



Low Carbon Economy Index

Executive Summary
December 2009

Summary and key findings

The world economy has been consuming the carbon budget required to limit warming to two degrees more quickly than modelled targets for 2020 and 2050 allow. In order to address this carbon debt, keeping atmospheric concentrations of carbon below 450 ppm, the world economy faces the challenge of decarbonising between 2008 and 2020 at more than four times the actual rate of carbon intensity reduction achieved globally since 2000.

Key findings

- **Carbon budget:** PwC's model estimates that there is a need to stay within a global carbon budget for the period from 2000 to 2050 of just under 1,300 GtCO₂, to have a fair chance of limiting global warming to 2°C.
- **Performance off track:** The report reveals a widening gap between this budget and actual carbon emissions. For 2000 – 2008, the cumulative global budget overshoot, or 'carbon debt', is estimated at around 13 GtCO₂ (roughly equivalent to the annual carbon emissions of China and the US combined in 2008). Global carbon emissions in 2008 were already around 10% above levels implied by these estimated annual budgets. Even the EU is 7% off track.
- **Carbon achievement gap:** The world will already have exceeded its estimated global carbon budget for the first half of this century by 2034, 16 years ahead of schedule, at current rates of carbon intensity improvement.
- **Carbon challenge:** If the world had started in 2000, it would have needed to decarbonise at around 2% a year up to 2008 according to these budgets. But the global rate of carbon intensity reduction actually achieved up to 2008 was only around 0.8%. The result is that the world now has to decarbonise at a rate of 3.5% a year between 2008 and 2020 to get back on track —more than four times faster than the rate achieved since 2000 at the global level. This is greater than the levels of improvement in carbon intensity seen in the 1990's in the UK (with its "dash for gas") and in Germany (after reunification). The PwC Low Carbon Challenge index indicates that the G20 now needs to cut its carbon intensity levels by around 35% by 2020, and around 85% by 2050.
- **Key players:** China, the US, the EU and India together account for around 63% of the estimated cumulative carbon budget for 2000-50. These 'Big 4' economies will therefore be critical to agreeing and implementing any global climate change deal at Copenhagen and beyond.

The low carbon challenge

- **Global investment opportunity:** According to IEA estimates, the level of incremental investments required globally to secure this decarbonisation amounts to £430 billion in 2020, rising to \$1.15 trillion by 2030, above business as usual. This investment translates into 18,000 windmills of 3MW and 20 nuclear plants every year; as well as 300 concentrated solar plants; 50 hydro power plants; and for 30% of coal-fired power plants to be installed with CCS technology by 2030.
- **Key policies:** To be able to deliver this scale of investment, the private sector will need not just targets, but a binding and effective framework of policy commitments. Establishing a global market for carbon trading would be one element in this, together with adequately funded arrangements to support technology transfer to less developed countries. For the G20 economies, this also means keeping to their pledge on phasing out fossil fuel subsidies. Phasing out these subsidies, combined with strong domestic policy frameworks and mechanisms to put an international price on carbon emissions, are essential if low carbon alternatives are to attract the necessary investment flows within the timeframe required.
- **The importance of Copenhagen:** Two years ago in Bali, governments agreed that the Copenhagen summit would mark a turning point in international cooperation on climate change. In the weeks leading up to Copenhagen, the jigsaw pieces have started to come together, with most major countries pledging specific national emissions targets. There may not be sufficient time to complete the picture of a comprehensive legally binding protocol by mid-December, but an ambitious political deal will pave the way to more robust national and global measures. New policies and radical regulation will need to come into effect rapidly in the next few years. Businesses have a short window to prepare, and those that are ready for the transition will benefit from the opportunities arising from a low carbon economy.

► Summary and key findings

Copenhagen calling

The UN climate conference in Copenhagen in December 2009 presents a crucial opportunity for global leaders to lay the framework for a low carbon economy. Despite delays and challenges in the final stages of the negotiations, pledges from many of the world's largest economies in the immediate run up to the event have added new momentum to the Copenhagen process. The priority now is to convert these into an ambitious global deal, with the appropriate mechanism and adequate funding to deliver it.

There is mounting scientific and political consensus around the need to limit warming to 2°C. Three questions are therefore paramount:

- **Carbon budgets:** What are the global and national carbon budgets that this translates into?
- **Adequacy of commitments:** Will the sum of national commitments made at Copenhagen keep us within the carbon budget?
- **Policy framework:** Will governments implement a set of national policies to ensure they meet these targets?

