CARBON TRUST

Climate change – a business revolution?

How tackling climate change could create or destroy company value

Acknowledgements

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The views expressed in this report are not necessarily those of either the individuals who provided input or of their organisations.

* Martin Brough left Oxera to join Dresdner Kleinwort's energy team in July 2008
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Preface

The Carbon Trust is an independent company set up in 2001 with the support of the UK Government. Its mission is to accelerate the transition to a low carbon economy. The Carbon Trust carries out a wide range of activities, including working directly with business to reduce carbon emissions, explaining the strategic implications of climate change and investing in new technologies and businesses that will help to tackle climate change.

The Carbon Trust has engaged with investors since commencing its thought leadership work. Investors play a crucial role in holding companies to account on their strategies and providing the investment capital for the new technology and infrastructure that will lower carbon emissions. We regard investors as one of the four pillars of the transition to a low carbon economy, together with business, government and consumers.

This study was designed to test the hypothesis that a move to a low carbon economy could be revolutionary for a number of mainstream industry sectors and therefore should be carefully managed. We set out to quantify the level of opportunity and risk available to companies in different sectors depending on their situation and level of preparedness. We also wanted to understand why investors in many mainstream sectors are not yet significantly concerned by the implications of a move to a low carbon economy.

We commissioned McKinsey & Co. to work with us on an independent study to research these issues. We investigated the impact of a transition to a low carbon economy on six industry sectors: Aluminium, Automotive, Beer, Building insulation, Consumer electronics and Oil & Gas. These sectors each have high value to institutional investors, the potential for significant change resulting from the move to a low carbon economy and are otherwise different in terms of their exposure to different climate change-related drivers, reflecting different parts of the wider economy.

While this report was written from an investor perspective, it also has important messages for policy makers and for companies.

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Executive summary

Introduction

In this report, we set out a range of global carbon mitigation scenarios and related assumptions for the transition to a low carbon economy. We demonstrate how these assumptions and scenarios could affect projected company cash flows and therefore company value.

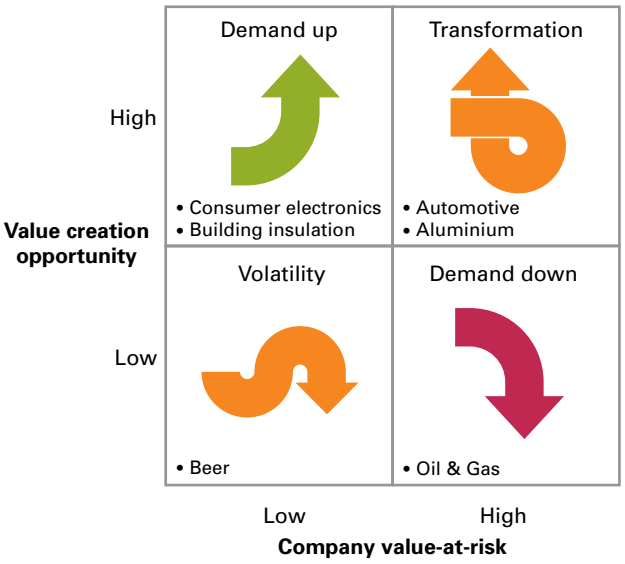
Based on these assumptions, we have found very significant potential opportunities and risks for current projections of company value. These vary by sector and depend on company response: whether they proactively seek out new commercial opportunities or fail to adapt to a low carbon economy.

Given the significant scale of potential impact, we believe the investment community, companies and policy makers must urgently consider the impact of deep and sustained emissions reductions on their investment, strategy and policy decisions. This should be based on their own analysis and views of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings

- Today, investment and business decisions do not put us on a path to a low carbon economy. They appear to be in line with greenhouse gas concentrations rising to more than 700ppm CO_2e[1] compared to a target of less than 550ppm CO_2e.
- Tackling climate change could create opportunities for a company to increase its value by up to 80%[2] if it is well positioned and proactive. Conversely, it could threaten up to 65% of value if the company is poorly positioned or a laggard. The scale of the opportunities and threats we analysed – within six sectors that total approximately $7 trillion in market capitalisation – are therefore very significant for investors and business managers.
- The opportunities and risks are driven by shifts in consumer behaviour, technology innovation and regulation. Regulation is usually the key initiator of change although the cost of carbon is not the decisive factor in many sectors.
- The impact of tackling climate change will, therefore, vary by sector. We identify four ways in which value could be created or destroyed: sector transformation, upward demand shift, downward demand shift and increased volatility – see Chart 1 (right).
- In response, strategic investors should discriminate between sectors and companies on the basis of their opportunities and risks. Businesses should incorporate climate change in their core strategy and investment decisions. Policy makers should work with business and investors now to create a policy framework which rewards early action and an efficient transition to a low carbon economy.

Chart 1 *How climate change could create and destroy company value*



Source: Carbon Trust and McKinsey & Co. analysis.

[1] The long-term concentration of greenhouse gases in the atmosphere is measured in parts per million of carbon dioxide equivalent, reflecting the equivalent average radiative forcing of each gas over a 100-year period. Greenhouse gases include carbon dioxide, methane, nitrous oxides and halocarbons.

[2] The percentage value creation opportunity or risk is defined as the relative increase or reduction in value of a company which may result from the move to a low carbon economy, based on the net present value of its anticipated future cash flows. Any resulting shift in company value will depend on its actual response and sector exposure.

Investment and business decisions do not, for now, put us on a path to a low carbon economy

Deep cuts in greenhouse gas emissions are required to avoid catastrophic climate change

If the global economy were to continue to grow on its current path, then greenhouse gas emissions could rise from an estimated atmospheric concentration of 433 parts per million carbon dioxide equivalents (ppm CO_2e) in 2006[3] to around 1000ppm CO_2e or more by 2100, threatening catastrophic climate change[4]. To avoid the worst effects of climate change (limiting long-term temperature rises to 2ºC) requires greenhouse gas concentrations to remain below 550ppm CO_2e and possibly below 450ppm CO_2e[5]. To remain below 550ppm CO_2e requires annual global emissions to peak by 2020 at the latest, followed by deep cuts in emissions. This presents a major challenge for the global economy.

Current market assumptions imply a rise in greenhouse gas concentrations to exceed 700ppm CO_2e

There has been a step change in understanding of climate change impacts amongst investors and leading businesses in the past 18 months. However, with the notable exception of the power sector in some regions, climate change has not featured as a key investment theme in most mainstream business sectors or as a major strategic driver for most businesses. Current assumptions of industry analysts and experts across the individual sectors we studied are not consistent with a transition to a low carbon economy. This does not usually reflect an expectation of failure, but rather implicitly assumes that success could be achieved by the efforts of other sectors or at a later time.

Combining the emissions trajectory implied by the lower end of current market sentiment and action across sectors, we estimate this would lead to greenhouse gas concentrations rising to exceed 700ppm CO_2e and a very high risk of catastrophic climate change.

A change in market sentiment will need to take place if policy makers implement regulations that allow them to meet the stated aims of the UNFCCC, G8 and EU of avoiding serious climate change, which imply a target to stabilise below 550ppm CO_2e.

Investors' current outlook on climate change primarily reflects regulatory weakness

The current outlook reflects a number of prevailing views including: a) uncertainty as to the nature and timing of regulatory initiatives to drive the transition to a low carbon economy; b) the potential for policy to mitigate value-at-risk through concessions to existing industry players; and c) a belief that climate change is a long-term issue and that companies will have time to react when necessary. This may be rational today, but the increasing momentum to tackle climate change, combined with the significant potential impact on value now require a quantitative perspective on the implications for value.

Uncertainty over tackling climate change requires the use of scenarios to assess opportunity and risk

We developed a methodology to quantify company value opportunity and risk whilst addressing both the long-term nature of climate change and uncertainty over how it will be tackled. Our methodology starts by identifying the key climate change-related value drivers affecting companies in each sector. Next we developed a range of alternative global scenarios and industry sub-scenarios for the transition to a low carbon economy. Finally, we quantified the impact on projected company cash flows of each scenario for a range of typical 'archetype' companies in each of the sectors studied: Automotive, Aluminium, Oil & Gas, Building insulation, Consumer electronics and Beer. Any change in value either upwards or downwards from business-as-usual reflects the value-at-risk or value creation opportunity.

[3] The number refers to the combined concentration of the main greenhouse gases covered by the Kyoto Protocol, measured in terms of 100-year global warming potentials. The warming impact is partially offset by the cooling effect of aerosols, the impact of which is much more uncertain – see European Environment Agency *Atmospheric greenhouse gas concentrations (CSI 013) assessment* published April 2008.

[4] Estimates based on table 3.1 of the *Intergovernmental Panel on Climate Change Synthesis Report (2007).* The full range of IPCC scenarios by 2100 spans the very wide range 600-1250ppm CO_2e, but the lower levels embody assumptions that are clearly inconsistent with current trends and business expectations in the absence of strong mitigation actions.

[5] See Intergovernmental Panel on Climate Change Fourth Assessment 2007, the Stern Report (2006) and Meinshausen, M (2007) *Emission pathways and concentration levels under a 2ºC climate target*, presentation to EU Parliament temporary committee on climate change 10 September 2007.

The transition to a low carbon economy will have major, but different, value implications across sectors

There are four key climate change-related drivers of value

Our framework identified four interrelated drivers of value:

- **Targeted regulations:** in some sectors specific regulations are being introduced to incentivise or mandate change, for example introducing maximum product emissions standards. These will expose competitive differences of capability to respond.
- **Consumer behaviour:** changes in consumer preferences will affect demand for different products. This will also be affected by the availability of lower carbon substitute products.
- **Technology innovation:** technology breakthroughs will be critical in certain industries. Winning companies will be those that are able to access the best technologies at lowest cost.
- **Cost of carbon:** policy makers have already begun to introduce a 'cost of carbon' which applies to the CO_2 emissions of some businesses. This will expose competitive differences between operations.

These drivers influence not only costs, but more importantly, relative costs and competitive advantage as well as shifts in demand for product types. Together this determines value creation opportunities and value-at-risk.

Up to 80% value creation opportunity for well positioned, proactive companies and up to 65% value-at-risk for badly positioned or laggard companies

Our analysis demonstrates considerable potential for companies which prepare well and positively position themselves for the climate change challenge to outperform and create value. Across the sectors studied, companies in the Building insulation sector demonstrate the greatest opportunity – up to 80% gain in value, with significant opportunities in Automotive (60%), Consumer electronics (35%) and Aluminium (30%). In this report we limit the analysis to new opportunities in existing core business areas. We have not quantified potential new opportunities in adjacent business areas, such as carbon capture and storage or emerging renewable energy (which may be applicable to the Oil & Gas sector, for example).

The value-at-risk for companies with strategies geared towards business-as-usual and which do not adapt ranges from a limited risk of only 5% in Consumer electronics through to a potential risk of up to 65% in each of Automotive and Aluminium, depending on the scenario analysed. See Chart 2 (over) which illustrates the maximum identified value creation opportunity and risk for each sector.

Automotive industry: transformed by new technology

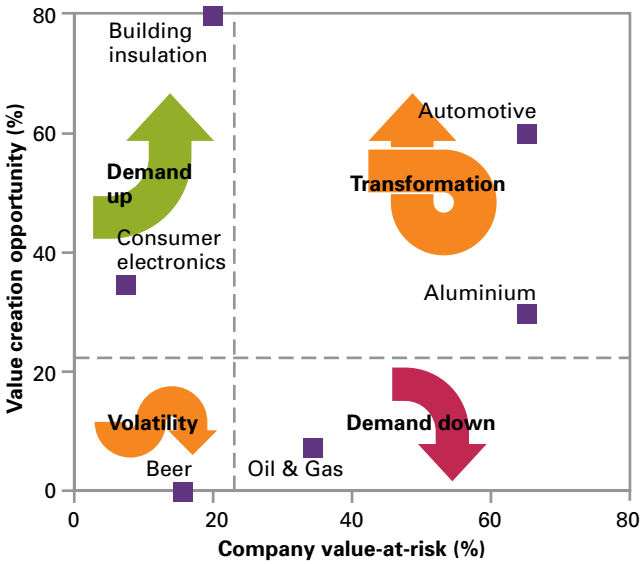
Auto passenger kilometres are forecast to roughly double over the next 40 years. To tackle climate change, global auto emissions could need to reduce by up to 80%. This is likely to be primarily achieved by targeted regulations to reduce new per vehicle emissions. This would stimulate further technology innovation in vehicle design and power trains, including improvements to the internal combustion engine, hybrid technology and, potentially, electric or hydrogen vehicles. It may also lead to biofuels playing an increasing role, although land use pressures may limit their potential. Continuing high gasoline costs (potentially reflecting a cost of carbon) may shift consumer preference further towards smaller, more efficient vehicles. Auto companies will probably need to invest in further technology innovation and fleet design. Winning companies will be those that can reduce vehicle emissions at lowest cost whilst meeting consumer preferences. A failure to do so places significant value-at-risk.

The ways in which value could be created or destroyed differs by sector

The combination of value creation opportunities and value-at-risk enables a classification of sectors (see Chart 2):

- **Transformation:** both value-at-risk and opportunity are high. This will transform the nature of the business as players adapt to a new mode of competition. Auto and Aluminium are examples from the sectors studied.
- **Downward demand shift:** the value-at-risk is significant and reflects a downward shift in demand in the sector. Value creation opportunity is low in the core business area (but could be significant in adjacent business areas). Oil & Gas is an example.
- **Upward demand shift:** the value-at-risk is low, but there is considerable value creation opportunity in capturing an increase in volume for the sector as a whole. Buildings insulation and Consumer electronics are examples.
- **Volatility:** the value-at-risk and the opportunity are relatively low, reflecting only a modest likelihood of significant long-term impact. However, short-term cost impacts or demand changes could cause volatility in earnings. Beer is an example.

Chart 2 *Maximum identified value creation opportunities and value-at-risk for companies from the transition to a low carbon economy*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: Analysis based on discounted cash flow valuations of typical invented 'archetype' companies in sectors. The points represent the greatest risks and opportunities identified across the scenarios studied for core operations, but exclude new opportunities outside of core business areas.

Aluminium industry: transformed by shift to low carbon energy sources

The Aluminium industry continues to enjoy strong growth but is one of the most carbon intensive commodities, with total emissions of up to 20tCO_2e/tonne aluminium. This will probably need to reduce as part of tackling climate change. The key driver of change will likely be an imposed cost of carbon across the value chain. This will significantly advantage low carbon intensity operations (based on hydro or nuclear electricity). Any regional asymmetry in carbon price could also put value at risk in regulated geographies, unless border adjustments on imports are implemented rapidly. There may also be a demand shift from primary aluminium to either significantly higher recycled material (90% lower energy) or increasing substitution by lower carbon materials. Winning companies will rapidly move to low carbon intensity operations and successfully invest in recycling. High carbon intensity operations could face significant value-at-risk.

Climate change is a key strategic issue in most industries

We compared our climate change scenarios to a number of other scenarios involving significant value-at-risk, but not related specifically to climate change. In each industry (except Beer) the value-at-risk from climate change was of a similar or greater magnitude to other significant non-climate change-related issues. For example, in Automotive, the climate change-related value-at-risk could be comparable to a sustained 10% cost disadvantage. In Aluminium, the climate change-related value-at-risk could be greater than a 20% increase in average energy costs without any corresponding increase in price. Within Oil & Gas, the climate change-related value-at-risk for refiners could be greater than a 10% reduction in gross margins on the refining of crude oil.

Different sectors will face different periods of 'creative destruction'

Different industries will undergo periods of high pressure on cash flows at different times. This will be the time a sector experiences the greatest competitive pressure to change and displays highest earnings volatility. We see this as accelerating the ever present 'creative destruction' effect by which established businesses gradually decline as new entrants increase in competitiveness.

Some industries are more likely to be affected in the short term, for example Beer where biofuel requirements are already affecting food crop prices. Others are more likely to be affected in the medium term (5-10 years) where regulations are taking shape but may take time to bite – Aluminium (imposed cost per tonne carbon emitted) and Automotive (reductions in per vehicle emissions) are examples. Oil & Gas is more likely to be affected in the long term, as the reduction in demand eventually affects cash flows from around 2020 onwards.

Indirect effects on industry can be as critical as direct effects

Changes in one industry often have a significant effect on other industries. It is therefore essential, when assessing the impact of climate change, to analyse effects beyond the industry under investigation. For example, the more significant value-at-risk for the refining industry is likely to come from regulation in the Auto industry to increase fuel efficiency, rather than on refining itself. Similarly, the Consumer electronics industry may benefit from higher fuel prices which in turn leads to greater concern to manage home energy consumption using electronic devices and avoid unnecessary travel using enhanced telecommunications.

Oil & Gas industry: sector shift in volumes in core operations following reduced demand and substitute renewable energy

Consumption of oil and gas is responsible for c.30% of global CO_2e emissions. These emissions are forecast to double by 2050 unless action is taken. The industry itself is responsible for significant emissions (approximately 5% of global CO_2e). Tackling climate change could require that consumption peaks within the next 20 years and then reduces significantly. The industry could be indirectly affected by a range of measures to reduce demand for oil and gas below business-as-usual levels whilst stimulating renewable energy supply. The industry also could be directly affected by a cost of carbon applied to its own operations, which is of particular relevance to downstream refining economics. There may be upside opportunities in new adjacent business areas such as carbon capture and storage or renewable energy, although the size of the opportunity is uncertain and has not been included in this report. Winning players can mitigate the value-at-risk by anticipating changes in demand and managing new capital expenditure correctly whilst investing to achieve below average carbon intensity in operations and diversifying. A failure to take these actions places significant value-at-risk.

Greatest value-at-risk and opportunity may exist in specialist niches of industry sector value chains

Value-at-risk and opportunity are likely to be highest in certain specialist niches of each value chain, where players are more exposed to shifts in regulation, technology or consumer demand than are integrated manufacturers. For example, in Auto, battery manufacturers could stand to gain most on major breakthroughs in electric vehicle technology. Meanwhile, in Beer, packaging companies stand to gain or lose the most based on any sudden changes in packaging regulation to a lower carbon format.

Value shifts will depend on policy design, company preparation and transition speed

Regulation is usually the key initiator of change

Regulation, technology and changes in consumer behaviour are the key climate change-related drivers of change in any industry. The drivers are interrelated, but regulation typically initiates change, often having a direct effect on an industry and also being the cause of increased technology innovation and/or changes in consumer behaviour. This places considerable value creation opportunity and risk in the hands of policy makers.

The choice of policy framework and implementation can be critical to value

The mechanism by which emissions cuts are achieved can be just as important to value as the total reduction in emissions. We identify a number of ways in which different policy frameworks and detailed implementation measures can determine the level of value-at-risk:

- **The nature of 'Targeted regulations' can be critical to value-at-risk and value creation opportunity:** at times, regulators need to use specific regulations to incentivise or mandate change. However, such regulations, if not well designed, can have significant effects on industry economics and can stifle competition between technologies. For example, in one of the Auto industry scenarios we assume a specific preference for hybrid technology which in the scenario proves a costly solution compared to incentivising breakthroughs in electric vehicles or biofuels.
- **Asymmetry of carbon price can cause significant value-at-risk:** the level of value-at-risk and opportunity in different industries can be critically driven by regional differences in the applicable cost of carbon. Where a globally traded commodity price is set by players who do not incur a cost of carbon, there can be considerable value-at-risk for those that bear the cost. Policy makers will need to address this regulatory differential in order to maintain the competitiveness of domestic industry, especially at higher carbon prices.
- **Regulatory concessions can reduce value-at-risk:** policy makers can mitigate value-at-risk for industry players by making certain concessions. For example, in the EU Emissions Trading System, the issue of free allocations of emissions allowances reduces the net value-at-risk to players. However, any concession or subsidy will tend to slow the pace of change and is expensive. Early and well-signalled implementation of policy can enable a smoother transition without the need for transition subsidies.

Building insulation: upward demand shift via a drive to improve energy efficiency

Buildings are currently the source of approximately 21% of global emissions and will be a key focus of emission reduction activities. Long-term growth in construction is forecast to remain strong in developing regions. Change for the industry will probably be driven by targeted regulations that impose minimum energy efficiency standards. This should significantly increase demand for building insulation materials.

However, a prevailing cost of carbon may increase basic raw materials prices and poses a downside risk. Winning industry players will position themselves to capture high growth in developing markets and develop higher value-added products with higher margins, whilst reducing the carbon footprint of products. A failure to capture increased growth places modest value-at-risk from a rise in input costs.

Companies that prepare for change should create value and avoid value-at-risk

In each of the sectors analysed, greater preparation increases the chance of companies seizing upside opportunity and mitigating most, if not all of the risk. For example, Auto players can gain increased sales and avoid value-at risk by taking early steps to invest in technology for a lower emissions vehicle fleet of the future. In Oil & Gas exploration and production, provided lower demand is anticipated and players avoid over investment in increased capacity, much of the value-at-risk can be avoided and there should be a corresponding increased chance of seizing opportunities in new business areas.

The speed of transition will affect the efficiency of the transition

Company preparation for the move to a low carbon economy is essential to creating and preserving value. However, the faster the pace of change required, the more difficult it will be for companies to prepare and avoid incurring costs that place value-at-risk. This places a considerable responsibility on companies to anticipate and prepare in advance. It also places a significant responsibility on policy makers to announce as early as possible both the level of ambition and nature of the policy framework to achieve emissions cuts, preferably by individual sector, so that companies can have the confidence to act decisively.

