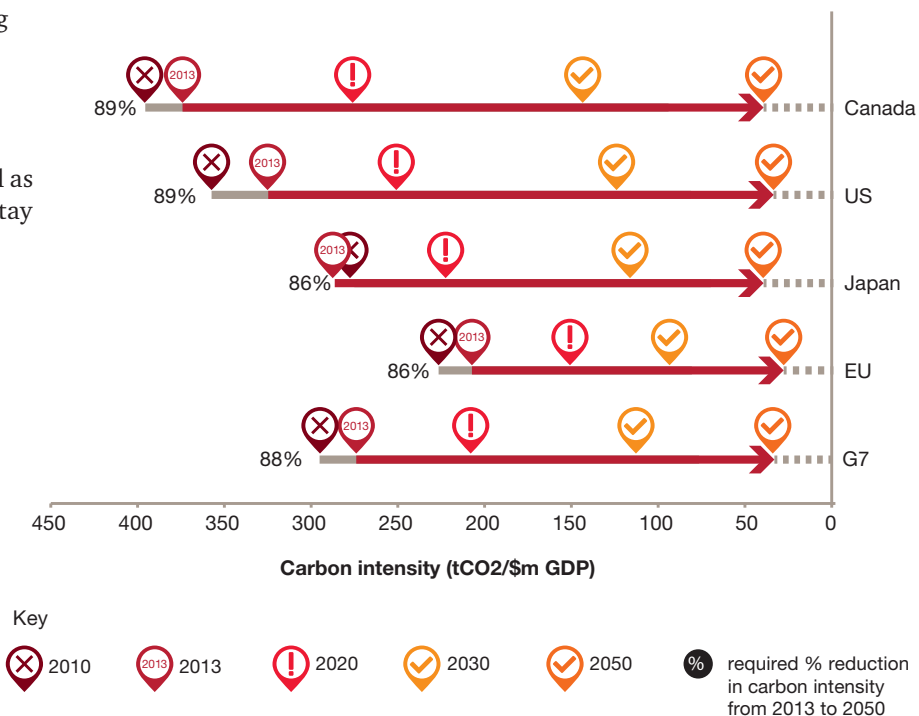
The G7 economies have set their respective 2020 carbon targets, known as the Cancun pledges, relative to 1990 or 2005 base years, and some countries have expressed their targets as a range. Assuming the ambitious end of the targets, the G7 as a group needs to reduce carbon intensity by 3.8% a year between 2013 and 2020.

Assuming these pledges are met, we estimate what their targets for 2030 and 2050 need to be to meet a 2°C warming scenario. The analysis suggests that the G7 would expect to experience a 5.9% annual carbon intensity reduction between 2020 and 2050.



G7 carbon intensity reality and ambition

Carbon intensity is measured by calculating the level of carbon emitted for every GDP dollar produced. This chart illustrates the levels of carbon intensity for each of the respective G7 countries between 2010 and 2013, their pledged targets for 2020 as well as the required targets for 2030 and 2050 to stay within the 2°C carbon budget.