To help assess the velocity of this transition to a low carbon economy, PricewaterhouseCoopers has developed two new indices for the G20 economies:

- The **PwC Low Carbon Achievement (LCA) Index**, which assesses how much progress countries have made this century in reducing the carbon intensity¹ of their economies; and
- The **PwC Low Carbon Challenge (LCC) Index**, which assesses the 'distance to go' for key countries in reducing their carbon intensity.

The index looks at the period from 2000 to 2050, and an intermediate timeframe to 2020.

Four economies, the US, China, India and the EU, are key to tackling change, as they make up 63% of the global carbon budget. For the US, China and India, and representing the EU, the UK, we have identified:

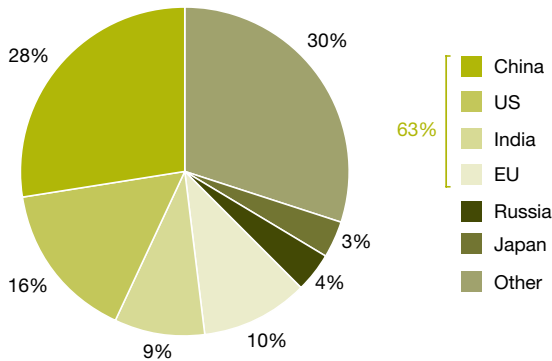
- a) **Carbon Budgets:** a national carbon budget for 2000 – 2050.
- b) **Commitment Gap:** the adequacy of the current reduction commitments relative to that budget.
- c) **Policy Gap:** the adequacy of the current policy framework as a means of driving the required emissions reductions.

Global Carbon Budget

There is broad consensus² that, to stand a fair chance of limiting the global average temperature change to 2°C, concentration levels need to be at no more than 450 ppm CO₂e by the end of this century. This means that there is a finite amount of carbon dioxide (CO₂) the world can emit during this period, and we have estimated the global carbon budget for 2000 – 2050 to be 1,300GtCO₂.

Figure 1 represents a possible geographic allocation of the cumulative global carbon budget from energy use of just under 1,300GtCO₂ for the period from 2000 to 2050. The ‘Big 4’ of China, US, India and the EU collectively account for around 63% of this cumulative global carbon budget and will therefore be crucial for the success of any global effort to combat climate change.

Figure 1: Cumulative Global Carbon Budget for 2000 – 2050 (c. 1,300GtCO₂)



Source: PwC analysis

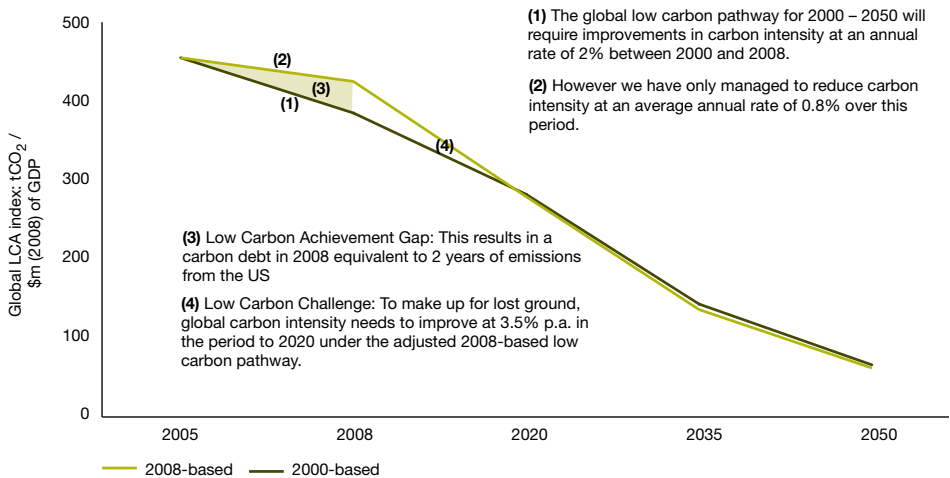
As a plausibility test, we have compared our analysis with the International Energy Agency (IEA) World Energy Outlook 2009, including the cumulative carbon budget³ and the 450 scenario for 2030 emissions. We found the two sets of projections to be broadly similar (see Appendix in the Full Report for details).