Implications

From our analysis of value-at-risk and opportunity, we make the following observations and recommendations for different stakeholders:

Investors (asset managers and advisers) – include tackling climate change as a key driver of investment strategy

- Carry out value-at-risk and opportunity analysis based on the full range of climate change-related drivers and then screen for companies likely to outperform as a result of the climate change challenge.
- Monitor potential triggers which could herald a change in market sentiment on tackling climate change. Shorter term triggers could include a new 'Global Deal' on climate change policy, potentially at the UNFCCC Conference of the Parties meeting at Copenhagen in December 2009.
- Review the portfolio implications of climate change following a comprehensive value-at-risk and opportunity analysis. Seek to mitigate any adverse effects on portfolio risk and return expectations, for example by rebalancing portfolio interests.
- Engage with companies to hold management to account on the development of far-sighted but flexible strategies for climate change.
- Engage with policy makers to ensure an efficient policy which both succeeds in combating climate change and preserves and creates shareholder value.

In this report we make specific recommendations for **sector analysts, pension trustees, investment consultants** and **actuaries.**

Consumer electronics: potential upward demand shift for electronic communications and controls

The Consumer electronics industry has enjoyed strong growth in recent years, but the resulting proliferation of devices is causing disproportionate growth in electricity demand and associated emissions. Targeted regulation is likely to impose product efficiency measures such as a maximum standby power demand or reduced power pack heat loss. This would impose some costs on manufacturers, although they are likely to be modest provided industry players prepare.

Meanwhile, if consumers lead the way in reducing emissions, this could drive increased demand for communication devices that reduce travel and electronic controls to manage energy demand in the home. Winning companies will be those that invest in reducing their product emissions whilst designing products that enable a lower carbon lifestyle. Companies that fail to prepare could miss out on substantial upside whilst facing some value-at-risk.

Companies – incorporate tackling climate change in business strategies

- Carry out a comprehensive strategic review of the key climate change-related drivers of value and implications for the company of deep emissions cuts across a range of scenarios of relevance to the industry.
- Implement strategies for the move to a low carbon economy, including no regrets moves to reduce emissions of operations and products whilst building flexible options for the future including access to new technology or capital.
- Work closely with regulators, seeking a collaborative, rather than combative approach to identifying regulations which both achieves necessary reductions in emissions and gives the greatest opportunity for value creation.

Policy makers – avoid delay in taking action

- Articulate the level of ambition and high level policy framework for tackling climate change including timing and key milestones for emissions reductions.
- Avoid delay in taking policy action that creates clear signals and strengthens incentives to invest in low carbon assets. Delay risks increased company value-at-risk and a more volatile, costly transition to a low carbon economy.
- Maintain consistency of policy to help create a stable environment for companies and investors to plan for the future.
- Carefully choose policy frameworks that, where possible, provide a level playing field for all participants and enable companies to find the best strategy to achieve emissions reductions goals.

Policy makers, investors and business should collaborate to ensure an efficient transition to a low carbon economy

In this report, we explain how tackling climate change presents a significant challenge to all stakeholders. Whilst policy will likely initiate change, the policy makers' task is complicated by the broad nature of the climate change challenge. Frequently the industries affected are global in nature. Policy must be coordinated to sustain global trade. Change is also required across a diverse range of activities, including buildings, transport, commodities and industry production. The efforts to reduce emissions in one industrial sector will affect the extent of change required by another. This requires a coordinated approach across sectors and geographies in order to succeed.

To successfully and rapidly design a broad sweep of policy across multiple sectors and geographies will require significant interaction and openness between policy makers, investors and industry representatives at national, regional and international levels. This will require a new platform for collaborative policy formulation. In pursuit of its mission to accelerate the transition to a low carbon economy, the Carbon Trust is committed to catalysing the interaction of governments, investors and business at all levels to achieve a smooth transition to a low carbon economy.

The remainder of this report explains the background and context to the study, the methodology used, the analysis of the six sectors and gives more detail on the implications of this work for different stakeholders.

Beer: potential volatility from increased input costs and regulation of packaging

The carbon footprint of beer is not substantial compared with its value, but typically the packaging of bottled or canned beer comprises more than 50% of the carbon footprint. The industry could be directly affected by targeted regulations which aim to reduce the carbon content of packaging and require a switch to new formats. Input costs may also be affected indirectly by other measures to tackle climate change, for example a cost of carbon increasing packaging raw materials costs and demand for biofuels raising barley and maize costs. There is also a risk to crop prices and water supplies from adverse physical climate change. Winning companies will be those that anticipate packaging changes whilst preparing for potential spikes in costs. Although the opportunities and risks associated with climate change are relatively modest for this industry, short-term price spikes could lead to some volatility of earnings.

Introduction and context

Climate change has not been a significant investment theme in most sectors. Whilst this can be rationalised, the conditions for a change in sentiment are rapidly approaching.

Mainstream investor awareness of climate change high, but actions low

2007 saw a step change in the response of the investor community to climate change, with many significant analyst publications laying out good explanations of the science, politics and economics of climate change. Investments in low carbon technologies accelerated strongly, with nearly 50% compound annual growth.

Chart 3 shows the results of an informal survey of asset managers and analysts carried out by McKinsey & Co. and the Carbon Trust in spring 2008. All respondents either agreed or strongly agreed with the statement "I believe climate change will have a significant impact on shareholder value, at least in certain sectors". However, with the notable exception of the power sector in some regions, climate change has not featured as a key investment theme or, necessarily, a key strategic issue in most mainstream sectors.

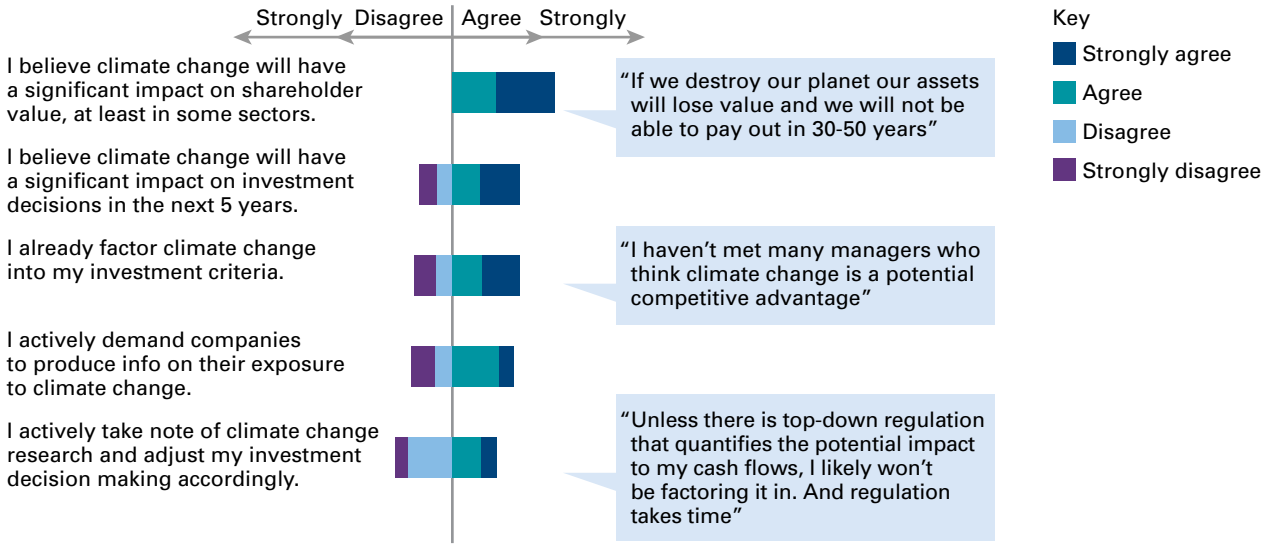
There appears to be a mismatch between the investors' commentary on climate change (led primarily by bank economists and SRI analysts) and the reaction of analysts in mainstream sectors.

Climate change: a certain challenge...

There is increasing consensus amongst scientists, economists and politicians that average global temperature increases should be limited to 2°C in order to avoid the most catastrophic effects of climate change.

If long-term greenhouse gas concentrations are limited to 450ppm CO_2e[6] there is estimated to be a 50% chance of meeting this target. If they are limited to 550ppm CO_2e there is estimated to be a 20% chance of meeting the target[7].

Chart 3 *Results of interviews with asset managers and advisors*



Source: Answers in response to a survey of UK asset managers and advisors carried out March-May 2008. n = 25, excludes 'don't knows'

[6] The long-term concentration of greenhouse gases in the atmosphere is measured in parts per million of carbon dioxide equivalent, reflecting the equivalent average radiative forcing of each gas measured in terms of a 100-year global warming potential. Greenhouse gases include carbon dioxide, methane, nitrous oxides and halocarbons.

[7] These probabilities are based on a presentation by Meinshausen, M (2007) *"Emission pathways and concentration levels under a 2°C climate target"*, presentation to EU Parliament temporary committee on climate change 10 September 2007.

If the global economy continued on its current path then annual greenhouse gas emissions would increase from about 50 $GtCO_2e$ today to perhaps 90 $GtCO_2e$ in 2050[8]. This would lead to greenhouse gas concentrations increasing from 433ppm in 2006[9] to more than 1000ppm by 2100 and to severe climate change.

To be on a path to stabilise at 550ppm CO_2e, greenhouse gas emissions must peak by about 2020 and be cut to about 30 $GtCO_2e$ by 2050. To be on a path to stabilise at 450ppm CO_2e, they must peak very soon and be cut to about 10 $GtCO_2e$ by 2050[10]. These cuts will challenge all parts of the economy.

…but an uncertain future

The scale of the challenge is known, but uncertainty remains over:

- The cuts that each country will commit to.
- When each country will take action.
- The opportunities for cutting emissions.
- The policies that will be used to drive the cuts.
- What relevant breakthroughs in new technology and changes in consumer behaviour will occur.

To ensure concerted action will require a combination of new regulations (for example a cost of carbon and targeted regulations such as minimum emissions product standards), breakthroughs in low carbon technology and shifts in consumer behaviour. The evolution of these interrelated drivers is very difficult to forecast.

Market beliefs imply rising greenhouse gas emissions

The cuts needed to stabilise greenhouse gases at 450-550ppm CO_2e were beyond those anticipated by most sector analysts and industry experts with whom we spoke and often beyond the outer limit of what they could believe.

These sector views primarily reflect uncertainty as to the commitment of policy makers to follow through on the required reductions in emissions. In most cases, the sector view does not reflect an explicit anticipation of failure to tackle climate change, but rather implicitly assumes that success could be achieved by the efforts of other sectors or by action later.

If these sector views are taken at face value as predictions of the future, then we estimate greenhouse gas concentrations would eventually stabilise at a level that would exceed 700ppm CO_2e.

An adjustment in understanding will need to take place if policy makers implement regulations that allow them to meet the stated aims of the UNFCCC, G8 and EU of avoiding serious climate change.

Market's current reaction to climate change can be rationalised

The market's current stance may be rational. We have identified six reasons to take a 'wait-and-see' approach to the climate change challenge. However, for each of these reasons, the situation is changing.

1. **The impact of climate change is too uncertain**: as identified above, many of the details concerning how we respond to climate change are yet to be agreed. However, there is now sufficient certainty on how emissions could be reduced to enable scenario analysis to take place. This gives a range of potential outcomes against which value impacts can be tested.
2. **Lack of framework to understand the risks associated with climate change**: some asset managers identified the lack of a clear framework as an issue in understanding the consequences of climate change. There appears to be significant focus on the direct cost of carbon, and less focus on the more strategic impacts that could take place in an industry, for example through the impact of new technology or changes in consumer behaviour. There is also less attention paid to indirect effects on other industries that can have a profound effect on the industry under review. For example a stimulus of supply for renewable energy electricity, combined with new electric vehicle technology could dramatically reduce demand for refined oil products. Our impact assessment methodology aims to identify the full range of impacts.
3. **Climate change drivers currently have limited impact on company cash flows:** given the short-term focus of many investors, perhaps unsurprisingly there has been low interest in climate change as a key driver of value.

[8] Ignoring both actions to mitigate climate change and the consequences of failing to mitigate.

[9] The number refers to the combined concentration of the main greenhouse gases covered by the Kyoto Protocol, measured in terms of 100-year global warming potentials. The warming impact is partially offset by the cooling effect of aerosols, the impact of which is much more uncertain – see European Environment Agency *Atmospheric greenhouse gas concentrations (CSI 013) assessment* published April 2008.

[10] Estimates based on Table 5.1 in the Intergovernmental Panel on Climate Change (2007) Synthesis report.

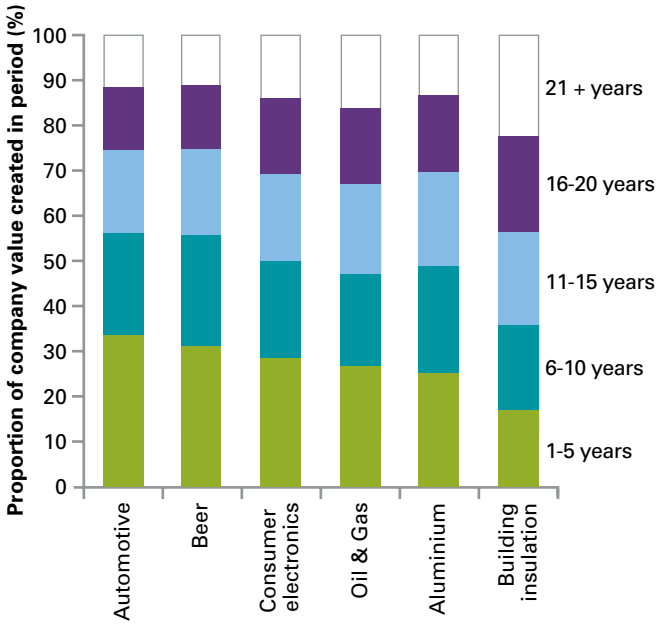
However, regulations such as Phase III of the European Emissions Trading Scheme (EU ETS) are now being devised which will affect near-term performance across a wide range of sectors. New technologies are being deployed which will give some companies an advantage over others (for example hybrid and small electric vehicles) and some consumers are beginning to want to live a lower carbon life (for example purchasing more efficient vehicles, albeit that this is more likely currently driven by high oil prices). Some of these conditions have already been experienced by the European power sector, where the cost of carbon is now a driver of earnings in this sector. Other sectors could follow shortly, for example the Aluminium sector.

4. **Regulators may provide a 'soft' landing:** there is often a belief that the impact of regulations to drive the move to a low carbon economy would limit the value-at-risk. There have been some examples, including the issue of free carbon emissions allowances and grandfathering provisions in Phases I and II of the EU ETS which actually enabled the European power sector to profit from their participation in the scheme, rather than to bear a net cost. However, shifts in long-term demand, the competitive effects of different cost bases and access to technology will be harder for regulators to justify compensation against.

5. **Business has a long time to react to the consequences of climate change:** the climate change challenge can appear to be a long-term problem to which business can react over the long term. There is therefore time for business to start to react to changes in demand in the market place and respond accordingly. Whilst this might be true in some sectors, the time for action in many sectors has now commenced. For example Auto R&D in electric vehicles is required now to enable mass market production potentially from as early as 2015-2020 in OECD markets, as may be required under some scenarios. Similarly, new aluminium plants should now factor in a cost of carbon which could well apply in many regions over the lifetime of the plant (20+ years).

6. **Future cash flows are heavily discounted:** long-term changes to cash flow are naturally discounted in today's valuation of a company and this minimises the impact of long-term effects. However, analysis across the different industries reveals that, on average, greater than 50% of the value of a company resides in the value of cash flows to be generated in the years 10+ onwards (illustrated in Chart 4). The move to a low carbon economy can have a profound effect on these cash flows and still put significant value-at-risk, as well as creating the opportunity for increased cash flows.

Chart 4 *Proportion of company value due to cash flows generated in the next 5, 10, 15 and 20 years*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: Analysis based on discounted cash flow valuations of hypothetical but typical companies, using typical company discount rates.

The Carbon Trust approach to scenario based transition value-at-risk and low carbon opportunity analysis

Despite the uncertainties concerning climate change, we believe there is now sufficient belief in the likelihood of action to achieve a significant reduction in greenhouse gas emissions, and sufficient understanding of the range of drivers that could be used to achieve that reduction for it to be possible to build meaningful scenarios of the path towards a low carbon economy.

Analysis of the value-at-risk in the transition to a low carbon economy, and the opportunities that will arise, can then be conducted for companies in each scenario. This improves understanding of the level of pressure on investments and the key triggers of change in value that might take place.

Combining the results from individual scenarios creates a pattern of value-at-risk and opportunity which yields insight as to those investments that could gain or lose in the move to a low carbon economy.

Methodology to quantify transition value creation opportunity and risk

A scenario-based approach to calculating value creation opportunity and risk enables an understanding of the likely range of pressure on different industry sectors.

Introduction to our approach

Any methodology to address the potential impact of the move to a low carbon economy on companies must be able to deal with the uncertainty concerning the nature of efforts to tackle climate change. For this reason, we developed a scenario-based approach to calculating the range of value-at-risk and opportunity. This does not aim to develop a precise evaluation of the impact on values, but rather to give a quantitative indication of the level of pressure and potential for winners and losers within different industry sectors. Any resulting impact on value will, of course, depend on the actual response of companies.

A five-step approach to identifying value-at-risk and opportunity

Our methodology has five key steps, outlined in Chart 5 below. We address each of these in turn in this section.

1. Build a fact base of the industry

To attempt any valuation methodology, it is essential to have a good understanding of the relevant fact base and drivers of value in today's paradigm. As this is an investor's current area of expertise it is not necessary to describe in detail the types of action required here. For each of the six industries studied, we created the relevant fact base. This then sets the context both for developing relevant scenarios of the future evolution of climate change and for identifying the new climate change-related value drivers and the impact of such value drivers on an industry player.

Chart 5 *A five-step approach to identifying the value-at-risk and opportunities in the transition to a low carbon economy*

1. Build industry fact base	2. Identify low carbon economy industry drivers	3. Develop future scenarios	4. Impact on 'BAU' archetype value	5. 'Winners/ losers' analysis
• Concentration and distribution of players • Value chain analysis • Basic economics (revenues, profit pools, growth) • Basis of competition – differential technologies, cost bases etc	• Business-focussed regulations • Technology development • Consumer behaviour changes • Identify qualitative impact of each driver on P&L dynamics of a typical player	• Macro scenarios for tackling climate change (based on different drivers) • Industry sub-scenarios consistent with macro scenarios	• Develop industry archetype for study (company prepared for business-as-usual – 'BAU') • Quantify impact of drivers on cost, volumes, prices • Quantify total cash flow impacts • Calculate value from net present value of discounted cash flows	• Develop alternative 'winner/loser' archetypes • Repeat scenario analysis on new archetype features • Compare impact on value

2. Identify the key climate change value drivers

Our next step is to identify the key climate change-related value drivers which could affect industry economics.

There are four interrelated drivers of change to achieve a low carbon economy:

1. **A cost of carbon** created either via a cap and trade system or a tax on emissions.
2. **Targeted regulation** by governments to change specific behaviours or incentivise innovation in specific areas.
3. **New technology innovation or capital deployment**: breakthroughs in technology or the ability to change capital deployment (e.g. from coal to gas power generation).
4. **Consumer behaviour shifts:** any change in consumer behaviour which causes a change in demand for different products.

These drivers can impact a company directly. They can also impact competing sectors, or sectors further up or down the sector's supply chain and therefore have an indirect impact on the company. It is important to consider both effects. For example, car emissions standards will indirectly drive change in the oil exploration and production sectors.

In Chart 6 we lay out a grid of potential drivers and their influence on the economics of a company. In Appendix 2, we also lay out a (non-exhaustive) list of questions which could assist in identifying the different climate change-related drivers of value in any industry.

Having identified the drivers, it is important to identify the effect the driver may have on the economics of a player. We observe three areas where changes in economics can have a significant effect on an industry:

1. **Cost:** a new regulation or technology could impose a cost on industry, for example a cost of carbon in a cap and trade scheme could impose a cost on Aluminium players, both via the cost of carbon on direct emissions and via the indirect effect of a cost of carbon causing electricity generation costs to increase.
2. **Revenue:** the introduction of new costs, of new technology or of changes in consumer preference can have an affect on overall sales volumes. Any overall shift in volume will affect revenues. Pricing will be closely connected to the ability to pass through costs and will also depend critically on the marginal cost of supply in the industry, which depends on competitive dynamics as well as alternative substitutes. Of course price and volume are closely connected, and typically a new price/demand equilibrium will be established depending on the price elasticity of demand.
3. **Competitive differential:** as important as the absolute cost imposed on an industry is any relative difference in cost which may give some players an advantage over others, and enable a margin advantage and the ability to capture more share. For example, more efficient, higher margin refineries may be less affected than average refineries by an imposed cost of carbon, and provided price is set by the most expensive marginal player in the industry, then more efficient players may be able to make a margin on the differential in the imposed cost of carbon.

3. Develop future scenarios

Having identified the drivers of value, it is next necessary to identify the nature of the environment in which business is operating. Given the uncertainty over how climate change may be tackled it is necessary to generate a series of scenarios which cover a range of potential outcomes. Scenarios need to comply with two key criteria: internal consistency and relevance. The scenarios also need to describe not only the 'destination' at a point in time, but also the 'journey' over time which will be relevant to company performance across a number of years. Lastly, the scenarios should cover a realistic range of potential outcomes to stress test the implications for value-at-risk and opportunity.