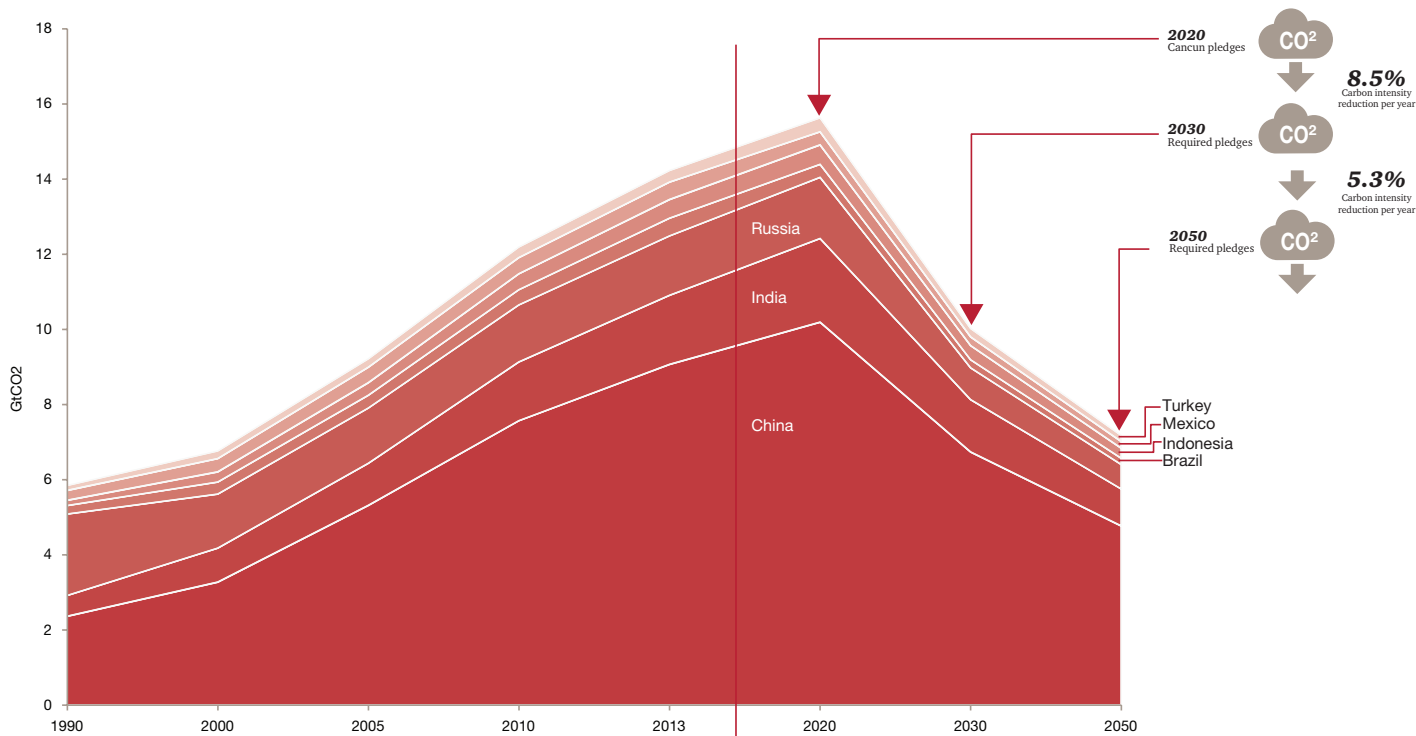


E7 historical energy-related emissions and targets

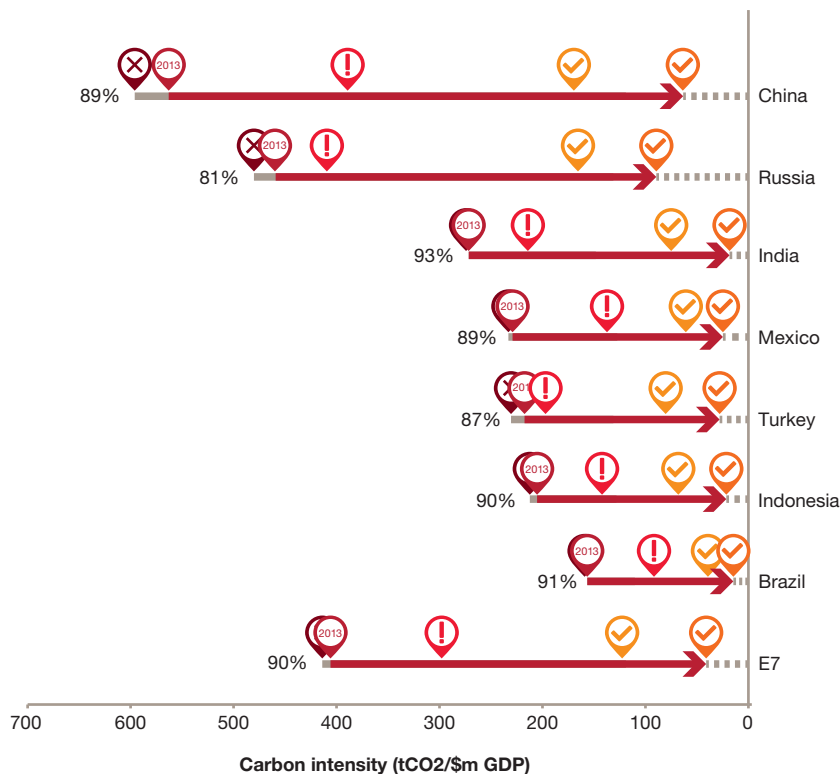
The chart shows the historic and required targets on emissions for the E7 countries from 1990 to 2050.