Low Carbon Economy Index

Global performance

The first element of the Low Carbon Economy Index, the Low Carbon Achievement Index, compares the performance of the leading G20 economies. PwC has estimated a global low carbon pathway over the period 2000 – 2050. The required reduction in carbon intensity between 2000 and 2008 is estimated at 2% p.a.

Figure 2: Global Low Carbon Achievement Gap



Source: BP data for 2000 and for 2008 in 2008-based variant, PwC model projections for Greener Growth + CCS scenario variants

The low carbon pathway over the period 2000 – 2050 shown in **Figure 2** is based on an objective to stabilise atmospheric concentrations of CO₂e at no more than 450 ppm by 2100, which scientists suggest is the minimum that needs to be done to mitigate the risks of harmful climate change.

In actual fact, the world has achieved reductions averaging only around 0.8% per annum since 2000. At the current rate of carbon intensity improvements, the world will have used up its global carbon budget for the first half of this century by the early 2030s and will fail to reach stabilisation levels at 450 ppm by 2100. Indeed, atmospheric concentration will exceed 1,000 ppm CO₂e by the end of the century⁴.

Key findings: At a global level, the world has drifted off the low carbon pathway for carbon intensity by 2008 by approximately 10%. **Figure 2** illustrates this global low carbon achievement gap.

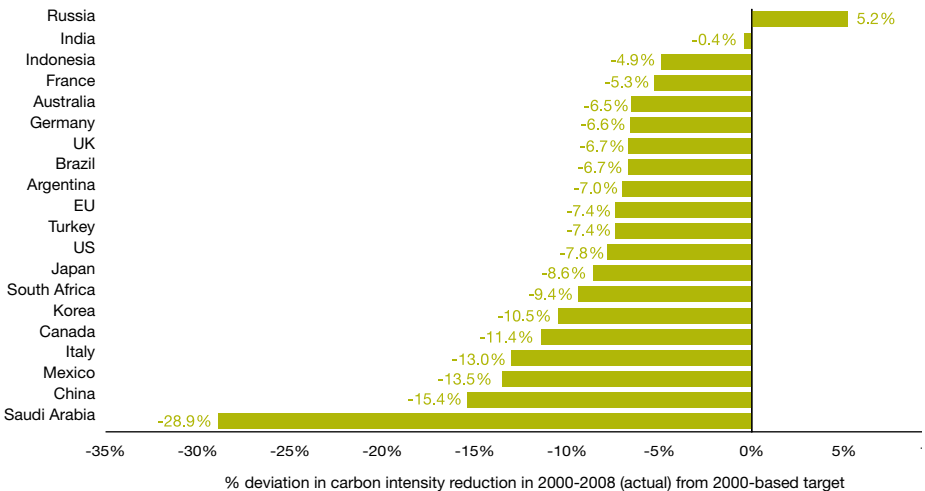
With a 10% shortfall from the low carbon pathway, the world has to make up for lost ground from now through to 2020 and beyond through an adjusted low carbon pathway. To get back on track by 2020 would require a fourfold increase in the rate of carbon intensity reduction achieved globally since 2000.

This means that the world would need to reduce its carbon intensity by around 3.5% a year up to 2020 to make up the ground lost since 2000. This is greater than the levels of improvement in carbon intensity seen in the 1990's in the UK (with its “dash for gas”) and in Germany (after reunification).

Country performance

Figure 3 summarises our assessment of how far progress in reducing carbon intensity in each G20 member between 2000 and 2008 compares to the low carbon pathway for 2000 – 2050.

Figure 3: PwC Low Carbon Achievement Index (2008)