We therefore developed a series of global macro scenarios drawing on research by Oxera, the economic consultancy, which set out an internally consistent view of the balance of economic activity consistent with achieving a 'success' scenario of 550ppm CO_2e. See box: 'The Carbon Trust 2050 Scenarios' (page 17).

Finally, having constructed the macro scenarios, relevant industry sub-scenarios need to be created that are relevant to, for example the Auto or Beer industry. These were linked to the fact base obtained and were otherwise made as consistent as possible to the macro scenario – see the separate sections on each sector analysed for a description of the sub-scenarios for each of the industry sectors.

Driver	Sample drivers	Impact on the market		Impact on competitive dynamics
		Costs	*Revenues (price/volume)*	
Cost of carbon				
• On this industry (direct) • On other industries in this supply chain or competing sectors (indirect)	• Cap and trade system • Carbon tax	• Impact of cost of carbon on operations • Impact of cost of carbon on input costs (e.g. raw materials)	• Impact of additional cost on marginal pricing (price pass through) • Volume changes due to new product substitutes • New price/volume equilibrium (price elasticity of demand)	• Differential carbon intensity of operations • Differential costs due to unequal regulatory regimes • Any changes in who sets the price of commodity products
Targeted regulations				
• On this industry (direct) • On other industries in this supply chain or competing sectors (indirect)	• Targeted economic incentives (e.g. feed-in tariff, excise tax) • Minimum product standards (e.g. vehicle emissions standards) • Minimum information disclosures	• Impact of economic incentives (negative or positive cost) • Increased costs to comply with product standards • Increased overhead to comply with disclosure	• Impact of additional cost/revenues on marginal pricing (price pass through) • New price/volume equilibrium (price elasticity of demand)	• Differential application of targeted economic incentives • Differential costs based on different product performance • Differential costs due to unequal regulatory regimes
Technology breakthroughs				
• On this industry (direct) • On other industries in this supply chain or competing sectors (indirect)	• Deployment of further existing technology • Increased R&D to develop new technology	• Cost of new technology deployment • Cost of new capital investment • Cost of Research & Development • Reducing costs over time (learning curve)	• Impact of new technology cost on price and volume • Impact of new technology on attractiveness of products • New price/volume equilibrium (price elasticity of demand)	• Preferential access to technologies (e.g. patents or licences to intellectual property) • Cost advantage through better R&D
Shifts in consumer behaviour				
• On this industry (direct) • On other industries in this supply chain or competing sectors (indirect)	• Shift in demand for products – Fiscal incentives – Technological innovation of substitutes – Change in consumer preference	• Consumer preferences requiring investment in product design • Additional marketing and communication costs	• Consumer shift in demand for types of products • Availability of new substitutes	• Differential investment in product upgrades • Differential brand spend based on brand strength

Chart 6 *Four interrelated drivers of climate change-related value shifts in a sector*

The Carbon Trust 2050 scenarios

To test the consequences of the move to a low carbon economy on shareholder value, the Carbon Trust developed a series of low carbon scenarios for 2050 drawing on research by Oxera. Each scenario describes both the destination in 2050 and the journey from 2000 to 2050 in five-year increments.

We developed scenarios with three levels of ambition for the reduction in emissions over the period, illustrated in Chart 7.

A **'Business-as-usual'** (BAU) scenario which assumes that climate change is not tackled. This was calculated by taking a snapshot of today's economy and working forwards using a range of standard projections of population and economic growth and forecasts of ongoing improvements in emissions intensity.

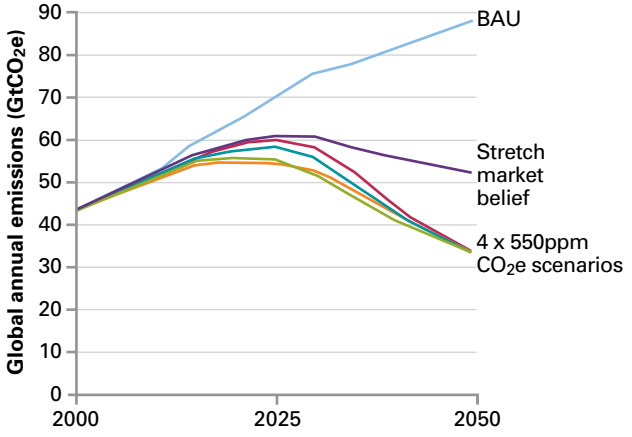
A **'Stretch market belief'** scenario that we estimate will lead to stabilisation at 700ppm CO_2e (and may trigger a 3-5°C temperature rise). This was generated as a composite of the level of ambition of analysts and industry experts across a range of industries. It does not reflect an explicit view of the overall ambition of the market, but rather the sum of a number of individual sector views.

Four **'success'** scenarios that were generated by taking a 2050 emissions target of 33 $GtCO_2e$ and then 'backcasting' the actions to be on a path to that target.

The 33 $GtCO_2e$ target is broadly consistent with stabilising greenhouse gas concentrations at 550ppm CO_2e and therefore having a chance, albeit less than 20%, of limiting climate change to 2°C.

Those committed to avoiding climate change are likely to pursue greater cuts, but even this level is sufficient both to illustrate our method and to highlight significant transition risks and opportunities.

Chart 7 *Emissions paths across the scenarios*



Source: Carbon Trust and Oxera analysis.

Note: Success scenarios constructed to be consistent with 550ppm CO_2e Stabilisation

The impact of cuts will vary according to how they are driven. Each of our four scenarios emphasises a different driver:

'Carbon markets' where widespread adoption of existing low carbon technology achieves the required reductions and this adoption is driven by the profit motive, supported by a cost of carbon that increasingly applies across most of the economy, first in OECD markets, then in developing markets (either via a cap and trade system or a carbon tax).

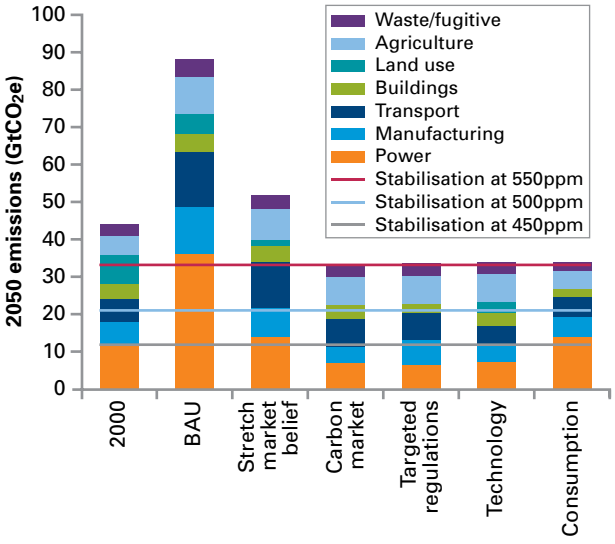
'Targeted regulations' where widespread adoption of existing low carbon technology achieves the required reductions but this adoption is driven by numerous government regulations that tackle specific behaviours and support specific technologies.

'Technology' where the key breakthroughs in low carbon technology are made and then widely adopted. This is achieved by increased R&D spend and rapid deployment of technology once developed.

'Consumption' where a shift in consumer preference means that the majority of people chose the low carbon ways of fulfilling their wants.

The resulting emissions by source are shown in Chart 8. Further detail on the scenarios is in Appendix 1. The scenarios are not forecasts – the future will probably be a complex mix of each driver. Instead they are 'what-ifs' to test company exposure to risks and opportunities.

Chart 8 *Variation in emissions by source in 2050*



Source: Carbon Trust and Oxera analysis.

Note: Further detail on how the scenarios were constructed is contained in Appendix 1.

4. Estimate the value impact for a typical incumbent company with a 'business-as-usual' (BAU) strategy

Having identified the climate change-related value drivers, the next step is to calculate the impact of the value drivers on industry economics.

This can be carried out for any company. However, as explained later, the Carbon Trust does not comment on specific companies. Therefore we test the impact on value for a typical industry player. We create an industry 'archetype' – i.e. an invented company with typical industry features such as standard product range, geographic footprint of operations and financial performance, and with a strategy focussed on business-as-usual. We create its projected free cash flows over time and then determine its valuation based on the net present value of its discounted cash flows ('DCF valuation').

The impact of the value drivers from each scenario is then tested against this archetype through estimates of the changes in assumptions of performance driving the free cash flow statement. This then gives a new cash flow statement and a new DCF valuation. Any reduction in value between the archetype in each scenario and the business-as-usual scenario is then termed the 'value-at-risk' and any increase, the value creation opportunity. The results for each of our industry sectors can be seen in the next section of this report.

5. Conduct winners/losers analysis

To better understand the scope for competitive differential of performance in the industry and the opportunity for a positive response, the next step is to develop alternative archetypes with improved strategies for performance under the conditions of the alternative scenarios.

This changes the assumptions of performance, producing an alternative free cash flow projection and a new value. The differential in performance of this archetype vs. the business-as-usual case gives the value creation opportunity.

The meaning of transition value-at-risk and value creation opportunity

The value-at-risk that we calculate gives an indication of the level of sensitivity of an industry player to the value drivers identified and is therefore indicative of the pressure that the climate change challenge will place on the industry. The level of opportunity gives an indication of the extent of competitive differentiation and potential for winners and losers.

The higher the opportunity and risk, the greater the prospect of abnormal returns taking place in the industry with increased sector volatility and higher than average divergence of performance.

We see this as an acceleration of the ever-present 'creative destruction' effect[11] by which value is generated by new entrants succeeding at the expense of incumbents failing.

We limit our analysis to first order impacts for each value driver, and we do not carry out more complex dynamic modelling arising out of the new competitive regime, such as ongoing market share shifts within the same market. The results are therefore not necessarily a prediction of resulting change in either short-term or long-term valuations or share price, which will depend on more complex interactions.

Whilst the effect on share price is more complex, it can reflect a greater impact than first order value-at-risk and opportunity as typically the market will factor in the more complex interactions that could lead to greater market performance over the short to medium term.

[11] 'Creative Destruction' is a term popularised by Joseph Schumpeter to describe the effect by which capitalist competition simultaneously creates value in new companies and destroys value in incumbents over time. It is also the title of the book published in 2001 by Richard N Foster and Sarah Kaplan which identified at both sector and company level competitive pressures and periods of discontinuity (i.e. major changes from regulation, technology and consumers) lead to abnormal returns (though these often return to the mean in the long run). In addition they found that the ratio of net entrants (entering companies less exiting companies relative to the number of companies in the industry) had increased from c. 2 in every 10 companies in 1960 to c. 3 in every 10 companies by 1993 and has increased beyond this in sectors facing periods of discontinuity. The average life expectancy of a company in the Fortune 500 index of leading global companies (i.e. length of time it would be expected to remain in the index) has reduced from approximately 65 years in 1930 to around 15 years in 1990.

Classifying exposure

The combination of value-at-risk and value creation opportunity enables a classification of sectors into four broad categories illustrated in Chart 9:

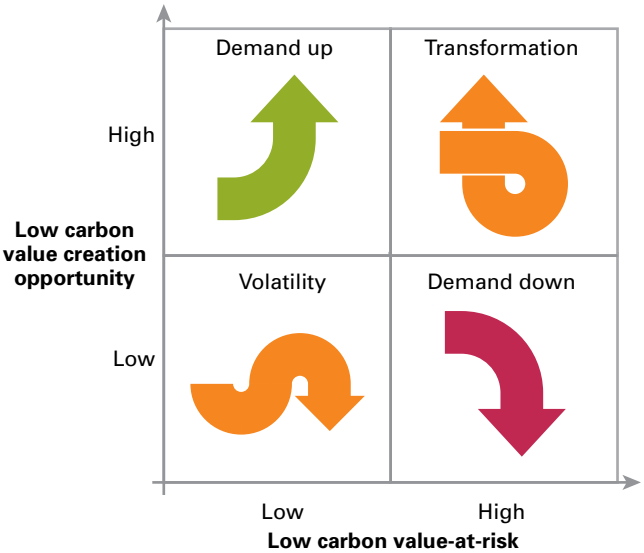
Transformation: both value-at-risk and opportunity are high. This will transform the nature of the business as players adapt to a new mode of competition.

Downward demand shift: the value-at-risk is significant and reflects a downward change in demand in the sector. Value opportunity is low as opportunities are not readily accessible in the same business area.

Upward demand shift: the value-at-risk is low, but there is considerable value opportunity based on capturing an increase in volume for the sector as a whole.

Volatility: the value-at-risk and the opportunity are relatively low, reflecting only a modest likelihood of significant long-term impact. However, short-term cost impacts or demand change could cause cash flow volatility.

Chart 9 *Classifying exposure to risks and opportunities in the transition to a low carbon economy*



Source: Carbon Trust and McKinsey & Co. analysis.

The illustrations used in this report

The following sections contain examples of how this method could be applied to companies in six different sectors. This illustrates how the exposure to risk and opportunity is likely to vary.

The Carbon Trust generally does not comment on specific companies. Therefore the analyses on the following pages have been done on hypothetical companies. The hypothetical companies have been constructed to be typical of their industry but not representative of any one firm.

We encourage you to use our methodology on firms and sectors that interest you rather than rely on our conclusions when considering real companies.

Automotive industry analysis

Climate change poses a tremendous challenge for the auto industry: how to both meet consumer demand for a near doubling in car travel by 2050 and reduce total automotive greenhouse gas emissions by at least 30%, and potentially as much as 80%.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Auto industry. Based on these scenarios and assumptions, the transition to a low carbon economy could transform the Auto industry, offering significant value creation potential to a hypothetical 'archetype' company that proactively invests to capture available opportunities whilst presenting significant risks to a hypothetical 'archetype' company that fails to adapt.

We identify the following key drivers of change:

- Targeted regulations will probably initiate a drive to reduce the per vehicle emissions for new vehicles.
- The pressure to reduce emissions will stimulate further innovation in vehicle design and power trains and the potential use of biofuels.
- Consumers may continue to shift preference towards more efficient and potentially smaller vehicles.

The magnitude of the value creation opportunity and risk for our archetype companies suggests that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions in the Auto sector – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry that could be transformed

- To avoid catastrophic climate change, total passenger car emissions need to be cut by at least 30% (if other sectors are required to do more) and preferably 80% (to allow for potential failure of reduction in other sectors) by 2050.
- Cutting emissions might require as many as 35% of OECD new vehicle sales to be hybrid vehicles, or 20% to be pure electric vehicles by 2020.
- Cutting emissions places value-at-risk for companies not well prepared for the change – a reduction in emissions of 80% by 2050 could create a transition value-at-risk of up to 65%.
- Companies that position themselves well for the transition to a low carbon economy could create up to 60% additional value compared with their prospects under business-as-usual.

Auto industry context

Just under 55m passenger cars are sold annually, and recently this figure has grown at 3.3% a year, driven by demand from emerging markets. The 'Triad' markets of the US, Japan and Europe have seen recently flat or declining growth reflecting economic conditions. The industry is highly competitive and the current environment has seen some manufacturers struggling to compete against a backdrop of increasing raw material prices and consumer vehicle 'mix shift' (i.e. to smaller vehicles) in the light of high oil prices. In response, some manufacturers are investing heavily in new, more efficient models, using a mix of hybridisation technologies as well as improving the internal combustion engine. Sales of the Toyota Prius have outstripped expectations and even small electric cars are gaining media attention and niche sales in leading cities. This could be a foretaste of conditions to come on the move to a low carbon economy.

Auto's emissions challenge

The first elements of the new environment are already visible: regulation on fuel efficiency or emissions per km are in place in the USA (the federal CAFE standards and the California state standards) and the EU is debating a set of proposals aiming at 120gCO_2/passenger km in 2012 (including biofuels). The UK, France and Spain vary the tax on cars based on their emissions efficiency.

The climate change challenge will add to the already high pressure on the Automotive industry at present from increasing raw materials prices and consumers' preference for smaller cars, caused by concern over the high cost of oil and the downturn in the economic environment. Climate change-related drivers of value include:

- **Regulation:** policy measures (either via a cost of carbon or targeted regulations such as emissions reductions limits) will drive an ongoing reduction in the emissions of new vehicle fleet sales, which will in turn stimulate the implementation of new technologies to reduce per vehicle emissions, such as light weighting, aerodynamic design and new power trains and control systems.
- **Technology:** reductions in minimum emissions standards will require manufacturers to improve the efficiency of the internal combustion engine (ICE) and stimulate the introduction of breakthroughs in a number of competing technologies including hybrid technology and, ultimately, electric or hydrogen powered vehicles. Increased biofuels will also be introduced into the liquid fuel base.
- **Consumer behaviour:** a high cost of gasoline (maintained by policy) together with a focus on emissions will continue to steer consumers towards more efficient, smaller vehicles as well as potentially using other forms of transport such as train or bus. If per vehicle emissions cannot be reduced, success could only be achieved via a reduction in consumer demand for car travel, leading to lower global sales.

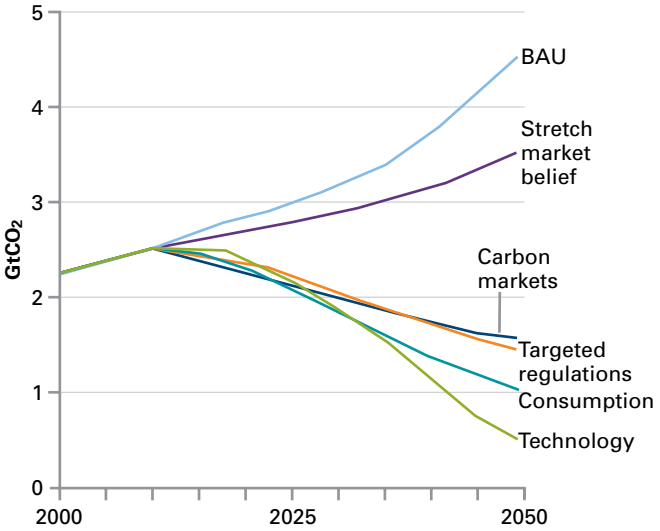
These drivers will present difficult choices for auto companies such as the level of investment in new power train technology and vehicle design. However, the changing environment presents opportunities for those who prepare well in advance. Given the lead times required to develop new power trains and design new vehicles (up to seven years), this puts pressure on the industry to prepare now for the changes to come over the next 5-15 years.

The Auto industry scenarios

We developed specific Auto industry scenarios consistent with the circumstances of each of the macro scenarios described earlier in the methodology section:

Business-as-usual (BAU): without any additional concerted action to tackle climate change, passenger car emissions roughly double to nearly 5GtCO_2e in 2050. This assumes the average fleet efficiency improves by 20% and that, by 2050, 5% of cars are hybrids and 3% run primarily on biofuel.

Chart 10 *Scenarios for global passenger car emissions*



Source: Carbon Trust and Oxera analysis.

Stretch market belief: additional modest measures are taken to tackle climate change from passenger cars. Average fleet efficiency improves by 35%, mainly by improvements in internal combustion energy efficiency, 5% penetration of hybrid and biofuels vehicles and a further 3% penetration of electric vehicles by 2050. This appears to be consistent with some analysts' expectations.

Carbon markets: a broad carbon market is established globally which applies a cost of carbon of $100/t$CO_2$e which applies to all OECD markets by 2015 and all markets by 2030. Fuel costs remain high, combined with some per vehicle emissions targets. Second generation biofuels are successful and fuel 40% of car kilometres by 2050. Conventional cars double their fuel efficiency on today's average and 20% of vehicles use hybrid technology (and half of these are 'plug-in' hybrids that use grid electricity to power half their journeys).

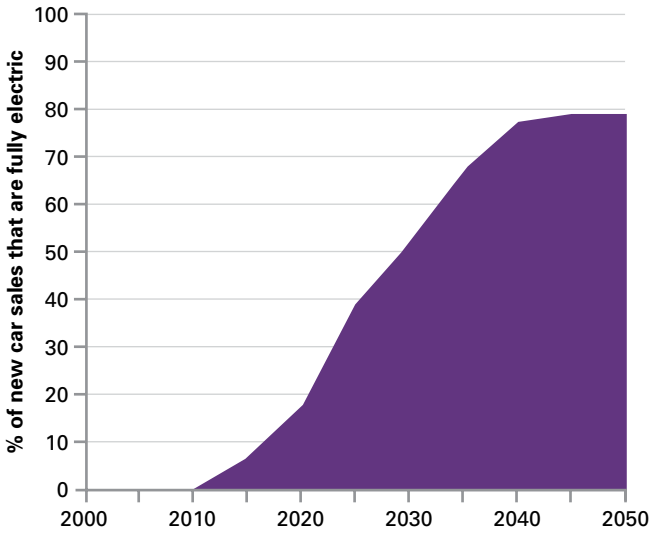
Targeted regulations: governments drive widespread adoption of a 'winning' technology – assumed here to be hybrid power trains – and ensure 80% of the fleet is hybridised by 2050. Of this, by 2020 50% are 'plug-in' hybrids that use grid electricity for 50% of their journeys.

Technology: a breakthrough in electric vehicle manufacture is assumed (most likely in battery design) enabling a significant conversion of the vehicle fleet to fully electric vehicles over the next 40 years.