The E7 economies set their Cancun targets differently. Some countries use a carbon intensity metric, others set emissions targets relative to business-as-usual (BAU), or absolute targets relative to a base year. Turkey has yet to set a carbon emissions target for 2020, but we have assumed their total emission targets to be their current electricity emissions targets which is 7% below BAU by 2020.

To meet their 2020 targets, carbon intensity for the E7 economies needs to fall by 4.2% a year between now and 2020. By 2020, to meet a two degrees target emissions for the E7 economies need to peak and start falling in absolute terms. Assuming the 2020 targets can be achieved, we would expect to see for the E7 group an 8.5% annual carbon intensity reduction between 2020 and 2030 and then further 5.3% annual reduction until 2050.



This chart illustrates the levels of carbon intensity for each of the respective E7 countries between 2010 and 2013, their pledged targets for 2020 as well as the required targets for 2030 and 2050 to stay within the 2°C carbon budget.



Key



Betting on Paris 2015

Expectations and necessity

A new global climate agreement is expected to be signed in Paris in December 2015, and will be due to take effect by 2020. It will be founded on a set of national emissions targets and financial pledges. The spotlight in the lead up to Paris will be on the content of these pledges, and whether the emissions reductions proposed by each country are collectively enough to keep warming within the 2°C limit by 2100.

The process is hard to predict, as it is based on a bottom-up approach of national 'contributions' rather than a top-down division of the global carbon budget.

The critical role of national targets

At this stage in the negotiations process, countries are expected to submit their 'intended nationally determined contributions', or INDCs, in advance of Paris by March 2015. Contributions are expected to include longer-term, economy-wide, emissions reduction targets as well as potentially energy targets, policies and investments.

The submission of INDCs will then be followed by an iterative process throughout 2015. This will add up and review the contributions in light of their feasibility and aggregated impact in terms of the reductions needed to achieve the IPCC targets. The INDCs will then form the building blocks of the negotiated outcome at the UNFCCC 21st Conference of Parties in Paris at the end of 2015.

The stakes are high, and already analysts are citing two challenges facing the Paris climate agreement.

Voluntary commitments: The first is that this voluntary, bottom up, approach has, in the past, failed to put us on the path consistent with a 2°C target. Some countries, confronted by the emerging realities of the rising costs of inaction may opt for ambitious pledges, others may choose to prioritise more immediate concerns over the changing climate.

Tight timetable: The second is timing. Getting the initial INDCs submitted, reviewed, iterated and finally agreed by Paris 2015 is going to be an immense challenge. Even if leading countries show unparalleled ambition in their submitted INDCs, there will only be a matter of months between the initial submission of contributions and Paris itself.

One possible outcome, recognising these challenges, is that the Paris deal provides a foundation of pledges from all, and that the UN process then outlines a timeframe for countries to increase the ambition of pledges sealed in Paris, so that the numbers do eventually add up to what is required meet the 2°C goal. But this model of deferred accelerated decarbonisation carries a significant risk of failure – especially as current progress suggests countries are already falling short of their 2020 pledges.

Smoke signals to look for before Paris

With timing of the essence, there are a number of developments to watch out for ahead of the climate talks in Paris 2015 that look to be preconditions of success:

- **Big footprint leadership:** The outcome of the New York UN Climate Leaders' Summit, hosted by Ban Ki-moon on September 23 2014, will be highly influential. Strong attendance by heads of state, and strong calls for increased ambition and action – whether jointly or individually – will provide legitimacy to the efforts of their negotiating teams in Lima and beyond, while encouraging governments to put forward more ambitious targets.
- **INDC pledges:** The emissions reduction pledges submitted by countries by March 2015 are the building blocks of a deal. How the renewed pledges add up will shape the likely carbon emissions trajectory for the world for the next decades. These pledges can be increased after Paris, and a new UN process would likely be introduced to enable this, but the INDCs will demonstrate the short-to-medium term willingness of governments to decarbonise.
- **'Draft decisions' papers: laying down the policy foundations:** Specific policies, what's in and what's out, will be the battleground for negotiators in the next months. The more that is locked down before Paris, for example in the 2014 summit in Lima, Peru, the more likely it is that there could be an international deal. Draft decision papers that secure at least a high level policy consensus will therefore be critical. Working groups of the UNFCCC process are gearing up activities by making public some possible options for the Paris 2015 deal.
- **A change in the carbon rhetoric?** Above all, as some renewables appear to approach cost parity, and as the costs of climate inaction – from flooding to food insecurity – appear to grow, the strongest determinant of success will be the broadening of the emerging recognition by both business and political leaders that taking decisive action to mitigate climate change is not a cost, it is a pre-condition for sustained economic growth.

The next two annual UN climate summits in Lima and Paris will indicate the direction in which the world is headed on climate change. Where we are now is clear: inadequate pledges, inadequately implemented. If these four indicators above of success are met, though, the picture could start to look different. The stage is then set for one meeting to take us off the path to 4°C, beyond the present promises of 3°C, towards a policy framework for a future where warming is limited to 2°C.

Appendix

(1) The LCEI model and approach

In summary, the LCEI model considers energy-related carbon emissions, driven by a series of assumptions including economic growth projections, primary energy intensity and fuel mix share. The model covers energy and macroeconomic data from individual G20 economies, as well as world totals. Details of our model structure are available in our first *LCEI report* in 2009.

Data on estimating the required pledges are based on taking the IPCC findings on potential emission pathways, as described in Chapter 6 of the Working Group three in the AR5 series, and comparing that with the

emissions data/projection in the LCEI model. Further sense-checks are also conducted against the UNEP Emissions Gap report. An important caveat is that we have presented point estimates on required pledges and decarbonisation based on a series of assumptions, but in practice pledges and decarbonisation rates can fall within a range due to modelling uncertainties and climate variability.

(2) Assumptions on Cancun pledges

We have included the following pledges in our estimates for the G20 economies.

Country	Pledges for 2020	Target used in estimates in this report (where ranges exist)	Pledges for 2030
China	40-45% carbon intensity below 2005	45%	
US	17% absolute below 2005	17%	
EU	20-30% absolute below 1990	30%	40% absolute below 1990
India	20-25% carbon intensity below 2005	25%	
Russia	15-25% absolute below 1990	25%	
Japan	25% absolute below 1990 Revised to 3.8% reduction on 2005 levels	25%	
Korea	30% below BAU (4% abs below 2005)	30%	
Canada	17% below 2005	17%	
S Africa	34% – 42% below BAU	42%	
Mexico	2% below 2000	2%	
Brazil	36- 39% below BAU	39%	
Australia	5 – 25% below 2000	25%	
Indonesia	26% below BAU	26%	
Turkey	Electricity emissions 7% below BAU	7% across all energy	

PwC Advisory services

Climate change has emerged as one of the most important political and business issues of our time. We work with companies and policy makers helping to set the agenda, analyse the issues and develop practical solutions.

We can help you understand which issues will have the greatest impact in your organisation, form a coherent strategy to address them, and then support you through the often complex organisational changes needed to put your strategy in place.

www.pwc.co.uk/sustainability-climate-change

Contacts

Leo Johnson

leo.f.johnson@uk.pwc.com

Jonathan Grant

jonathan.grant@uk.pwc.com

Lit Ping Low

lit.ping.low@uk.pwc.com

This publication has been prepared for general guidance on matters of interest only, and does not constitute professional advice. You should not act upon the information contained in this publication without obtaining specific professional advice. Data used from third-party sources has not been independently verified or audited. Any third party views in this publication have not been edited or reviewed, nor is their inclusion an endorsement of them. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this publication, and, to the extent permitted by law, PricewaterhouseCoopers LLP, its members, employees and agents do not accept or assume any liability, responsibility or duty of care for any consequences of you or anyone else acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it.

© 2014 PricewaterhouseCoopers LLP. All rights reserved. In this document, "PwC" refers to the UK member firm, and may sometimes refer to the PwC network. Each member firm is a separate legal entity. Please see www.pwc.com/structure for further details.

140820-152755-AL-OS