Source: PwC estimates

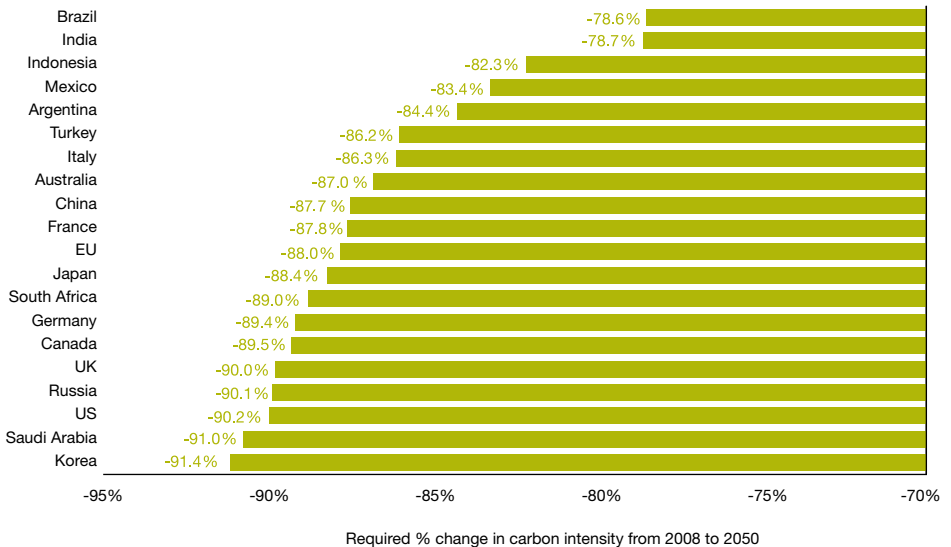
► Summary and key findings

- According to our analysis, **the EU** ranks towards the middle of the G20, with carbon intensity reductions around 7-8% adrift from their 2000 – 2050 low carbon pathway. This varies by country within the EU, however, with France being a relatively good performer and Italy rather less strong. Germany and the UK have intermediate results compared to other EU states, with carbon intensity reductions by 2008 that are around 6-7% adrift from their pathways.
- **The US** has similar results to the EU, reflecting some progress on energy efficiency but still lacking a marked shift towards a lower carbon fuel mix over this period.
- **China** scores less well over the period since 2000, following significant progress in reducing its carbon intensity during the 1990s. Its shortfall in the present decade reflects a brief period in 2003 – 2004 when energy consumption rose faster than GDP in China, although this has improved since 2005, with growth in energy consumption slowing relative to GDP growth.
- **India** has also achieved significant improvements in energy efficiency over the period since 2000, but has made less progress so far in diversifying away from its reliance on fossil fuels, particularly coal.
- **Russia** is the only country that has reduced its carbon intensity since 2000 by more than their budgeted amount, directly attributable to rapid improvements in energy intensity over this period.
- **Saudi Arabia** scores poorly on this index, as it has a uniquely high dependence on fossil fuel amongst the G20 nations. Moving away from fossil fuel is likely to involve more short term challenges relative to other countries in the G20, but reducing its dependence on oil / gas production and moving towards renewable sources, e.g. concentrated solar power may be a viable long term strategy.

Our country-specific estimates of the low carbon challenge (see **Figure 4**) suggest that most major economies need to reduce carbon intensity by over 85% between 2008 and 2050. Some emerging economies like India and Brazil⁵ have less far to go on this measure, but significant challenges remain. In particular:

- **India's** needs to decouple carbon from growth is especially critical, given the combination of its ambitions for growth and its rising population.
- **China, EU and the US** will all require over 85% reduction in carbon intensity. Although the low carbon pathway for China assumes similar improvements in carbon intensity to the US and EU, aggregate emissions in China will continue to grow until 2025 as its rapid industrialisation process continues.

Figure 4: PwC Low Carbon Challenge Index (2008 -2050)



Source: PwC estimates

Are current climate change policies up to the challenge?

G20 governments have a huge challenge to achieve the required reductions in carbon intensity by 2050 (see **Figure 6** for the required carbon budgets for 2020 and 2050 for the G20 economies). It will require concerted efforts from all countries on all fronts including energy efficiency, greater use of nuclear and renewables and, in the longer run, the broad deployment of carbon capture and storage.

But because climate change is driven by increases in concentrations of CO₂, rather than emissions of a particular year, the trajectory is as important as the end game. One of the key objectives of Copenhagen is to establish interim budgets that must be achieved for the world to be on track towards a low carbon path. A lack of action in the short term could require rates of decarbonisation over the longer term that are incompatible with growth, and put the 450 ppm goal out of reach.