Consumption: consumers lead the way to reduce auto emissions by travelling less, and therefore owning fewer cars. The cars that are owned are predominantly biofuel (34%) or hybrid (30%) powered and preference is given to the most efficient models and configurations. Globally, passenger km per capita fall in the OECD, and increase much more slowly in the rest of the world as these countries establish effective mass-transit systems before car ownership reaches OECD country levels.

Chart 10 (previous page) illustrates the consequences of these scenarios for global emissions from passenger cars. It is striking to note the rapid change in proportion of hybrid or electric vehicles which may be required to meet the reduction in emissions. For example, under our Targeted regulations scenario, where governments introduce regulation that drives through particular technologies, 35% of all new OECD vehicles sold could need to be hybrid by 2020. In the Technology scenario (illustrated in Chart 11), where breakthroughs in battery and renewable energy technology are made, nearly 20% of all vehicles sold would be electric by 2020.

Chart 11 *Technology scenario: a breakthrough in battery technology enables rapid dominance of electric vehicles*



Source: Carbon Trust and Oxera analysis.

Significant risks and rewards for auto companies

To test transition value-at-risk and opportunity, we used an automotive archetype with the following features:

- Mid-sized manufacturer of passenger cars, with approximately 6% market share in OECD, 5% market share in BRIC (Brazil, Russia, India and China) and 3% share in the rest of the world and sales of 3m vehicle units per year.
- Average industry profitability (5.5% EBIT margin).
- Full range of vehicles (compact to luxury and SUV) with average emissions per vehicle by class.
- Strategy aimed at 'business-as-usual' – not well geared towards tackling climate change.

We built the company's profit and loss and free cash flow statement and tested its performance under each scenario to identify transition value-at-risk.

Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: the archetype's focus is on ICE models. Unit sales grow with the market from 3m today to just over 6m in 2050. It does not participate in the sub-scale hybrid and electric vehicle markets. It invests to continue to improve the efficiency of its vehicles (at a cost of $1,800 per vehicle). However, this cost falls steadily (4% per year) and is entirely passed on to consumers. This results in profit margins remaining stable with a company discounted cash flow valuation of $50bn based on 2010 sales of $76bn and earnings before interest and tax of $4bn.

Stretch market belief: more stringent regulations cause the archetype to invest more in fuel efficiency at a cost of $2,600 a car. Initially it can only put up prices by $2,300 as competitors have lower costs, but it closes this gap over 10 years. It also participates in the hybrid market, which adds $6,000 per car compared with its conventional vehicles and initially lower cost competitors mean it can only charge $4,800 extra for hybridisation. The archetype's value is now just over $47bn, giving a transition value-at-risk of 6%.

Carbon markets: the archetype is required to invest even more heavily in improving its ICE engines towards 50% efficiency improvement, and makes a greater ratio of hybrid cars but again at similar initially loss-making economics. The company's value is just under $40bn, giving a value-at-risk of 25%.

Targeted regulations: the archetype is required to manufacture increasing numbers of hybrid vehicles, reaching 60% of sales by 2030. It continues to bear the same poor economics per vehicle as in the above scenarios so the archetype's value falls to just over $30bn, giving a value-at-risk of 40%.

Technology: in this scenario, electric vehicles swiftly dominate but the archetype enters the market late and bears a higher cost per unit than average. Due to poor design, it only achieves 1.5% market share in this new electric car market. This reduces its value to $18bn, giving a transition value-at-risk of 65%.

Consumption: the archetype has lower sales growth due to the reduction in passenger kilometres travelled. The archetype also bears $6bn exceptional charges to upgrade production to produce more efficient vehicles. Its value falls to just under $25bn, giving a transition value-at-risk of 50%. These assumptions are summarised in Chart 13. The results of this value-at-risk analysis are shown in Chart 12.

Low carbon automotive opportunities (for the proactive company)

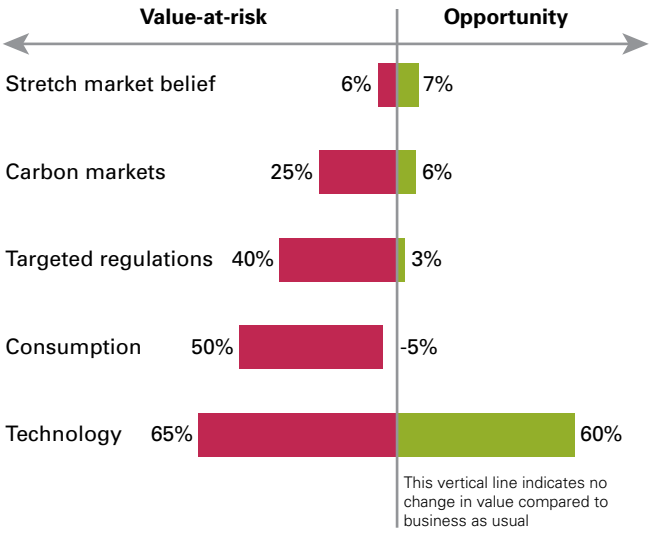
Preparation can mitigate the transition value-at-risk identified in the previous section and present opportunities for companies to grow their value beyond today's levels.

To illustrate the scale of the opportunities we repeat the previous calculations but assume that the archetype has costs initially at the low end of the assumed range, enabling growth in margins. The lower costs are assumed to be a result of starting early and taking advantage of the learning effects (perhaps two years' head start in ICE and biofuel improvements) and increasing R&D (initially by $250m a year for hybrid technology and $500m a year for electric).

This leads to a value creation opportunity of 6 or 7% above business-as-usual in the Stretch market belief and Carbon market scenarios. In the Targeted regulations scenario the level of government intervention means that value is unlikely to be created much above today's levels. In the Consumption scenario, the reduced preference for cars means that it is unlikely that even a well prepared company could grow market value compared to today, although it could mitigate all but 5% of the risk.

The greatest opportunity exists under the Technology scenario because of the wide range of possible costs and, if a company makes the breakthrough to give it low costs, it is likely to be able to protect that advantage and use it to grow market share. The winning archetype therefore makes improved margins per electric vehicle (~$1000 in 2015) contributing to a 5% overall price premium above costs. We assume that where our archetype has a 5% global share in conventional vehicles, it captures more than 10% of electric sales. This gives a potential value creation opportunity of 60%. We note this may be an extreme scenario, but it is dependent on breakthroughs in technology that have not yet taken place.

Chart 12 *Company value-at-risk and opportunity*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

***Chart 13** Summary of key scenario assumptions for archetypes*

Scenario	Annual passenger kilometre growth (km) global vehicle sales growth (%)	Power train mix (2030) and efficiency improvement (%)	Assumed incremental power train cost for calculating archetype transition risk	Assumed initial increase in price for calculating archetype transition risk	Assumed incremental power train cost for calculating opportunity	Transition value-at-risk	Low carbon value opportunity
Business-as-usual	Km: 2% Sales: 2%	ICE: 90% (-15%) Hybrid: 5% (-35%) Biofuel: 5% (-15%)	ICE: $1,800	ICE: $1,800	n/a	n/a	n/a
Stretch market belief	Km: 2% Sales: 2%	ICE: 90% (-35%) Hybrid: 5% (-55%) Biofuel: 5% (-35%)	ICE: $2,600 Hybrid: $6,000	ICE: $2,300 Hybrid: $4,800	ICE: $2,150 Hybrid: $4,800	6%	7%
Carbon markets	Km: 2% Sales: 2%	ICE: 55% (-50%) Hybrid: 15% (-70%) Biofuel: 30% (-35%)	ICE: $3,400 Hybrid: $6,000	ICE: $3,000 Hybrid: $4,800	ICE: $2,800 Hybrid: $4,400	25%	6%
Targeted regulations	Km: 2% Sales: 3%	ICE: 25% (-50%) Hybrid: 60% (-70%) Biofuel 15% (-50%)	ICE: $3,400 Hybrid: $6,000	ICE: $3,000 Hybrid: $4,800	ICE: $3,400 Hybrid: $4,400	40%	3%
Technology	Km: 2% Sales: 2%	ICE: 35% (-50%) Hybrid: 10% (-70%) Biofuel 5% (-50%) Electric 50% (-90%)	ICE: $3,400 Hybrid: $6,000 Electric: $22,000*	ICE: $3,000 Hybrid: $4,800 Electric: $12,000*	ICE: $3,400 Hybrid: $4,800 Electric: $11,000*	65%	60%
Consumption	Km: 1% Sales: 0.5%	ICE: 50 (-50%) Hybrid: 20% (-70%) Biofuel: 30% (-50%)	ICE: $3,400 Hybrid: $6,000	ICE: $3,000 Hybrid: $4,800	ICE: $2,800 Hybrid: $4,400	50%	-5%

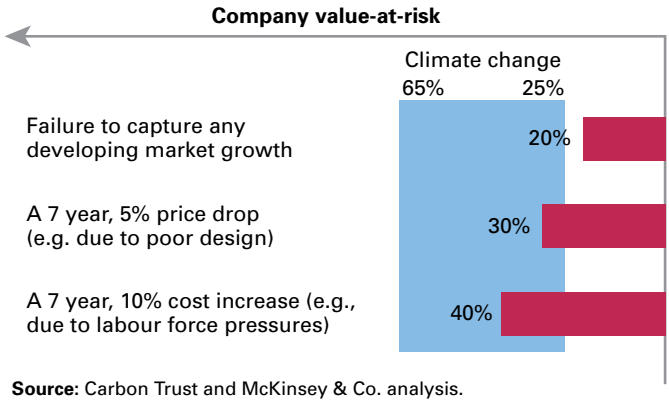
Note: Learning effects mean that additional power train costs fall at 4% a year for ICE, 6% for hybrids and 7% for electric vehicles based on learning rates;

*Electric power train costs are in year of mass production launch (c.2015)

Climate change is a key driver of value

By altering some of the assumptions in the business-as-usual scenario we can illustrate the importance of the climate change transition risk relative to other non-climate change-related events. This is set out in Chart 14.

Chart 14 *Significance of the climate change-related company value-at-risk compared with other factors*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the value-at-risk to a business-as-usual focussed company from a series of non-climate change-related events or assumptions and compares this to the range of value-at-risk identified for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy across a range of scenarios.

Auto industry pressures will be greatest during period 2015-2030

Our cash flow projections for the archetype company show that cash flows will be most affected from the period 2015 onwards. However, the preparations required to sell new drive trains need to be made up to seven years in advance and therefore from today preparations must be made for this period.

Implications for investors

Shorter horizon investors (0-3 year) should focus on identifying the key attributes likely to be recognised in the short term and following triggers of news flow that could cause a short-term shift in opinion on the long-term prospects of companies. Winning companies in the short term could display the following features:

- Lower than average fleet emissions by vehicle class.
- Established hybrid technology and a well developed electric vehicle R&D programme.
- Positive reputation for low carbon products.

News flow ('triggers') that might affect valuations over the long term:

- Regulatory events, including the existence and level of ambition of a new 'Global Deal' on emissions, regional/national emissions regulations (including passage of EU proposals in EU Parliament) and national vehicle taxation policies.
- Auto technology breakthroughs, either in the Auto industry itself or in battery technology.
- Extent of success in combating emissions reductions elsewhere and consequential potential level of pressure on the Automotive sector.

Long-term 'universal' investors should focus on ensuring all major players in the industry are ready for the transition to a low carbon economy. Activities include:

- Engage in active dialogue with auto companies to scrutinise their stance and strategy towards climate change.
- Engage with policy makers to ensure a long-term, stable environment for investments.
- Reassess the balance of their portfolio in the light of the changing risk/reward nature of the sector, given the likelihood of higher volatility.

Aluminium smelting analysis

Aluminium is one of the highest carbon intensity commodities and continues to enjoy high growth. Tackling climate change will require some combination of reducing primary aluminium demand, increasing recycling rates and moving to lower carbon power generation.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Aluminium industry. Based on these scenarios and assumptions, the transition to a low carbon economy could transform the Aluminium industry, offering significant value creation potential to a hypothetical 'archetype' company that proactively invests to capture available opportunities whilst presenting significant risks to a hypothetical 'archetype' company that fails to adapt.

We identify the following key drivers of change:

- A 'cost of carbon' applied to the industry – this particularly affects future cash flows if a different cost of carbon applies in different regions creating competitive differences.
- A potentially significant shift to further recycling of aluminium, potentially stimulated by a regulatory push for more recycling.
- A potential reduction in global demand for aluminium, due to regulatory or commercial pressure for the use of lower carbon substitute products.

The magnitude of the value-at-risk and opportunity for our archetype companies suggest that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions for the Aluminium sector – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry that could be transformed

- A business-as-usual player with average carbon emissions intensity could face up to 65% value-at-risk due to the impact of a cost of carbon and reduced demand for primary aluminium, if it does not adapt.
- However, low carbon intensity players in light regulatory environments can mitigate this risk almost entirely.
- Aluminium recycling could experience a boom, yielding upside value creation opportunities of up to 30% for a player that invests in equivalent market share in the secondary aluminium market.

Aluminium industry context

Aluminium is a global industry producing approximately 38bn tonnes of primary aluminium in 2007 and an estimated further 17bn tonnes of secondary (recycled) aluminium (31% of the total market). The industry has experienced strong growth (5-10% per year since 2000), driven substantially by growth in China (responsible for >90% of growth by some estimates). Recent power shortages in some markets and rising input costs have contributed to record prices in 2008 (up to $3,400/tonne), giving the industry total revenues of ~$150bn. Long-term growth forecasts are robust (~6% per year to 2020), as aluminium proves an enduring and useful product in the manufacturing boom in Asia (for example in construction, power distribution and automotive) and a return to cheaper energy is forecast. Within upstream production, there are three key stages: bauxite mining, alumina production and aluminium smelting and casting. In this study we focus on aluminium smelting and casting which is responsible for the majority of emissions of the industry.

Aluminium's emissions challenge

Primary aluminium is one of the most energy (and carbon) intensive commodities, and the industry is collectively responsible for c.1% of global greenhouse gas emissions, including indirect emissions of power generation.

Each tonne of primary aluminium requires approximately 15MWh electricity to produce. The total greenhouse gas emissions per tonne of aluminium production significantly depends on the source of power generation, approximately two thirds of which is 'captive' – i.e. controlled by the aluminium smelter via ownership or long-term contract, rather than grid supplied. If the electricity is from hydro-electric or nuclear sources then the effective emissions are close to zero. If it is from coal, then the emissions from electricity generation may contribute up to 15 tonnes of CO_2e per tonne of aluminium (tAl) produced (if inefficient coal-fired power is used).

It is estimated that approximately 40% of global power generation used by smelters is hydro, with a further 5% nuclear/biomass and the remaining 55% fossil fuel based. On this basis, the average emissions from electricity use in smelting are about 8 tCO_2e/tAl. Recent rapid growth has been achieved primarily on coal-fired power stations in China and cheap oil and gas in the Middle East causing this average to deteriorate in recent years.

The production of bauxite and alumina together produce approximately 0.7t CO_2e/tAl. Aluminium smelting then produces a further 2.5t CO_2e of process-driven and 2.3t CO_2e of heat-driven emissions. This results in an average total emissions of ~13t CO_2e/tAl, with a range from ~5 to ~20 tCO_2e/tAl.

Recycled aluminium produces less than 1 tCO_2e/tAl, because it avoids most of the direct emissions and requires only 5–10% of the energy.

Despite the high carbon intensity, aluminium's usefulness as a product extends to helping to reduce greenhouse emissions in certain key categories, for example acting as a light-weighting material in vehicles. However, these advantages may be offset by advances in new substitute materials in the construction, packaging and transport sectors such as carbon fibre or advanced plastics.

The key drivers which will likely stimulate a move to reduce carbon emissions in the aluminium industry include:

- **Regulation:** the most likely key driver for the industry will be imposition of a cost of carbon both on its direct emissions and on the indirect emissions of the power industry. Regulators may also focus on increased recycling rates, as part of a lower consumption model. This is further discussed below.
- **Technology:** process emissions for aluminium are significant, caused primarily by the degradation of the carbon anode during electrolysis, as well as some fluoride-based emissions arising from the electrolytic flux used (cryolite). A technological breakthrough to reduce these emissions could make a significant reduction to the ~2.5tCO_2e emissions/tAl, although this does not appear imminent.
- **Consumption:** a significant effort could be made to replace primary aluminium with lower intensity materials. One option would be to replace more primary aluminium with secondary (recycled) equivalents. Approximately 50% of recycled aluminium comprises re-used scrap, the remainder being waste primary aluminium. The total level could be pushed from today's ~31% towards 50% of total supply depending on the turnover of in-use aluminium products. Other options include developments in glass, other metals, plastics or composites that might be able to cut product life-cycle emissions at a lower cost than using aluminium.

The above pressures should ultimately drive primary aluminium producers to seek low carbon power generation sources (e.g. hydro), to reduce process emissions overall, invest in recycling unit growth and, as a short-term strategy, seek to invest in markets that might avoid regulation (although this may fail if a sector deal were put in place that captured all producers equally).

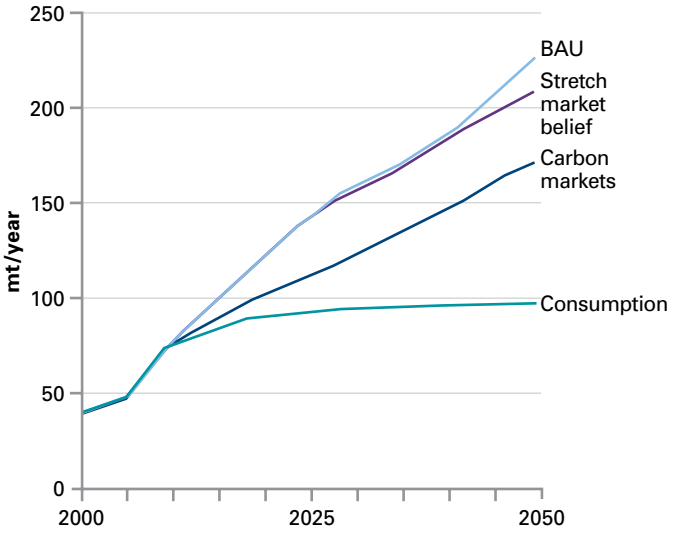
Aluminium emissions scenarios

Given quite similar overall levels of aluminium demand in each scenario, we only focus on and develop specific aluminium industry scenarios based on two of the four 'success' scenarios – Carbon markets and Consumption scenarios. The overall picture of aluminium consumption and of the resulting industry emissions in each scenario are illustrated in Charts 15 and 16.

Business-as-usual: in the base case, growth in total Aluminium consumption (primary and secondary) is assumed to rise by an average of 5.75% annually between 2008 and 2020, then fall back to 2.6% to 2030 and 1.5% over the long term. Any market cost of carbon is minimal and only applies to indirect emissions, not direct Aluminium industry emissions. Recycling rates are assumed to remain steady at just over 30%.

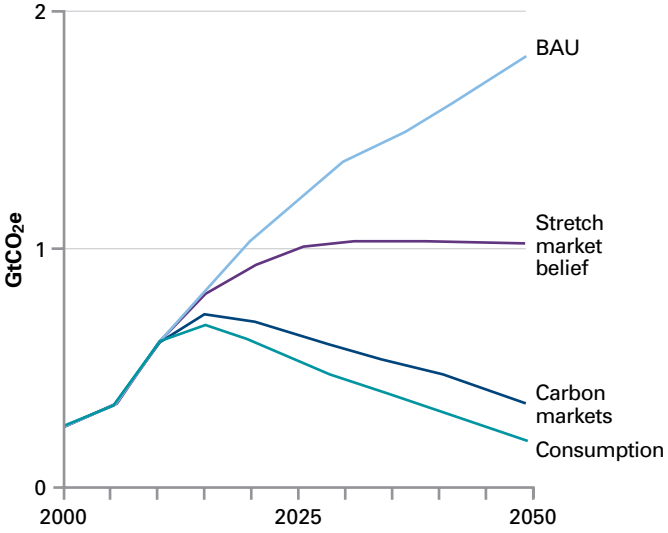
Stretch market belief: a modest cost of carbon starts to feed through to aluminium prices from 2015, building to an average of $25/tCO$_2$ by 2030. OECD countries feel the effect of carbon costs earlier, but are initially prevented by global competition from passing these costs into prices. Emissions per tonne of primary aluminium fall from the average of 13tCO$_2$e/tAl today to 7tCO$_2$e/tAl by 2050. The primary aluminium average growth rate (2008-2020) falls from 5.75% to 5.45% whilst secondary aluminium recycling rates grow to 34% in 2030 and 36% in 2050.

Chart 15 *Scenarios for total aluminium consumption (primary and secondary)*



Source: Carbon Trust and Oxera analysis.

Chart 16 *Scenarios for global aluminium emissions*



Source: Carbon Trust and Oxera analysis.

Carbon markets: demand for aluminium is reduced by a higher cost of carbon which feeds through into aluminium prices from 2015 and builds to an average of $100/tCO$_2$e by 2030. Again, OECD countries feel the effect of carbon costs earlier, but are initially prevented by global competition from increasing their prices. Under the high cost of carbon, electricity consumption decarbonises, which combined with other efficiency savings reduces the industry's emissions to around 3tCO$_2$e/tAl by 2050. Growth slows due to some substitution with other materials, and within the Aluminium sector there is a switch to secondary product: the primary aluminium average growth rate (2008-2020) falls sharply from 5.75% to 3% as recycling rises to 40% of consumption in 2020 and 45% by 2050.