Figure 5: Carbon intensity reductions required between 2008 and 2020

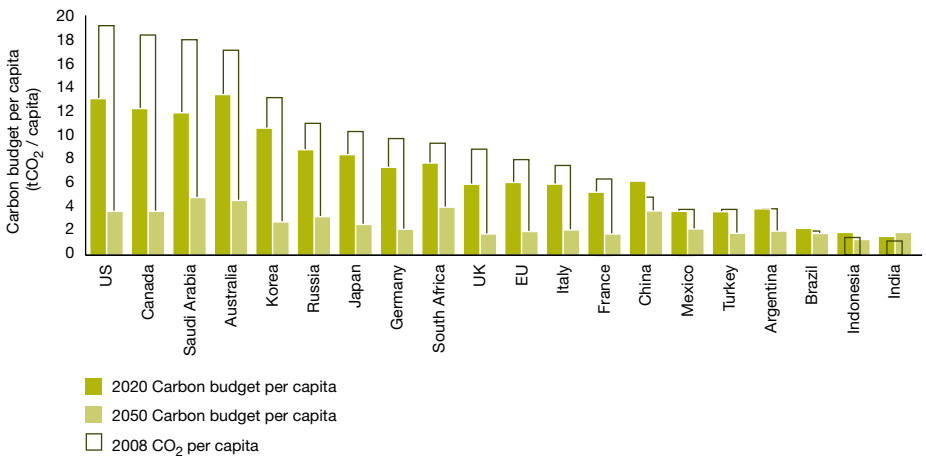
Country / Region	Annual average % reduction in ratio of carbon emissions to GDP	% reduction in ratio of carbon emissions to GDP	
	(2000 – 2008)	Cumulative (2008-2020)	Annual average
China	0.7%	43%	4.6%
US	2.2%	42%	4.4%
EU	1.8%	37%	3.8%
India	2.1%	26%	2.5%
World	0.8%	35%	3.5%

Source: PwC estimates

The performance of the four key economies that collectively account for nearly two-thirds of global energy-related carbon emissions will determine whether the 450 ppm stabilisation level can be achieved.

Following the principle of common but differentiated responsibility, each economy will decarbonise at a rate which reflects national circumstances. Thus although the analysis suggest similar rates of reduction in carbon intensity for the four countries, in reality the US and EU will face very different challenges from China and India, which start from a lower base of emissions per capita.

Figure 6: Carbon budget by emissions per capita in 2020 and 2050



Source: PwC analysis

The targets that have been set thus far by major G20 economies send positive signals on the direction of travel. The level of ambition varies, which reflect the challenges countries have in the transition to a low carbon economy. But leaders need to realise that slower progress in the short term will need to be redressed by more challenging longer term targets.

Existing pledges and policies

The EU has pledged to cut emissions by 2020 to 20% below 1990 levels, or by as much as 30% if there are similar commitments by other major economies. The existing commitment is reasonably close to their carbon budget; 30% would take the EU well below this. But the test will be whether these pledges can be met by 2020. Key policy measures include the EU ETS (Emissions Trading Scheme) and action to boost the share of renewables.

The **US** is a relative latecomer in terms of targets and policies on climate change. However, over the past year, the US administration has introduced a number of notable new proposals relating to climate change, with the 2009 American Recovery and Reinvestment Act giving a strong financial stimulus to low carbon technologies with a view to reducing emissions by around 1% –1.5% per annum up to 2020. Proposals before Congress for an American Clean Energy and Security Act look likely to support and extend this objective, particularly if an effective carbon trading scheme can be put in place in the US. Although proposed domestic legislation is still being debated in Congress, the US Administration has announced that President Obama will pledge cuts of 17% relative to 2005 levels by 2020, increasing to 83% by 2050, when he attends the Copenhagen conference later this month. This represents an encouraging step forward by the world's largest economy and has helped give new momentum to the political dialogue ahead of Copenhagen.

China has also stepped forward with an ambitious new target ahead of Copenhagen. Already committed to reduce energy intensity by 20% between 2006 and 2010, China has now said it will aim to reduce carbon intensity in 2020 to 40% – 45% below 2005 levels. The latest economic and environmental data from China suggest that the 2010 goal is within reach, and the new target for 2020 assumes similar annual improvements. Delivering sustained reductions over this timeframe, however, will require significant progress, not just on energy efficiency, but also on shifting to a lower carbon fuel mix, with less reliance on coal and/or use of CCS for coal-fired power stations. China clearly believes that this is achievable - the new promise is “a voluntary action”, not conditional on a global deal.

India has also made progress on reducing its energy intensity recently, and is aiming for an increased share of renewable energy in the overall fuel mix. In the longer term, reducing India's reliance on coal and introducing renewable energy on a large scale will remain a key focus of policy over the period to 2020.

The low carbon investment challenge

The technologies to achieve this scale of reduction are available, and in many cases economically viable; what is required is the political momentum and the right policy framework that will help scale up the deployment of these measures and technologies.

Returning to a pathway that will deliver a low carbon economy without negatively impacting GDP will have significant implications for investment flows in the energy sector and in technologies to support the scale up of renewable energy.

According to the IEA, investments in energy averages \$1.1 trillion a year under a business-as-usual scenario and significant incremental investments will be required to reduce emissions over this scenario. By 2020 they estimate that additional, annual investment totalling \$430 billion, or 0.5% of world GDP, will be required; this includes investment in power, transport, industry and buildings. The US and China will each account for around a fifth of this amount, with the EU and India expected to make incremental investment of \$70 billion and \$20 billion respectively in 2020.

By 2030, annual investments need to rise to \$1.15 trillion above business as usual. The IEA translates this extra investment into 18,000 3MW windmills and 20 nuclear plants every year; 300 concentrated solar plants; 50 hydro power plants; and for 30% of coal-fired power plants to be installed with CCS technology.

To be able to deliver this scale of investment, the private sector will need the appropriate signals from governments. Establishing a global market for carbon trading would be one element in this, together with adequately funded arrangements for technology transfer to developing countries. For the G20 economies, this also means keeping to their pledge on phasing out fossil fuel subsidies (without exacerbating fuel poverty). The biggest developing economies spend \$310 billion a year in such subsidies, according to the IEA, while the OECD subsidised around \$20 – 30 billion a year. Thus current levels of fossil fuel subsidies (up to \$340 billion) are already close to the level of investments required in 2020 for low carbon technology, estimated at \$430 billion. Phasing out these fossil fuel subsidies, combined with other strong domestic policy frameworks and mechanisms to put an international price on carbon emissions, are essential if low carbon alternatives are to attract the required investment flows.

► Summary and key findings

The importance of Copenhagen

Two years ago in Bali, governments agreed that the Copenhagen summit would mark a turning point in international cooperation on climate change. In the weeks leading up to Copenhagen, the jigsaw pieces have started to come together, with most major countries pledging specific national emissions targets.

There may not be sufficient time to complete the picture of a comprehensive legally binding protocol by mid-December, but an ambitious political deal will pave the way to more robust national and global measures. New policies and radical regulation will need to come into effect rapidly and radically in the next few years. Businesses have a short window to prepare, and those that are ready for the transition will benefit from the opportunities arising from a low carbon economy.

► Reference notes

- 1 Carbon intensity is defined as the ratio of carbon emissions to GDP. By focusing on trends in carbon intensity rather than total carbon emissions we do not penalise fast-growing emerging economies such as China and India and we automatically adjust for fluctuations in GDP due to the economic cycle (including the current recession). Our report focuses on carbon emissions from energy use since these are the most significant factor behind global warming, but progress on reducing carbon emissions from forestry and land use changes will clearly also be important and are factored into our model projections at the global level.
- 2 Some scientists are advocating different levels of stabilisation of concentration levels, ranging from 350 ppm CO₂e to 550 ppm CO₂e.
- 3 The World Energy Outlook (2009) estimated that the cumulative global CO₂ budget for 2000-2049 of 1.4 trillion tCO₂ will have moderate likelihood (50% probability) of keeping the global temperature increase below 2°C. A 1 trillion tCO₂ budget will have a 75% probability.
- 4 Scientists predict that this level of atmospheric concentration could lead to dangerous climate change, which could invalidate the economic growth assumptions in this study.
- 5 It should be noted that these figures only relate to carbon emissions from energy use and Brazil will also have a major role to play in reducing emissions from deforestation. The same applies to countries such as Indonesia, Canada and Russia.

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Contact details

Leo Johnson

Partner, Sustainability and Climate Change

+44 (0) 20 7212 4147

leo.f.johnson@uk.pwc.com

Richard Gledhill

Global Head of Climate Change

+44 (0) 20 7804 5026

richard.gledhill@uk.pwc.com

John Hawksworth

Head of Macroeconomics

+44 (0) 20 7213 1650

john.c.hawksworth@uk.pwc.com

Lit Ping Low

Sustainability and Climate Change

+44 (0) 20 7804 0345

lit.ping.low@uk.pwc.com

www.pwc.co.uk

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