Consumption: There is a concerted effort to use lower intensity materials than primary aluminium. The industry also experiences a cost of carbon equivalent to that in Stretch market belief. Total consumption of aluminium grows slowly to 2020, but this is due to an increase in the use of secondary material from 31% to 43% by 2020 and 48% by 2050 – the demand for primary material remaining steady from 2012. After 2020, replacement materials have been found for most uses of aluminium, and overall consumption grows very slowly at 0.5% a year. We note that this is a relatively extreme scenario, but represents a society with a new focus on lower carbon.

Aluminium smelter value-at-risk and value creation opportunity

To illustrate the calculations of the potential transition risk we use an industry archetype with the following features:

- Produces 1m tonnes primary aluminium (~2.5% market share), but no secondary aluminium.
- Operations based 50% in OECD markets likely to be affected by cost of carbon in the short term.
- Electricity generated from sources equivalent to the global average (40% hydro, 5% nuclear, the rest mainly coal).
- Average industry profitability (EBIT of 13%).

We then test how the discounted cash flow valuation of the archetype would change in each of the scenarios. The critical assumptions are illustrated in Chart 17 and the results in Chart 18.

Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: the company enjoys strong, sustained growth, maintaining its share and margins. On a discounted cash flow basis, its value is $7.7bn. Transition value-at-risk is calculated relative to this value.

Stretch market belief: the company maintains its share of the primary aluminium market as growth slows in line with the market. Its OECD located plants (including power) experience the full cost of carbon from 2010 but can only start to pass this through as higher prices from 2015. It reduces its average emissions in line with the market, to half their current levels by 2050. This leads to a value below $7bn and therefore value-at-risk of 15%.

Carbon markets: similar to Stretch market belief, the company experiences a cost of carbon, reductions in demand growth and increased recycling rates, although these are more extreme than in Stretch market belief. Despite maintaining share, the unprepared archetype has a much lower value of $2.8bn and transition value-at-risk of 65%.

Consumption: flat primary demand growth driven by widespread substitution with new materials and higher recycling rates drives a fall in value to $3.3bn, giving a value-at-risk of 60%.

Aluminium low carbon value creation opportunity (for the proactive company)

We next considered the performance of an archetype which has the following differences:

- Greater use of renewable energy: 80% hydro, 10% nuclear and only 10% from fossil fuels.
- Improved regulatory environment, with an increased proportion of operations which only incur a cost of carbon in line with the price-setting player or where in OECD markets aluminium prices include the prevailing cost of carbon due to border tariffs or sector agreements.
- An acquired stake in the recycling market of 2.6% share in this market, purchased at prevailing market value based on BAU projections of growth.

We then tested how the discounted cash flow valuation of this archetype would change in each of the scenarios. The results are illustrated as the high end of the bars in Chart 19 (over).

Chart 17 *Critical Aluminium assumptions by scenario*

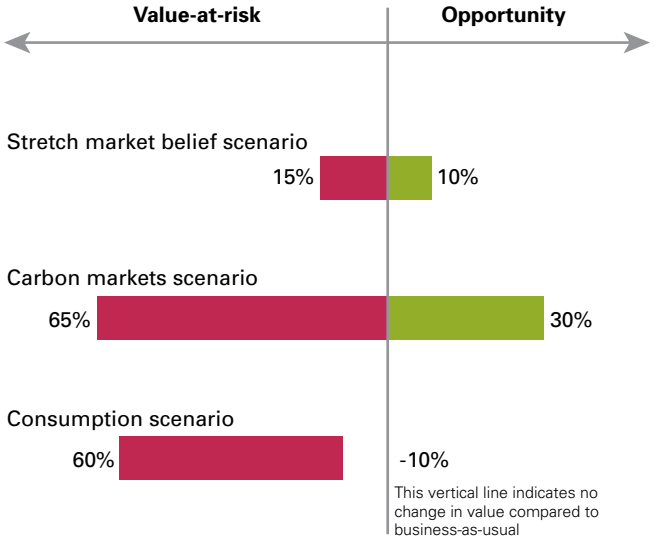
Assumption/ Scenario	Global average Cost/tCO_2e in 2030	Recycle rate 2020, 2030, 2050	Total growth *primary* aluminium demand	Transition value-at-risk	Value creation opportunity
BAU	0 (only applies in EU at low level)	2020: 31% 2030: 31% 2050: 31%	2008-2020: 5.75% 2020-2030: 2.60% 2030-2050: 1.50%	n/a	n/a
Stretch market belief	$25	2020: 31% 2030: 34% 2050: 36%	2008-2020: 5.45% 2020-2030: 2.45% 2030-2050: 1.50%	15%	10%
Carbon markets	$100	2020: 40% 2030: 43% 2050: 45%	2008-2020: 3.10% 2020-2030: 1.50% 2030-2050: 1.50%	65%	30%
Consumption	$50	2020: 43% 2030: 45% 2050: 48%	2008-2020: 0% 2020-2030: 0% 2030-2050: 0%	60%	-10%

Stretch market belief: the more favourable regulatory environment enables the company to pass on the imposed cost of carbon to customers and, eventually, to make a margin compared to competitors due to its lower carbon intensity operations. Somewhat higher than expected growth in recycling drives an upside on the acquisition value. The total value of the business is therefore $8.7bn, 10% above business-as-usual.

Carbon markets: as with Stretch market belief, the more favourable regulatory environment enables the company to pass through the cost of carbon and make increasing margin over its competitors. The carbon price increases the relative profitability of aluminium recycling and drives growth in this area. The total value of the business is therefore $9.9bn, 30% above business-as-usual and almost triple the value of the archetype in this scenario.

Consumption: in this scenario the significant changes to primary aluminium demand still make a dent to value which is not entirely matched by the improved performance of the recycling business. The total value of the business is $6.8bn, 10% below business-as-usual.

Chart 18 *Company value-at-risk and opportunity*



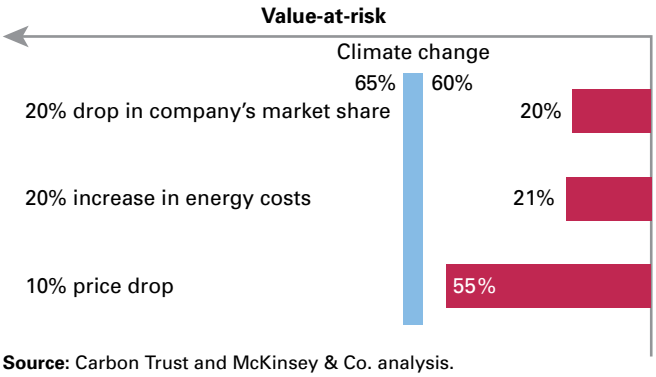
Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Climate change is a key driver of value for the Aluminium industry

We compared the transition value-at-risk on the move to a low carbon economy against a number of other key risks to an industry player, using the same methodology to show that climate change-related drivers are significant events for the value of players in the Aluminium industry.

Chart 19 *Significance of the climate change-related company value-at-risk compared with other factors*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the value-at-risk to a business-as-usual focussed company from a series of non-climate change-related events or assumptions and compares this to the range of value-at-risk identified for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy across a range of scenarios.

Implications for investors

Shorter term investors will need to focus on those attributes that are likely to make a difference in short-term performance and also the newsflow which may trigger, over the short term, a new understanding of the longer term prospects of the company.

Key features of winning companies could include:

- Lower overall carbon intensity of operations, due to higher low carbon power generation supplies, in particular hydro electricity, nuclear or, potentially, biomass power generation. This must also be 'captive' – i.e. not subject to price rises in line with the marginal cost of electricity production on the grid.
- Facilities primarily located in areas likely to avoid a cost of carbon in the short term. This could give a short-term advantage, although we anticipate any cost of carbon arbitrage opportunity between unregulated and regulated sources is likely to be eliminated entirely by 2030, and likely in a much quicker period between major jurisdictions through some sort of border adjustment.
- Companies with an ability to capture value in aluminium recycling, which is likely to grow faster than primary production over the next decade or so, given the much lower carbon footprint. In particular, integrated players with greater downstream operations may be able to build strong scrap aluminium collection operations.

Investors must also pay attention to triggers which might herald a new market understanding of the differential long-term prospects of different companies. This could include the following:

- Potential regional regulation that introduces a cost of carbon on the industry. Key questions will be the timing of regulation, the level of any free allowances and whether or not foreign imports will be subject to an equivalent cost.
- Potential specific sector level emissions targets that might be negotiated for aluminium as part of a 'Global Deal' on climate change, possibly at Copenhagen in 2009.
- Shifting demand patterns, away from primary aluminium production towards increased recycling for secondary aluminium, or towards aluminium substitutes (e.g. composites, plastics) which might cause a lowering of demand for primary aluminium.

Over the longer term, investors must engage with companies on their long-term strategy for tackling climate change, including power generation sourcing strategy, location of new facilities for growth and interest in recycling.

- Encourage aluminium players to work with key growth sectors such as automotive and construction to ensure their products are designed to capture growth in the move to a low carbon economy.
- Increase dialogue with regulators to ensure appropriate long-term signals are given of the likely scope of application of a cost of carbon to aluminium players. Ideally, the cost of carbon should apply uniformly to a single global market for Aluminium players and avoid any potential under-cutting of OECD-located aluminium players by unregulated foreign imports which do not bear the prevailing cost of carbon. There should also be an overall policy framework to increase access to renewable power generation, including increased permissions for long-term hydro-electric projects. This will need to focus on unlocking opportunities for otherwise stranded low carbon power in new (primarily non-OECD) markets.

Oil & Gas analysis

The Oil & Gas industry is at the heart of the climate change challenge. The fuels are central to the global economy yet demand must ultimately reduce in order to tackle climate change and the industry's own carbon emissions must also be reduced. These changes will have significant consequences for value.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Oil & Gas industry. Based on these scenarios and assumptions, the transition to a low carbon economy could cause a significant downward shift in demand for oil and gas as commodities compared to business-as-usual presenting significant risks to a hypothetical 'archetype' company that fails to adapt.

We identify the following key drivers of change:

- A range of regulatory pressures and technology breakthroughs in other sectors may reduce demand for oil and gas below business-as-usual forecasts.
- The industry (in particular refining) may also have to bear a cost of carbon on its own operations. If a different cost of carbon applies in different regions this could create competitive differences.
- There are upside opportunities in renewable energy and carbon capture & storage, although these sit outside of core operations and remain of uncertain size.

The magnitude of the potential value-at-risk for archetype companies that do not adapt to the transition suggest that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions in the Oil & Gas sector – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry facing a downward shift in demand

- Oil & Gas demand is likely to reduce compared to business-as-usual projections due to climate change-related policy – peak demand could occur as early as 2020 under our technology scenario.
- E&P players could face a transition value-at-risk from the move to a low carbon economy of 15%, rising to 35% in the event of falls in oil and gas prices – there is limited upside opportunity related to core E&P operations.
- Refining players could face a transition value-at-risk of up to 30% on the move to a low carbon economy, whilst winning players could gain up to 7%, primarily due to differences in carbon intensity of operations.

Oil & Gas industry context

Until very recently the Oil & Gas industry has enjoyed a buoyant period in which strong global demand, combined with limited spare capacity, has led to a period of prolonged price increases.

On the supply side, spare capacity of oil and gas production is anticipated to increase in the short term (2008-12) and alleviate supply pressure. Long-term concerns over security of supply, ongoing global demand and a lack of access to conventional oil supplies are also increasing exploration and production investment in higher cost, less conventional sources of oil (and gas) such as deep water access or tar sands fields.

Refineries continue to experience strong growth in Asia. However, declining demand for gasoline in Europe and evidence of a plateau in demand in the US may be a herald of changes to come for the industry as a result of the move to a low carbon economy.

We note that the balance of value in the industry is tilted heavily towards exploration and production (E&P) (~80%) vs. refining (including marketing) (~10-15%) and Chemical and Power (~5-10%). Most of the value of E&P players is

contained within the cash flow anticipated in proven ('P1') reserves (~80%), with limited value in probable ('P2') reserves (~10-20%) and prospective ('P3') reserves (~5-10%). In our study, we consider separately the impact of a move to a low carbon economy on the E&P and refining business.

Oil & Gas climate change challenge

Oil and gas are currently essential to the global economy and together, their use accounts for approximately 30% of all greenhouse gas emissions and nearly 60% of fossil fuel-related CO_2 emissions.

The Oil & Gas industry is itself a major emitter of CO_2 and other greenhouse gas emissions during the exploration, production, refining and transportation of the fuels. These steps account for ~5% of global CO_2e emissions, even before the combustion of fuel by the end consumer.

The carbon intensity of exploration and production per barrel of oil varies by source of oil. For light crude, production accounts for ~15 kg CO_2e/bbl, about 4% of the ~410 kg CO_2e/bbl emitted when the oil is used. Producing oil from tar sands emits ~150 kg CO_2e/bbl, about 33% of the ~450 kg CO_2e/ bbl emitted when the oil is used.

Refining is more carbon intensive than E&P on average, producing carbon emissions per barrel of oil which vary depending on the efficiency of the refinery and also the quality of the source of oil between ~20kg/bbl to 40kg/ bbl, 5–10% of the combustion emissions.

The carbon intensity of both the product and the activity of the industry makes this a key focus of climate change action. Key climate change-related drivers which will stimulate the move to a low carbon economy are likely to be:

Regulation: there will be a focus on increasing efficiency in the automotive sector (see Auto analysis section) and in industry, as well as stimulating substitute renewable energy. The industry itself will also likely incur the cost of carbon on its own footprint, which is of particular relevance to downstream refining economics and, potentially, high carbon exploration and production such as tar sands.

Technology: the introduction of biofuels and other substitute renewable energy sources such as solar or wind power will reduce demand for fossil fuels including oil and gas. Short-term coal-to-gas switching may maintain growth in gas consumption, although this may reduce with a switch to carbon capture and storage coal generated electricity.

Consumption: a combination of fiscal measures and increased awareness of climate change should stimulate consumers to reduce emissions, particularly in the transport and domestic heating sectors (e.g. via vehicle mix shift effects or improved home insulation), contributing to an overall reduction in demand.

The climate change challenge for core operations will involve anticipating changes in demand in order to manage new capital expenditure correctly and improving the overall carbon footprint of operations whilst maintaining margins as a significant cost of carbon is introduced. There is also the opportunity to diversify into new areas such as renewable energy and carbon capture and storage.

Oil & Gas demand scenarios

We developed specific Oil & Gas scenarios consistent with the circumstances of the macro scenarios described earlier in the methodology section. Given quite similar overall levels of oil and gas production in each 'success' scenario, we only focus on the two more different results for oil and gas demand highlighted by our Carbon markets and Technology scenarios:

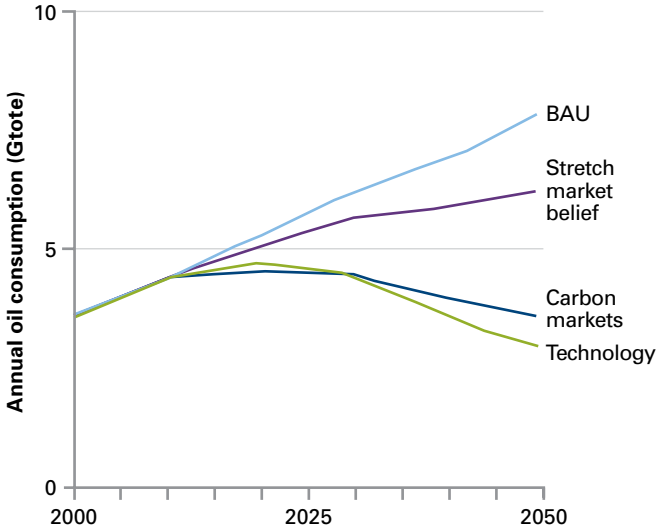
Business-as-usual (BAU): growth in oil consumption is forecast to rise at ~1.6% per annum and gas at ~2.0%, which would lead to a more than doubling of oil and almost tripling in gas consumption by 2050[12]. Significant climate change would occur in this scenario.

Stretch market belief: our understanding of the position articulated by some industry observers is that a number of measures (including regulations to tackle climate change and demand destruction due to high oil prices) could result in a modest fall in oil and gas consumption. Annual oil demand growth fades to 1.1% on average to 2050 rather than 1.6% per year. Gas demand peaks at 75% above 2000 levels in 2030 and then falls to 40% above 2000 levels by 2050. Significant climate change would still occur in this scenario.

Carbon markets: a broad carbon market is established. A $100/tonne CO_2e cost of carbon is generally applied in OECD countries by 2015, and in all major economies by 2030. This, together with other measures, triggers a progressive decarbonisation of the economy. Oil consumption peaks between 2020 and 2025 at 25% above 2000 levels, and falls back to 2000 levels by 2050. Gas consumption peaks in 2025 at 50% above 2000 levels, and falls back to only 5% above 2000 levels by 2050. If other sectors carry out more significant cuts, it is possible that the worst effects of climate change could be avoided.

[12] These assumptions are based on those of the International Energy Agency.

Chart 20 *Oil consumption scenarios (Gtoe)*



Source: Carbon Trust and Oxera analysis.

Technology: breakthroughs in low carbon technology such as viable mass market electric vehicles and cheap renewable sources of power (e.g. marine, solar) result in rapid decarbonisation of the economy. Oil emissions peak in 2020 at 30% above 2000 levels and then fall to below 2000 levels by 2050. Gas emissions peak at 65% above 2000 levels in 2030 and fall to 2000 levels by 2050. In this scenario, the sector does its 'share' of the required global emissions cuts. If all other sectors do the same, then the worst effects of climate change may be avoided. Charts 20 and 21 show the oil and gas consumption assumed in each scenario.

We consider the effect of each of these scenarios separately on E&P and refining businesses.

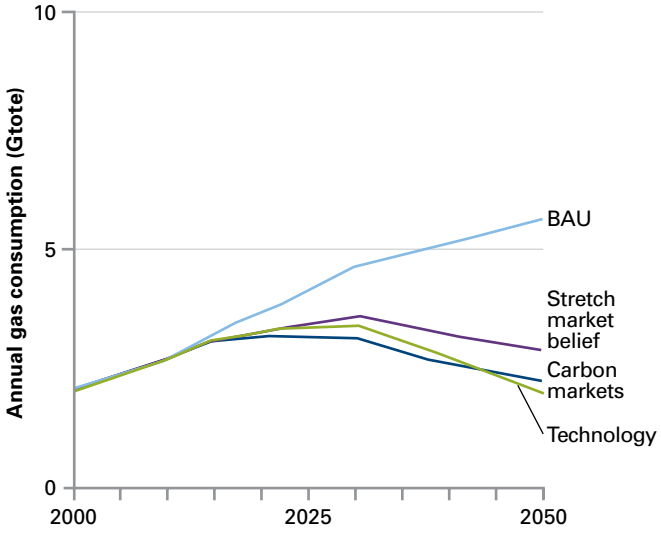
Exploration and production

To illustrate transition value-at-risk we use an E&P archetype company with the following features:

- Approximately 1% of global oil and gas production, distributed across a range of oil field types and geographies reflecting the global average.
- Typical industry profitability.
- 10:1 reserves to production ratio target and growth in keeping with the global market.

We then built the company's profit and loss and free cash flow statement and tested its performance under each scenario to identify transition value-at-risk. The key assumptions are summarised in Chart 22 and the results are summarised in Chart 23, which assumes no impact of falling demand on prices and Chart 24 (see page 36) which presents the sensitivity if prices should fall.

Chart 21 *Gas consumption scenarios (Gtoe)*



Source: Carbon Trust and Oxera analysis.

Chart 22 *Key assumptions for E&P transition value-at-risk and value creation opportunity*

Scenario	Year demand for oil or gas falls	Peak reserves ratio	Assumed shift in oil and gas prices	Value-at-risk (excluding/ including fuel price shift)	Low carbon opportunity (excluding/ including fuel price shift)
BAU	Never falls	10:1	No change	n/a	n/a
Stretch market belief	Oil: Never falls Gas: Falls 2030 on	11:1	No change	3%	1%
Carbon markets	Oil: Falls 2020 on Gas: Falls 2025 on	13:1	-7% (2020) -14% (2025) -20% (2030)	15%/35%	-4%/-20%
Technology	Oil: Falls 2020 on Gas: Falls 2030 on	12:1	-7% (2020) -14% (2025) -20% (2030)	15%/30%	-5%/-20%

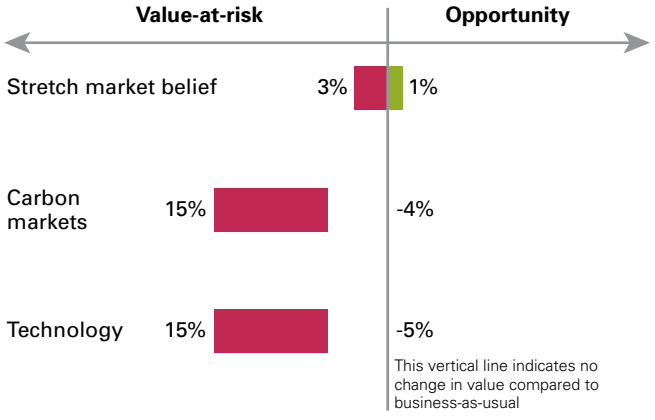
Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: we calculate transition value-at-risk relative to the value of the archetype company in the business-as-usual scenario. In this scenario the archetype enjoys strong, sustained growth in line with the demand for oil and gas. Using a discounted cash flow methodology it has a valuation of $113bn.

There are two components to the transition value-at-risk for this sector: first, the risk of lower revenues due to lower demand and second, the risk that firms have excess costs because they do not correctly anticipate the fall in demand. The revenue fall assumes that the company maintains its share of volumes as overall demand falls. It also introduces a sensitivity as to what would happen if the fall in demand triggered a fall in oil and gas prices[13]. The risk of excess costs is modelled by assuming that the company only gradually realises that demand is diverging from business-as-usual, and therefore continues to invest in production capacity for higher than realised demand. This extra cost is then assumed to require an exceptional cash charge of 1.5 times the operating cost reduction to unwind.

Stretch market belief: the lower demand for oil, and the fall in demand for gas from 2030 leads to a reduced company valuation of $110bn, giving a transition value-at-risk of 3%.

Chart 23 *E&P company value-at-risk and opportunity in scenarios where prices remain at current levels*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Carbon markets: demand for oil peaks in 2020, and for gas peaks in 2025. The company doesn't instantly respond to these falls, believing them to be temporary or reversible. This causes its reserve to production ratios to creep up from 10:1 to 13:1 in 2020, before falling as investment is scaled back. This results in a company valuation of $95bn giving a value-at-risk of 15%. If the fall in demand results in falling fuel prices (we assume a 20% fall by 2030), then the value-at-risk increases to 35%.

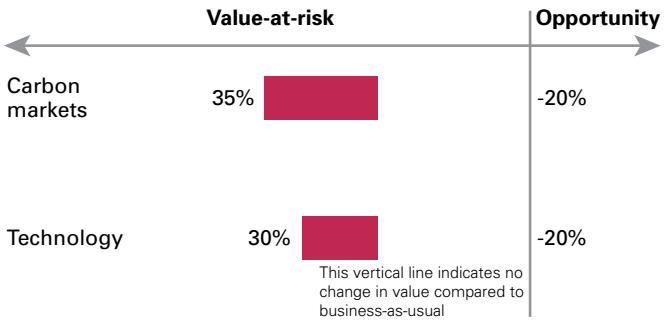
Technology: the shift in the transport fleet to fully electric vehicles, combined with a near zero carbon electricity grid, mean that the company sees a fall in demand for oil from 2020 and for gas from 2030. We assume the company initially misjudges the scale of the fall, although it is so large and irreversible that it corrects its investment levels more quickly than in Carbon markets. This results in a company valuation of $95bn, giving a value-at-risk of 15%. Once again, if the demand drop caused a fall in fuel prices resulting in a 20% drop in prices by 2030, then the value-at-risk would grow to 30%.

E&P low carbon opportunity (for the proactive company)

To estimate the size of the low carbon opportunities for the E&P industry we repeat the transition value-at-risk actions of a company that expected and prepared for the particular scenario. As noted earlier, we have not quantified opportunities outside of today's core business areas such as in renewable energy or carbon capture and storage. These may present considerable upside opportunities. The results of these low carbon opportunity calculations are shown in Chart 22 and discussed here.

[13] It is difficult to predict whether a fall in demand would result in a fall in price. It will depend on the reaction of the oil producers and whether there were any countervailing trends around energy security. Even if the prices paid to the oil companies for fuel drop, it is likely that the effective prices paid by consumers will continue to increase through carbon taxes.

Chart 24 *E&P company value-at-risk and opportunity in scenarios where fuel prices fall (see Chart 22 for shift in prices assumed)*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

In the case of the E&P industry, this preparation mainly involves correctly judging the shift in demand and therefore appropriately shifting and shrinking costs.

Stretch market belief: if a company correctly predicts the lower demand for oil then it can profit slightly on today's valuation by scaling back their level of investment to give a company valuation of $114bn and a value creation opportunity of 1%. This opportunity is wiped out, however, if the actions of others means that fuel prices fall in which case even this firm would have a value-at-risk of 20%.

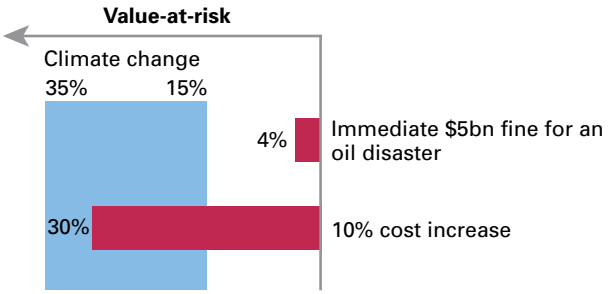
Carbon markets: again, if the company scales back its investment in preparation for the peak in oil and gas demand then it can reduce its value-at-risk to 4%. The fall in volume means that it can't grow its value above today's levels from investments in oil and gas.

Technology: the situation is similar to Carbon markets but the falls are more severe, so that even if a company correctly spots the shift it can only maintain its value at $107bn, a 5% value-at-risk and if fuel prices drop then this value-at-risk would increase to 20%.

Climate change is a key driver of value for E&P

Using the same valuation methodology and discounted cash flow model, we tested the value-at-risk from other drivers, such as a major oil spill, excess costs, or a drop in oil prices. The results are shown in Chart 25. This illustrates the relative importance of climate change compared to other business drivers.

Chart 25 *Significance of the climate change-related company value-at-risk compared with other factors*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the value-at-risk to a business-as-usual focussed company from a series of non-climate change-related events or assumptions and compares this to the range of value-at-risk identified for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy across a range of scenarios.

Refining

Our refining archetype has the following features:

- ~1.6 million barrels per day of global refining capacity.
- Refineries located in OECD markets which in aggregate have a carbon intensity of 30kgCO_2e/bbl and productivity set at the global average.
- Contribution to net income of $6 per barrel after variable operating costs.
- Growth in line with global market demand, to maintain market share.

As with E&P, we then built the company's profit and loss and free cash flow statement and tested its performance under each scenario to identify transition value-at-risk. The key assumptions are summarised in Chart 26 and the results are summarised in Chart 27.

Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: as before, we calculate transition value-at-risk relative to the value of the archetype company in the business-as-usual scenario. In this scenario the refining archetype enjoys strong, sustained growth in line with the demand for oil. Using a discounted cash flow methodology it has a value of $15bn.

There are two components to refinery transition risk under the scenarios: unexpectedly falling demand and uneven 'cost of carbon' prices.

Stretch market belief: in this scenario the demand for refined products grows more slowly and we assume that the archetype experiences up to $25 carbon cost on its business in 2015, and initially cannot pass on this cost on half of its business, due to unregulated competing foreign imports. It is gradually able to pass on this cost, but only completely in 2030. This results in a discounted cash flow valuation of $14bn and a value-at-risk of 7%.

Carbon markets: the archetype experiences falling demand from 2020 but initially believes the differences are temporary and doesn't realign investment to demand until 2030. The risk calculation then includes the potential need to make a one-off exceptional cash charge of 1.5 times the reduction in operating costs, to cover the costs of terminating employment and supply contracts and clean up or dispose of redundant sites.

This archetype is also exposed to a much greater carbon price asymmetry, paying $100/t$CO_2$e on its operations in 2015, and as in Stretch market belief, it initially cannot pass on this cost for half of its business and is only able to completely pass on these costs to consumers in 2030. This leads to a much lower company valuation of $11bn and a transition value-at-risk of 30%.

Technology: as before, the archetype experiences falling demand and faces similar difficulties and costs in correcting its cost base to reflect the new situation. The fall in demand is greater than in Carbon markets, but this is compensated for by a somewhat lower carbon price asymmetry. It only pays $50/t$CO_2$e on its operations in 2015 and as in Stretch market belief, it initially cannot pass on this cost for half of its business and is only able to completely pass this through by 2030. This leads to a company valuation of $12bn, giving a 20% value-at-risk.

Refining low carbon opportunities (for the proactive company)

To estimate the size of the low carbon opportunities for the refining industry we repeat the transition value-at-risk calculations but alter our assumptions for the archetype to reflect a company that expects and is well prepared for the particular scenario whilst other features are the same as the original archetype. The key assumptions and results are again shown in Chart 26 and Chart 27.

In the case of the refining industry, this preparation involves judging the climate change triggered shift in demand and managing exposure to carbon costs.

As with E&P, there are other low carbon opportunities that refiners could invest in (e.g. biofuel processing) However, as these are not established business areas, these have not been quantified.

Stretch market belief: we assume that the archetype correctly invests on the basis of the slower demand growth and has a combination of refineries and customers that allows it to always pass through the cost of carbon it faces. This mitigates most of the risk. If it achieved a 30% better than average carbon intensity then the company valuation would increase to just over $15bn, giving an opportunity of 1%.

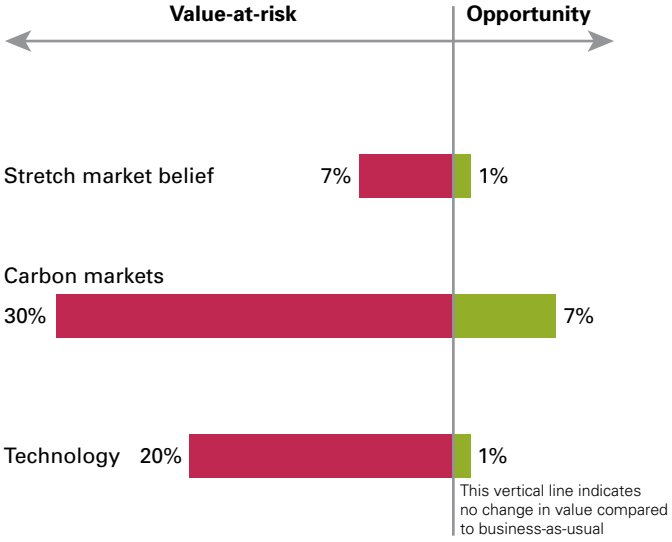
Chart 26 *Key assumptions for refinery transition value-at-risk and value creation opportunity*

Scenario	Peak demand	$/t$CO_2$ 2030+	Year by which full carbon cost paid	Transition value-at-risk	Market share of upside opportunity	Value creation opportunity
BAU	> 2050	0	n/a	0%	2%	0%
Stretch market belief	> 2050	$25	OECD: 2015 RoW: 2030	7%	2%	1%
Carbon markets	> 2020	$100	OECD: 2015 RoW: 2030	30%	3%	7%
Technology	> 2020	$50	OECD: 2015 RoW: 2030	20%	4%	1%

Carbon markets: we assume that the firm makes the same preparations as for the Stretch market belief scenario but is even tighter on managing the reduction in its capacity from 2020. Because the fall in demand is likely to be unevenly spread across products and regions we believe there is therefore an opportunity for the companies that prepare to use the higher margins from managing their costs to ensure that they shrink more slowly than the market, thereby increasing overall market share. When combined with the greater cost benefit of being carbon efficient (because the carbon price is higher) this leads to a company valuation of $16bn in this scenario, and an opportunity of 7%.

Technology: the fall in demand is greater, the firm has to work harder to try and maintain volumes and, because the carbon price is only $50, the benefit of improved carbon efficiency is lower than in Carbon markets. Therefore, the company valuation in this scenario is just above $15bn, giving a value opportunity in this industry of 1%.

Chart 27 *Refining company value-at-risk and opportunity*



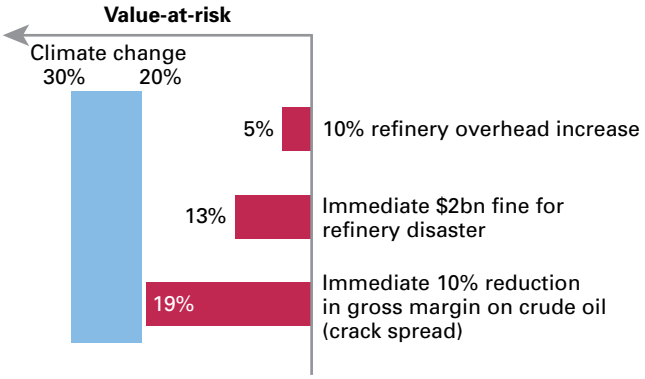
Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Climate change is a key driver of value for the refining industry

Again, using the same valuation methodology, we tested the value-at-risk from other, non-climate change-related value drivers, such as a major oil spill, excess costs or a drop in oil prices. The results are shown in Chart 28. This illustrates the relative importance of climate change compared to other business drivers.

Chart 28 *Significance of the climate change-related company value-at-risk compared with other factors*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the value-at-risk to a business-as-usual focussed company from a series of non-climate change-related events or assumptions and compares this to the range of value-at-risk identified for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy across a range of scenarios.

Oil & Gas industry pressures will intensify from 2020 as demand drops

For both E&P and refining, the pressure on cash flows intensifies as demand for oil and gas reduces. This tends to be from 2020 onwards (depending on the scenario). However, the changes in demand could be anticipated from as early as 2015 through increasing energy efficiency and changes in transport demand (e.g. a move to electric vehicles) and provision of alternative renewable energy.

Refining could also be adversely affected by a cost of carbon over the period 2010-2015 if foreign imports of unregulated refining product (no cost of carbon) undermine local margins.

Specific implications of Oil & Gas analysis for investors

The key focus will be on news flow that might indicate a need to change understanding of the long-term prospects of Oil & Gas companies. Key news flow 'triggers' that might affect valuations could include:

- Regulatory events, including the existence and level of ambition of a new 'Global Deal' on emissions, regional/national emissions regulations to reduce demand (e.g. EU proposals to reduce auto emissions), the elimination of national subsidies for oil and gas and any targets set at national level (e.g. UK's Climate Change Bill) which signal the overall level of ambition to reduce emissions within individual areas of the economy.
- Technology shifts that will replace major uses of oil and gas (particularly in the auto and electricity generation sectors, e.g. battery technology or renewable supply breakthroughs).
- Reactions of independent and national oil companies to global commitments to reduce the growth in fossil fuel use – in particular any commitment to reduce long-term supply to maintain price.

Features of companies best placed in any change in perception of long-term prospects include:

- E&P operations with access to cheaper oil reserves and relatively low investment in unconventional sources.
- Refineries with low, well managed and falling carbon emissions located in jurisdictions less likely to experience a cost of carbon but able to export into regulated regions.

Long-term 'universal' investors should focus on ensuring all major players in the industry are ready for the transition to a low carbon economy. Areas of focus include:

- Engage with E&P companies on their long-term expectation of demand and strategy for investment in 'unconventional' reserves.
- Engage with regulators to ensure that policies to reduce oil and gas demand occur in a clear, long term and predictable fashion.
- Reassess the balance of portfolio in Oil & Gas in the light of a potential fall in overall size of the sector and the volatility that may follow if appropriate climate change policies are put in place.

Building insulation analysis

Tackling climate change is likely to increase global demand for building materials that improve energy efficiency. There is a potential downside risk for some carbon intensive materials which might incur a 'cost of carbon'. Winning companies will be those best placed to seize growth opportunities.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Building insulation industry. Based on these scenarios and assumptions, the transition to a low carbon economy could cause a significant upward shift in demand for building insulation, offering significant value creation potential to a hypothetical 'archetype' company that proactively invests to capture available opportunities. There is only modest value-at-risk.

We identify the following key drivers of change:

- Targeted regulations that drive improving standards for buildings, increasing overall energy efficiency.
- Potential technological breakthroughs which enable the sale of higher margin insulation products.
- Carbon markets imposing a 'cost of carbon' on high carbon intensity materials, which could increase raw materials input costs.

The magnitude of the potential value creation opportunity for archetype companies that proactively invest to seize growth opportunities suggests that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions in the building insulation sector – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry with significant potential upward demand shift

- Building use is responsible for ~21% of global greenhouse gas emissions and its emissions are forecast to grow at 2% per year under business-as-usual. Reducing emissions will be a key focus of tackling climate change.
- Tightening of energy performance regulations for buildings across developed and developing countries provides a value creation opportunity for a hypothetical buildings insulation company of as much as +80%.
- There is a potential downside exposure for high carbon intensity building products which bear a cost of carbon – up to 20% value-at-risk assuming no growth upside.
- Investors should track key industry triggers, such as the tightening of building regulations or increases in critical input costs.

Building materials industry context

The construction of buildings is, by its nature, a truly global industry, accounting for ~12% of total GDP. Around half of all materials extracted from the earth are transformed into building materials and products. Across the world, new buildings are constantly being built and old ones demolished. In the developing world the growth of building construction is around 4-8% per year, driven by rapid economic growth, increasing populations and urbanisation.

In developed countries, despite the current slowdown in the market, modest growth of 1-2% is expected over the long term due to the continued need to upgrade the building stock to match the changing requirements of the economy (e.g. continued shift from industrial to office buildings) and replace ageing stock.

The construction industry value chain is complex with multiple players including manufacturers of building materials and construction equipment, engineering and construction companies, and building developers and owners. In this study we focus on the building materials industry (with approximately $1 trillion in sales) and specifically on the manufacturers of insulation materials (sales of ~$30bn p.a.).

The climate change challenge for the building materials industry

Building use is one of the largest sources of greenhouse gases, responsible for ~21% of global emissions. Global population and economic growth, allied with increasing energy demand within both residential and commercial buildings, is expected to lead to emissions growth of ~2% p.a. – giving a total increase of 70% by 2030 compared to 2002 levels. The increased energy demand will predominantly be in developing countries, driven by (amongst others) additional demand for electric water heating and air conditioning, and increased used of IT and consumer electronic equipment.

The critical challenge for the building sector is, therefore, to improve the energy performance of the building stock. The impact of these trends on the building materials industry are likely to be largely positive. Demand for building products should continue to grow in line with market growth. Further tightening of building regulations and enforcement across the world, alongside higher energy prices, should create additional demand for products which improve a building's energy performance. On the downside, increasing costs may be incurred through a carbon price impacting the commodities and energy used to manufacture building materials.

The key drivers which will likely stimulate a move to reduce carbon emissions in the building sector are as follows:

- **Regulation:** policy will be responsible for much of the improved energy performance in buildings. This is likely to come through tightening and broadening of building standards such as minimum energy efficiency standards and information labelling in the developed world. In developing countries, the introduction and/or effective enforcement of building regulation efficiency standards should further reduce global emissions.
- **Carbon markets:** the introduction of a carbon price could directly increase energy costs for building users. This will improve the business case for many of the energy efficient technologies that are available, leading to higher penetration and reduced energy use. It could also impose a cost on building materials manufacturers, depending on the carbon intensity of the product.
- **Technology:** the drive for greater buildings standards will likely stimulate greater innovation of more energy efficient technologies, primarily for the purpose of reducing energy costs, but also to give buildings a positive reputation for attempting to improve their carbon footprint. Advancements in 'thin' insulation technologies or easily retrofitted materials could lead to competitive advantage among players.

The above pressures on buildings will change the competitive landscape for buildings insulation players, providing significant scope for upside growth opportunity.

Scenarios for reduction of building material (insulation) emissions

Given quite similar overall levels of reduction in building emissions in each 'success' scenario, we only focus and develop specific industry scenarios based on one of the macro 'success' scenarios – Targeted regulations, for the building insulation industry, as well as the business-as-usual and Stretch market belief scenarios, as follows:

Business-as-usual: in keeping with historic industry projections, insulation companies enjoy a 3-4% growth rate in developed countries and a 5-6% growth rate in developing countries over the long term. Input costs and prices grow at 3% in the short term reflecting recent cost inflation but return to a 2% growth rate after 2012 following a stabilisation of materials costs.

Stretch market belief: this scenario reflects industry experts' and analysts' current projection for the industry as a result of tackling climate change. Buildings efficiency standards are increasingly adopted and enforced globally, leading to growth in insulation demand (over and above the base case) of 0.5-1.0% in the developed world, and 1.0% in developing countries. Some more innovative products are introduced leading to higher margins for some products in the developed world. A modest cost of carbon ($25/t CO_2e) prevails, reaching all OECD markets by 2015 and applying to some developing markets from 2015, reaching all markets by 2030.

Targeted regulations: a world of strong building regulations and heightened enforcement leads to increased demand for insulation across the world, and to more innovative (higher margin) products in the developed world. We assume demand growth of 1% above the base case in the developed world, and 1-2% in the developing world. Prices in the short term are assumed to grow at 2.5% above the base case in the developed world, stabilising in the long term. In addition to targeted regulations a cost of carbon of $50/t CO_2e prevails reaching all OECD markets by 2015 and applying in some developing markets from 2015, reaching all developing markets by 2030. This results in increased raw material and production energy costs for insulation manufacturers of 1-2% p.a. above the base case.

The details and impacts of the different scenarios for values are considered below.

Building materials (insulation) value-at-risk

To test the value-at-risk and opportunity available under the different scenarios, we constructed an insulation industry archetype with the following features:

- A large OECD based insulation company
- Sales revenue of $2.5bn, ~75% originated in developed countries, and ~25% in developing markets
- Not well prepared for the climate change challenge, with higher than average carbon intensity products.

Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: in this scenario, the company experiences the growth and cost profile of the market. The valuation of the company in this scenario is US$4bn. As this is the base case, there is no value-at-risk.

Stretch market belief: in this scenario, the wider industry experiences an increase in growth. However, we assume that the company is not well placed to improve its market position and therefore has the same growth profile as business-as-usual. Its products are high carbon intensity and the company experiences a 1% cost rise through the increasing application of the $25/t CO_2e carbon price which it is unable to pass through due to lower carbon intensity competitor products.

The valuation of our archetype in this scenario reduces to US$3.6bn due to the cost increase. This represents a value-at-risk of 10% vs. business-as-usual.

Targeted regulations: again the company is not well placed to improve its market position and therefore has the same growth profile as in business-as-usual. Its products are high carbon intensity and the company now experiences a 2% cost rise through the increasing application of a $50/t CO_2e carbon price which it is unable to significantly pass through due to lower carbon intensity competitor products.

The valuation of our archetype in this scenario reduces to US$3.2bn, representing a value-at-risk of 20% vs. business-as-usual.

We believe the above scenarios represent the maximum likely value-at-risk for a typical building insulation player.

Low carbon building insulation opportunity (for a proactive company)

To test the range of opportunity, we now test the impact of the same scenarios on a different archetype which is similar to the first, in terms of size and base of operations. However, its product range and geographic focus is better suited to capitalise on the increases in demand taking place as a result of the climate change challenge.

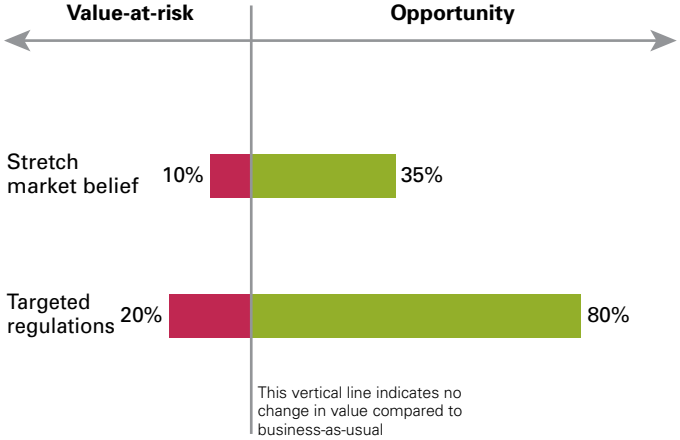
Stretch market belief: the archetype achieves the additional market sales growth and short-term price increase of the overall market. It manages to avoid any net effect of the cost of carbon due to low carbon intensity products (e.g. wood or biomass based) and to an ability to raise prices to cover any additional costs. The valuation of our archetype in this scenario increases to US$5.4bn, an upside value opportunity of 35% vs. the business-as-usual case. Around 80% of this opportunity is in developed markets.

Targeted regulations: in this scenario our archetype achieves the additional market sales growth and short-term price increase of the overall market. It manages to avoid any net effect of the cost of carbon due to low carbon intensity products (e.g. wood or biomass based) and to an ability to raise prices to cover any additional costs.

Under this scenario, the valuation of the company rises to US$7.2bn, a value creation opportunity of 80% compared to the business-as-usual scenario.

These results demonstrate a significant range of value-at-risk vs. value creation opportunity for players in each sector, and are summarised in Chart 29.

Chart 29 *Company value-at-risk and opportunity*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Climate change is a key driver of value for the building materials (insulation) industry

The climate change-related value-at-risk and opportunity are comparable to other changes facing the industry that have equally powerful and more immediately tangible consequences. For instance:

- A slow-down in the western insulation market from 3.0% to 2.0% growth would put value-at-risk for our archetype company of 22%.
- Significant growth of Middle Eastern and Chinese markets, with growth rising to 10% over the next five years would create additional opportunity for our archetype of 26%.

Specific implications of building materials industry analysis for investors

This is an industry that is likely to see a generally rising tide amongst all players in most scenarios. As a result, investment decisions may be more interesting at a portfolio level, rather than through determining company winners and losers.

There may be some opportunities for industry players to differentiate themselves, for example through aggressive green branding efforts that attract customers and/or unique product offerings with higher margins. Investors should target companies that are:

- Proactively targeting and developing new, higher margin energy efficiency related opportunities.
- Geographically well-positioned to take advantage of changing regulations and standards that may increase demand for energy efficient building materials and/or renewables.

Investors looking to make gains in the sector should seek to invest in advance of key triggers of an increase in demand. These could include the following:

- Tighter building regulations expected in Australia and possibly the US in the next 1-2 years. In Europe, building regulations are likely to continue to be tightened, for example the stated ambition for zero carbon new non-domestic buildings by 2019 in the UK.
- Heightened enforcement of building regulations in developing countries, in particular in China, where regulations are already strict but there is room for improvement in enforcement.

Consumer electronics analysis

Tackling climate change will likely require a reduction in power consumption of consumer electronics but have limited impact on industry valuations. There is significant potential upside opportunity in 'green' electronics.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Consumer electronics industry. Based on these scenarios and assumptions, the transition to a low carbon economy could cause a significant upward shift in demand for consumer electronics, offering significant value creation potential to a hypothetical 'archetype' company that proactively invests to capture available opportunities. There is only modest value-at-risk.

We identify the following key drivers of change:

- Potential technological breakthroughs which enable the sale of consumer electric goods that contribute to a lower carbon lifestyle, for example home energy controls or improved telecommunications.
- Consumer behaviour, which could drive the adoption of increased 'virtual lifestyle' type products such as home entertainment which result in a lower overall personal carbon 'footprint'.
- Targeted regulations, which are likely to mandate increased consumer electronics power efficiency, but which are unlikely to impose significant costs.

The magnitude of the potential value creation opportunity for archetype companies that proactively invest to seize growth opportunities suggests that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions in the consumer electronics sector – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry with significant potential upward demand shift

- Consumer electronics is driving disproportionate growth in power consumption, being projected to account for 30% of OECD residential electricity demand by 2020.
- The industry will likely be the focus of much stronger efficiency regulation and labelling requirements, although the cost to industry players to achieve significant reductions in power consumption is relatively modest.
- In the medium to longer term, individual consumer electronics companies could capture significant upside opportunities driven by demand for products which assist a high tech, low carbon lifestyle.

Consumer electronics industry context

The consumer electronics value chain stretches from R&D players (often vertically integrated) to semiconductor manufacturers, to consumer electronics OEMs, to retailers. The industry is fast-growing and highly globalised, generating over $390 billion in revenues worldwide in 2007. However, growth forecasts for the coming years are predicting slightly slower rates, due to the already high penetration of consumer electronics products. The three largest contributors to revenue today are standard cathode ray tube ('CRT') televisions, personal computers, and mobile phones but industry growth is currently driven by dramatic volume increases in newer products, such as digital portable equipment (growing at rates of up to 80% per year) and flat-screen televisions (growth rate of around 60% per year). While the U.S. and Western Europe continue to lead electronics consumption, representing more than 60% of sales, Asia produces around 65% of goods sold by value.

Gradual price reduction is common throughout the industry, generally at a rate commensurate with cost reduction from technology learning curves. Recently, the entry of Chinese players into the market with lower cost bases has compressed incumbent players' margins.

Consumer electronic devices are rapidly growing contributors to household carbon emissions

The consumer electronics industry represents an increasing proportion of residential electricity demand and, with current levels of expected growth, is forecast to be larger than lighting or electric heating and more than a third of household energy demand by 2020 in OECD markets. The industry therefore forms part of the problem of climate change, but also has the potential to be part of the solution.

Examples of potential reductions in greenhouse gas emissions to be made by the sector include:

- Reduction in device power consumption on standby by over 80%. These savings could be captured for less than $0.50 per device and potentially even for a net savings per unit when scaled.
- Efficiency improvements in external power packs could yield up to an 80% reduction in conversion losses. Improvement would cost less than $1 per power pack and would pay back to the consumer very quickly.

Climate change-related drivers of value are likely to include:

Regulation: targeted regulatory standards will be critical to capturing abatement opportunities. Efficiency regulation has historically been light, but it looks set to tighten in the European Union and other markets such as the United States and some Asian countries. The International Energy Agency (IEA) is lobbying for all countries to implement a one watt plan for standby power use similar to that in Korea. Standby power is a commonly mentioned feature of almost all national energy efficiency policy statements. This trend will be reinforced by growing use of, or requirement for, product labelling schemes such as Energy Star[14].

The introduction of carbon pricing should have limited impact on the industry outside of a few specific components (e.g. silicon) due to the relatively low average carbon intensity of production compared to value, provided companies are well prepared.

However, a poorly prepared company could sustain a rise in prices due to the need to suddenly switch supplier, redesign products or redesign production. In the worst case scenario, this could cause a cost rise of ~10% for a period of several years. There is also a risk of strict regulation imposing prohibitions on particular types of high-energy products (such as high-energy plasma televisions) which could lead to a drop off in revenue for companies who rely heavily on those categories of product. As such regulations are very hard to predict, we have not quantitatively estimated the impact of such changes.

Technology: there will be some increased component costs as a result of heightened emissions standards, but upfront costs are relatively low. The industry's high innovation capabilities should enable companies to reduce efficiency-related technology costs rapidly. We anticipate that any first mover advantage in lower emissions products will be limited by the ability of others to quickly catch up due to the condensed development cycles prevalent throughout the industry. However, there is potential for product development breakthroughs to support new low carbon technologies featuring as part of a low carbon lifestyle. Examples of new consumer electronic product opportunities include transport monitoring technology such as congestion charging monitors or transit planning systems, controls for ultra-efficient home heating, lighting and ventilation systems or for micro electricity generation systems based on solar or wind power.

Consumer behaviour: although consumers stand to benefit from the energy savings of more efficient electronic goods, consumer pressure alone is unlikely to provoke significant change across the industry. However, in a low carbon 'consumption' scenario, consumer uptake of home entertainment and communication devices could be a critical component of a lower carbon lifestyle. For example, a market could grow up around 'virtual lifestyle' technologies such as video conferencing and home entertainment products, as well as the lower carbon lifestyle controls and products identified above as potential technology innovations.

[14] Energy Star is a joint programme between the U.S. Environmental Protection Agency and the U.S. Department of Energy. It is a voluntary labelling programme designed to identify and promote energy-efficient products and appears on over 50 product categories including major appliances, office equipment, lighting and home electronics.

Consumer electronics value-at-risk and opportunity is driven by revenue opportunities rather than changes in input costs

Given quite similar overall levels of reduction in emissions between the scenarios, we only focus and develop specific consumer electronic industry scenarios based on two of the macro 'success' scenarios – Targeted regulations and Consumption, as well as the business-as-usual and Stretch market belief scenarios, as follows:

Business-as-usual: the industry continues to grow at a steady rate whilst also maintaining its margins at a constant level. There is no long-term shift in cost base, margins or anticipated growth rates.

Stretch market belief: some regulators introduce moderately aggressive efficiency targets in line with industry experts' and analysts' current high end expectations. This causes additional compliance costs for the industry but also some additional growth potential for innovative players.

Targeted regulations: in this scenario, there is a stringent tightening of efficiency standards, forcing early adoption of more expensive efficiency measures over and above the low cost options currently available.

Consumption: similar regulations apply in this scenario as for Targeted regulations, but an upturn in consumer demand for 'green' electronics is driven by a fundamental shift amongst consumers towards a low carbon lifestyle.

Transition value-at-risk (for a company that fails to adapt)

In order to test the value-at-risk for a consumer electronics player, we created an industry archetype player with the following features:

- Global consumer electronics manufacturer, with annual sales of ~$30bn, placing it on a level with the larger industry players.
- EBIT of ~7% in our base year of 2007.

We assume that this company is not otherwise particularly well prepared for the climate change challenge.

Business-as-usual: under business-as-usual, sales volume grows steadily by 3% each year, whilst costs and revenues stay in line, each growing by 2%, leaving a constant margin of ~7%. This base case gives our archetype a valuation of $127bn.

Stretch market belief: the company has not foreseen the regulatory changes that are imposed and so incurs costs at the high end of estimates. Cost of goods sold rise 5% over a five-year period to end 2012, after which it gradually reduces the cost increase to zero over the next 10 years. We assume that because others were well prepared and avoided significant cost increase, the archetype could not achieve any price pass through. The result overall is a 4% fall in valuation to $122bn.

Targeted regulations: similar to Stretch market belief, regulatory changes impose even more radical changes in product power consumption. This time, the company incurs an increase in cost of goods sold of 10% over the period 2008-2012, with gradual recovery over the next 10 years. Again, we assume that the archetype could not achieve any price pass-through due to lower cost-base competitors. In these circumstances the archetype's valuation falls by 7% to $118bn.

Consumption: the regulatory conditions are the same as Targeted regulations. However, the company is not able to capitalize on any additional growth due to a failure to lead on the design of new products. It therefore suffers the same transitional value-at-risk as under Targeted regulations of 7%.

Value creation opportunity (for a proactive company)

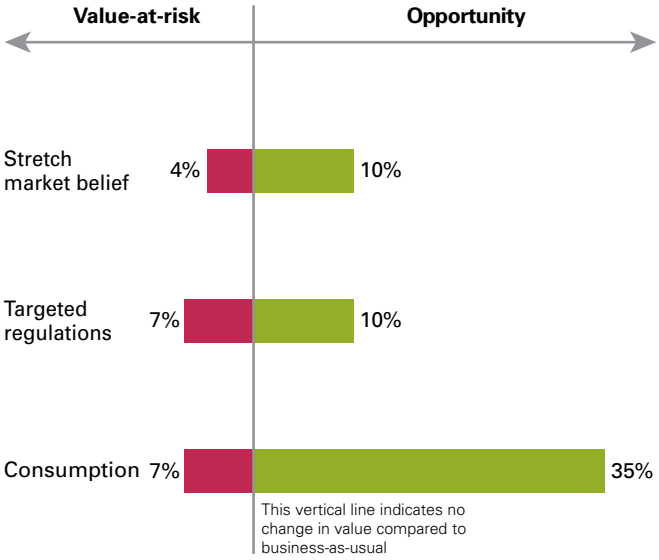
To consider the potential upside value creation opportunity, we next envisaged a consumer electronic archetype very similar to the previous archetype but which is much better prepared to capitalize on the climate change challenge. Its value in the scenarios is as follows:

Stretch market belief: in this scenario the company, through good preparation, avoids all the costs associated with reducing product emissions. It then captures value from low carbon products that reduce everyday carbon emissions (for example, video conferencing and advanced household utilities controls). We assume that our archetype is able to grow revenues by an additional 0.5% each year leading to a 10% increase in its valuation to $139bn.

Targeted regulations: similar to Stretch market belief, the company avoids all the costs associated with reducing product emissions, whilst capturing the same growth upside as in Stretch market belief. Its value is the same as in Stretch market belief.

Consumption: the company again avoids the costs of reducing product emissions. Meanwhile, it leads innovation of a new range of low carbon products, capturing the higher consumer-led growth of this scenario. In this scenario, the archetype grows its revenues by an additional 1% per annum over business-as-usual grow rates. This creates a 35% uplift in our archetype company's valuation to $172bn. These results are summarised in Chart 30.

Chart 30 *Company value-at-risk and opportunity*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Climate change could be a significant driver of upside potential

As seen in the scenario valuations, we do not envisage that the climate change challenge will put significant value-at-risk due to compliance cost increases. However, even modest increases in long-term growth rate can have significant effects on valuations. Climate change has the potential to be a significant driver of upside growth for the sector. Those companies that can seize the initiative to develop products suited to the new growth markets of a low carbon lifestyle could do particularly well.

It is possible that major electronics retailers will seek to navigate consumers to new types of lower carbon lifestyle electronic equipment. This could make retailers powerful brokers in determining the winners of tomorrow and therefore appealing to retailers' vision of product placement could be critical to success. However, many of today's players could be well placed to succeed in the future, provided they focus on taking advantage of new markets, whilst ensuring any costs of compliance with regulations are mitigated in advance.

Certain niche areas of the consumer electronics value chain might prove more at risk than equipment manufacturers. For example, raw materials suppliers have tighter margins compared with consumer electronics players, and limited ability to pass through any costs that result from increased regulation, especially if it is not applied globally. As a second example, semiconductor manufacturers are the point of innovation for many increases in standby and operating efficiencies, and therefore some winners and losers may emerge in this sector.

Implications for investors

In the short term, climate change will not be a major factor in investors' decision-making in the Consumer electronics industry as the industry will mostly be able to withstand the impact of short-term regulations for lower power consumption. However, any sudden change in regulation could introduce a small shock to input costs for the unprepared company.

Longer term, investors should invest in companies that have a track record of leading on products that catch new trends in consumer need. In this case, the ability to assist consumers to reduce their carbon footprint in the home (e.g. controls for home utilities management), as well as substitute for higher carbon activities (e.g. low cost and convenient video conferencing devices) could be winners.

Beer industry analysis

Tackling climate change may pressure beer companies by increasing raw materials prices and changing packaging requirements. However, value-at-risk and opportunity are relatively low and the industry is likely to recover from a series of temporary shocks to input prices.

Introduction

In this section, we set out a plausible range of global carbon mitigation scenarios and assumptions for the transition to a low carbon economy in relation to the Beer industry. Based on these scenarios and assumptions, the transition to a low carbon economy could cause some volatility in earnings for beer companies. However, overall, industry players are likely to withstand such effects.

We identify the following key drivers of change:

- Potential increases in the cost of packaging, resulting from increased raw material prices of glass and aluminium which may bear a 'cost of carbon'.
- Potential one-off increases in packaging if targeted regulations required a change in packaging to a lower carbon material such as biodegradable plastics.
- Potential increases in crop input prices resulting from competition for food products from the increased manufacture of biofuels.

Whilst the magnitude of the potential value-at-risk is not very large, the potential for short-term volatility of earnings due to price spikes suggests that investors, companies and policy makers should factor tackling climate change into their investment, strategy and policy decisions for the Beer industry – see Key findings. This should be based on their own beliefs and analysis of the potential shifts in regulation, technology and consumer behaviour that could trigger significant change in carbon emissions and business value.

Key findings – an industry facing some volatility of earnings

- In the short term, value-at-risk could be between 5 and 15% for an archetype company in the Beer industry, due to rising input costs.
- Value-at-risk is driven by the relative ability of brewers to pass through their increased costs to consumers. Any differential effect between competitors is likely to be temporary.
- There is scope for proactive companies to gain an advantage but we believe that these will remain niche opportunities.
- Investors should remain alert for key industry triggers, such as regulation changes or raw material price changes.

The Beer industry is growing steadily but is subject to pressure on margins

The global consumption of beer was around 1,700m hecto litres (hl)[15] in 2007 with recent steady annual growth rates of around 2%. Similar overall growth rates are predicted in the next few years, with emerging markets outside Western Europe and the United States providing most of the scope for expansion (Russia and China are expected to grow at 5-6% CAGR until 2015 compared with developed markets at 1-2% CAGR).

Growing global demand for cereal crops, packaging raw materials (e.g. aluminium, glass) and energy will continue to push up input prices. Whilst historically brewers have been able to pass through cost increases, recent price spikes have put margins under growing pressure.

[15] A hecto litre is 100 litres.

The climate change challenge for beer is mainly focussed on raw materials and packaging

In common with much of the food and drink industry, the cost elements of beer production exposed to climate change impacts are raw materials (hops, malt and barley), packaging (glass, aluminium or Polyethylene Terephthalate ('PET')) and distribution.

The carbon footprint of off-trade beer, the majority of sales, is dominated by its packaging (which for standard size units represents at least 50% of product-related emissions), with the overall footprint of a traditional disposable glass bottled beer generally higher than that of aluminium cans and PET bottles. Global requirements to reduce emissions from aluminium and glass will be relevant to the packaged beer industry, but will have different impacts in different markets as packaging practices vary country by country. Carbon emissions from on-trade beer include a significant proportion from the energy consumed by serving at a pump.

Climate change-related drivers of value are likely to be:

- **Regulation:** a cost of carbon could increase the costs of aluminium and glass used in packaging materials whilst targeted regulations may require a shift in packaging type to lower carbon intensity alternatives.
- **Technology:** an increasing manufacture of biofuels may drive up crop prices and cause unpredictable fluctuations in price.
- **Consumer behaviour:** consumers may develop a preference for low carbon beers, although this is unlikely to be more than a niche product area.

Costs will also be impacted by the physical effects of climate change on weather patterns which will hit crop yields. We do not formally study this impact due to the inherent uncertainties which would be involved in forecasting weather patterns.

At current price levels, demand for beer has historically appeared relatively price inelastic, but the ability to increase prices is dependent on the company's market position, the particular economic circumstances of its various geographic markets and the level of brand premium in a company's portfolio. In recent years, most brewers have also been able to offset cost increases through production and other efficiencies. The ability to absorb or pass on cost increases implies the impact on returns from a further fluctuation in costs should only be short term.

We also considered a potential upside from breweries moving into biofuels, or increasing the value of sales from bio-waste production, but did not examine this opportunity further on the grounds that there were not obvious market synergies for these new products to sit within the existing consumer products industry.

In terms of energy costs, we have assumed that any further price rises affecting distribution and production costs are offset by internal efficiency improvements.

Beer industry scenarios

Given quite similar overall levels of reduction in emissions between the scenarios, we only focus and develop a specific Beer industry scenario based on one of the macro 'success' scenarios – Targeted regulations, as well as the business-as-usual and Stretch market belief scenarios, as follows:

Business-as-usual: market conditions continue as generally anticipated with steady but modest growth in developed markets and higher growth in developing markets. There is no long-term shift in cost base or margins.

Stretch market belief: as a result of modest attempts to tackle climate change, biofuels compete with crops for land-use, causing a series of spikes in crop commodity prices. Costs of packaging raw materials rise with the additional cost of carbon emissions contained in the product.

Targeted regulations: conditions are similar to Stretch market belief, but more extreme, aiming to reduce emissions to 550ppm CO_2e. Significant biofuels production and a higher imposed cost of carbon of \$50/tCO_2e raise input costs for crop raw materials and packaging further. In addition, regulators impose a series of changes in packaging requirement, for example requiring increased recycling of glass and aluminium or a shift to lower carbon bio-plastic bottles.

The details of each scenario as applied to our beer archetype companies are considered below.

Beer value-at-risk and opportunity

In order to test the Beer industry value-at-risk from the climate change challenge, we developed an archetype brewer with multinational operations based mainly in developed markets, and with a product portfolio weighted towards mainstream rather than premium products. The following characteristics were assumed:

- Average wholesale price per litre of $0.55, with annual sales volume of 300m hl in the base year of 2007 (i.e. an approximate global market share of around 17%).
- Gross margin assumed at ~70% and EBIT at ~24% of net sales value.
- Raw materials (hops and barley) costs of 27% and packaging costs of 46% of total cost of goods sold.

Transition value-at-risk (for a company that fails to adapt)

Business-as-usual: the company's sales revenues increase at a steady rate of 1.5% per annum out to 2030 with no changes to the pricing structure. Input costs remain at a constant percentage of sales. The valuation of our archetype in the business-as-usual scenario is $53bn, which forms our base case.

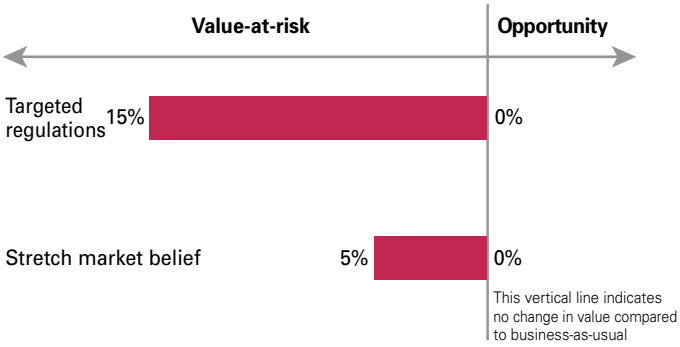
Stretch market belief scenario: we assume increases occur in the price of hops and barley. Carbon costs also affect the price of glass and aluminium in packaging. We assume this combines to cause a series of 20% increases in costs for both packaging and raw materials for our archetype at three separate points from 2010 to 2018, which is comparable to some of the higher rates already seen in the industry. We assume that the company is only able to pass on 50% of the cost increases immediately following the price rises, but that within a three-year period is ultimately able to achieve a 90% price pass through rate. The valuation of our archetype in this scenario falls to $50bn, with value-at-risk of 5% compared to Business-as-usual

Targeted regulations: similar to Stretch market belief, but the stricter regulatory regime causes a more severe set of price spikes in crop input prices and packaging of 50% above Business-as-usual, at the same timings as in Stretch market belief. The price increases are again substantially passed through over three years on the same basis as Stretch market belief.

In this scenario, the valuation of our archetype company falls to $46bn, with valuation-at-risk of 15% vs. the Business-as-usual scenario.

There is a possibility of the beer producer reaching a ceiling on price increases, beyond which price pass-through becomes incompatible with retaining sales volumes. Although not explicitly addressed in our model, this would clearly cause a much more substantial long-term effect on margins and industry value. We have also not modelled any impact on sales volumes from packaging regulations (for example, if retailers discontinued stocks of high carbon types of packaged beer) as we assume that impacts in particular markets would be short term and of small overall impact in a company with a global footprint. These results are summarised in Chart 31.

Chart 31 *Company value-at-risk and opportunity*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the potential value-at-risk for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy and the value creation opportunity for a company which is well prepared for the transition. See text for details of the assumptions and methodology used.

Value creation opportunity (for a proactive company)

In this sector there is no obvious opportunity for value creation and, due to the effect of assumed long-term price pass-through, the value-at-risk for the Beer industry is not as great as that for other sectors. However, the level of value-at-risk that does exist can be mitigated depending on ability to recover cost increases. This could be a differentiating factor between companies within the beer industry. The ability to mitigate value-at-risk will be driven by:

- Proportion of product portfolio based on premium brand beers.
- Significant ability to increase production efficiencies and offset cost increases.
- Successfully managing material supply sources and costs.
- Leadership in innovative forms of new packaging and marketing.

Other factors which are likely to impact company success, but are more difficult to predict with accuracy, are:

- The relative exposure to emerging markets, where the price pass through may be harder to achieve or result in volume decline.
- Potential for industry research into more resilient seed types that can survive harsher climate conditions (and opportunity to have proprietary intellectual property).
- Further steps towards security of supply, for example in purchase of water rights.

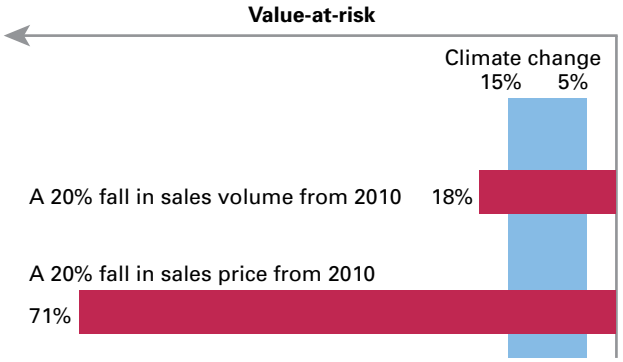
Effect of input cost increases is not as significant a driver of value as changes in price

The changes we have modelled do not indicate a very significant climate change risk for the beer industry, which is already familiar with fluctuations in input costs.

For comparative purposes, we also modelled the effect of a one-off 20% fall in each of sales price or volume in 2010 for our archetype. We have then assumed that revenues revert back to business-as-usual growth rates.

The change in sales price per unit shows the most significant impact in performance – with the one-off 20% reduction in price per unit creating a 71% fall in the company valuation against the Business-as-usual valuation of $53bn. A 20% reduction in sales volume has much less relative impact, creating a fall in value of 18% against business-as-usual. As such, climate change drivers of value do not appear as strategically significant to company values as potential shifts in sales prices, driven by market positioning and product portfolios. This is summarised in Chart 32.

Chart 32 *Significance of the climate change-related shareholder value-at-risk compared with other factors*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: This chart presents the value-at-risk to a business-as-usual focussed company from a series of non-climate change-related events or assumptions and compares this to the range of value-at-risk identified for a business-as-usual focussed company that fails to adapt to the transition to a low carbon economy across a range of scenarios.

Implications for investors

Investors should look for the features of companies with potential to perform best in the face of climate change pressures. Key features include:

- Resilience to cost increases, including a commodities hedging strategy or the potential for efficiency gains which can offset cost increases.
- Better strategic positioning to withstand cost increases, including a greater proportion of higher margin premium brands (with higher price pass-through potential), or vertically integrating with hops and barley producers.
- Innovative approach to packaging which would ensure a player is better placed in the event of a sudden change in packaging requirements. This could include experience in new packaging types or a collaborative relationship with the packaging supply chain.
- Potential to capture value either with low carbon brands which may provide premium positioning, or through R&D in production and sourcing (e.g. drought-resistant crops).

Investors should monitor key industry triggers of potential volatility in input costs, such as:

- Demand for biofuels, including legislation that may mandate a greater share of biofuels in transport. The intent to legislate stricter packaging regulation.
- Consumer uptake of low carbon or carbon neutral beers.
- Further evidence of potential adverse effects on crop raw materials shortages arising from physical climate change.

In addition, investors should take account of the increasing risk of volatility arising from the physical impacts of climate change on weather patterns, which will be uncertain and have the potential for significant impact on both costs and revenues.

There is also a possibility for investment opportunities on the periphery of the brewing industry which may be more sensitive to climate change. These could include:

- Input suppliers with geographically diverse supply sources or access to patentable seed research.
- Packaging specialists with a lead in low carbon packaging (e.g. plastics over glass, increasing recycling of glass bottles or biodegradable plastics).

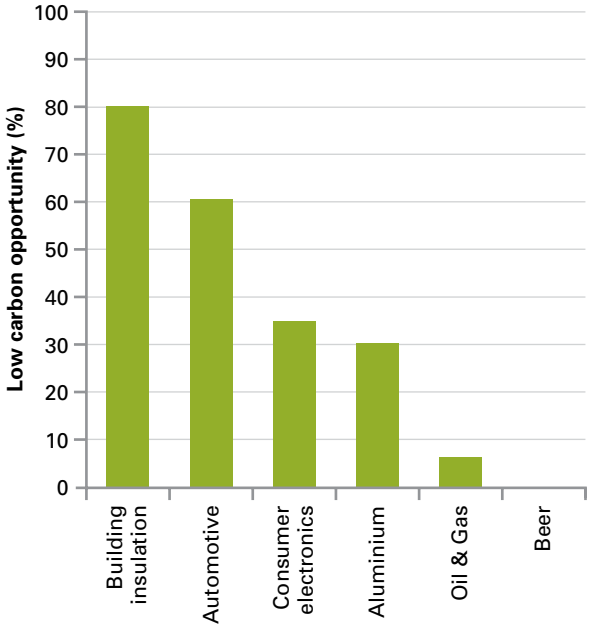
Summary and insights from analysis of value-at-risk and opportunity in six sectors

The transition to a low carbon economy threatens significant value-at-risk but also offers significant opportunities. This will cause periods of transformation for companies in some key sectors with increased winners and losers and greater volatility of earnings.

The transition to a low carbon economy threatens significant value-at-risk but also offers significant opportunity

Our analysis of winners and losers suggests significant upside potential for companies that prepare well (illustrated in Chart 33). Companies in Building insulation demonstrate the greatest opportunity – up to 80% gain in value, with significant opportunities in Automotive (60%), Consumer electronics (35%) and Aluminium (30%).

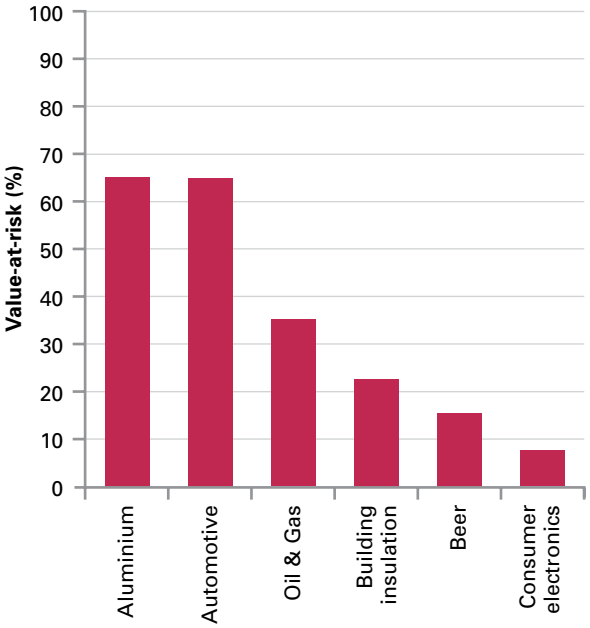
Chart 33 *Calculated maximum value creation opportunities for companies in this report*



Source: Carbon Trust and McKinsey & Co. analysis.

Typical companies prepared for business-as-usual in six sectors and not well prepared for the transition to a low carbon economy face significant value-at-risk (illustrated in Chart 34). This ranges from a limited risk of only 5% in Consumer electronics through to a potential risk of up to 65% in each of Automotive and Aluminium, depending on the scenario analysed.

Chart 34 *Calculated maximum value-at-risk for companies in this report*



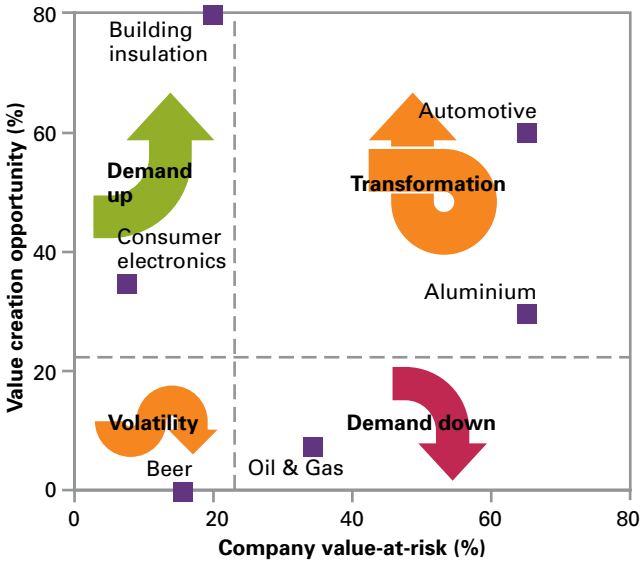
Source: Carbon Trust and McKinsey & Co. analysis.

Four different categories of sector impact from tackling climate change

We observed four different categories of industry sector arising from the impact of climate change pressures (illustrated in Chart 35):

1. **Transformation:** for some sectors, the pressure of tackling climate change unleashes considerable competitive forces as companies jostle for position in the new dynamic. Companies are pressured by high value-at-risk, but also have the opportunity to create considerable value. Whilst the industry overall will probably manage average returns, there could be significant divergence between winners and losers, with some players making abnormally large gains or losses depending on how well they have adapted to the transition to a low carbon economy. Automotive and Aluminium are examples.

Chart 35 *Calculated value creation opportunities and transition value-at-risk for companies in this report*



Source: Carbon Trust and McKinsey & Co. analysis.

Note: Analysis based on discounted cash flow valuations of hypothetical but typical companies in sectors. The points represent the greatest risks and opportunities seen across the scenarios studied.

2. **Downward demand shift:** the value-at-risk is significant and reflects a downward change in the long-term volume in the industry. However, the upside value opportunities within the same business area are low. Oil & Gas is an example.
3. **Upward demand shift:** the value-at-risk is low, but there is considerable upside value opportunity based on capturing an increase in volume for the sector as a whole. Buildings insulation and Consumer electronics are examples.
4. **Volatility:** the value-at-risk and opportunity are relatively low, reflecting only a modest likelihood of significant long-term impact. However, short-term cost impacts or demand changes could cause volatility in performance. Beer is an example.

Climate change is a key strategic issue in most industries

Using the same cash flow models and analysis, we compared our climate change scenario value-at-risk to a number of other scenarios concerning a significant strategic issue in the industry. In all sectors except Beer, the value-at-risk from climate change was of a similar order of magnitude to other significant issues. For example, in Automotive, the climate change-related value-at-risk is comparable to a sustained 10% cost disadvantage or a 5% pricing disadvantage. In Aluminium, the climate change-related value-at-risk is greater than a 20% increase in average energy costs without any increase in price. Within Oil & Gas, the climate change-related value-at-risk for refiners can be greater than a 10% reduction in gross margins on the refining of crude (the 'crack spread'). Tackling climate change is of a similar order of magnitude to other key strategic issues for these industries to address.

Industries will face different periods of 'creative destruction'

Our analysis of long-term cash flows identifies that different industries will undergo periods of particularly high cash flow pressure at different times. It is in these periods that different players will experience the greatest value-at-risk and there will be the greatest differential between winners and losers. These will represent periods of 'creative destruction' when new competitors create value whilst some players fail to create value and lose.

The timing of the effect differs by industry sector. Some industries are more likely to be affected in the short term, for example Beer, where biofuels requirements are already affecting food crop prices. Others are more likely affected in the medium term (5-10 years) where regulations are taking shape but may take time to bite – Aluminium (imposed cost per tonne carbon emitted) and Automotive (reductions in per vehicle emissions) are examples. Oil & Gas is more likely to be affected only in the long term, as the reduction in demand eventually affects cash flows from around 2015-2020 onwards.

Differential access to technology or capital can be critical

A technology or capital advantage can make a key difference to overall performance in the transition to a low carbon economy. For example, in Automotive, a lead in the manufacture of electric or plug-in vehicles could give a significant market share growth advantage. In Aluminium, above average access to superior low carbon capital investments, such as captive renewable electricity generation (e.g. hydro) should yield increased margins and an ability to expand operations, subject to energy supply capacity.

The greatest value-at-risk and opportunity may be in niche parts of the value chain of major industry sectors

In each industry that we studied, we reviewed the value chain of activities across the entire industry. In many cases, we realised that the most significant effect of climate change-related drivers of value might fall on particular components of the value chain in certain circumstances. Meanwhile significant industry players who typically purchase from smaller entities in the value chain are somewhat insulated from the effects of climate change, given their role in leading the industry and taking materials and components to manufacture the final product. Some examples to illustrate the point include:

- **Automotive:** manufacturers of battery technology have the greatest potential upside in the move to electric vehicles, meanwhile those manufacturing outmoded internal combustion engine parts might suffer disproportionately.
- **Consumer electronics:** manufacturers of key components which significantly govern power requirements, for example standby function or power pack manufacturers, could win or lose the most from a change of legislation.
- **Beer:** packaging companies may be most at risk (and have greatest opportunity, depending on technology and specialism) from a sudden shift in packaging requirements.
- **Aluminium:** recycling collectors may obtain increased margin from demand by recycling plants which may be operating to a mandate to use a certain proportion of recycled material.

Investors looking for significant value-shift opportunities may find some of the best opportunities amongst more specialist, niche players at key points in the value chain.

Companies that prepare can gain value and will avoid risk

Across each of the sectors where there is high value-at-risk or opportunity, our analysis demonstrates that the risks can be almost entirely mitigated with sufficient preparation, whilst opportunities can be seized more readily. For example, Auto companies that prepare well can avoid some of the high costs of implementing new power trains such as the hybrid or electric engine. If E&P and refining companies can anticipate demand correctly and plan capital expenditure accordingly, it is possible to avoid most of the value-at-risk. Aluminium smelters can similarly seek to reduce emissions by switching to lower carbon power supplies and investing in recycling. Consumer electronics and Buildings insulation companies can similarly plan to capture the upside growth.

However, in each case, business needs to be given sufficient warning of the change to come. Less warning of change and more abrupt changes in policy will almost certainly put more value-at-risk. This could be compounded by the inability of policy makers to afford to make any concessions to players in the transition. For policy makers, this means giving clear indications of not only the level of policy ambition but also the nature of policy frameworks and the timetable for introduction. We discuss this further in the Implications section.

Policy makers will significantly determine the nature of the transition

Regulation, technology and consumer behaviour are the key drivers of change in any industry. However, whilst the drivers are interrelated, typically the dominant driver in most scenarios is likely to be regulation, which often has not only a direct effect on an industry in terms of cost or relative competitiveness, but which also tends to be the root cause of stimulating increased technology innovation and/or changes in consumer behaviour.

For example, in Automotive, regulations to either raise the cost of fuel (e.g. via a cost of carbon or other taxes) and requiring certain maximum emissions per fleet vehicle sold will tend to drive new technological innovation, and also shift consumers towards preferring more efficient, lower fuel consumption vehicles.

The choice of policy framework and implementation detail is critical to value

Whilst much of the focus of the commentary on climate change concerns the level of ambition of emissions cuts, the mechanism by which such cuts is achieved is probably more important. We identified the following ways in which policy makers determine value-at-risk:

The nature of 'Targeted regulations' can be critical to value-at-risk and value creation opportunity: often an imposed cost of carbon will not provide sufficient incentive to achieve the behavioural change required. To overcome the barriers and achieve rapid change to reduce emissions, it may be necessary to use specific regulations to incentivise or mandate change. However, such regulations can have significant effects on industry economics. For example, we lay out the potential difference in value-at-risk and opportunity for the Auto industry, comparing the difference between a specific regulatory preference for hybrid vehicles and a programme of required per vehicle emissions cuts which stimulates either a breakthrough in electric vehicle technology or biofuels. Based on our scenario assumptions, a specific push for implementation of hybrid technology is assumed to prove costly for industry players, whilst achieving little more than the potential for improvements to the internal combustion engine combined with biofuels (note – this may not be the case in reality). Meanwhile, a push for technological innovation in electric vehicle technology could lead to much greater industry emissions reduction. It would also probably lead to a greater diversity of winners and losers depending on which companies achieved an advantage through the breakthrough.

Asymmetry of carbon price can cause significant value-at-risk: the level of value-at-risk and opportunity in different industries can be critically driven by regional differences in the applicable cost of carbon. We demonstrate this effect in our refining and Aluminium analyses. In each case, we assume that the global commodity price is set by a player in a non-OECD region which does not bear a cost of carbon. OECD companies then face margin reduction equivalent to the applicable cost of carbon, if unregulated foreign imports can access their markets without a border adjustment for the cost of carbon. Over time, the difference between OECD and non-OECD market costs of carbon should be eroded. As soon as all players face the same cost of carbon, prices will be set by the highest cost player and those with lower carbon intensity can actually profit at the margin to the extent of their lower carbon footprint. Policy makers must address this regulatory differential in order to avoid the unintended consequence of 'leakage' in which domestic production is unable to compete with foreign imports and is forced to make way for potentially higher carbon, but unregulated, foreign imports.

Regulatory concessions can reduce value-at-risk: policy makers can mitigate value-at-risk for industry players from climate change policy by making certain concessions. For example, in the EU Emissions Trading Scheme, the issue of free allocations of emissions allowances reduces the net value-at-risk to players. However, these concessions raise a key regulatory tension as they tend to slow the pace of change by giving business the required subsidy to continue higher carbon operations. It also causes the government to bear the cost of the value-at-risk which could become unsustainable in future, if very rapid change in capital stock is required. This points to the need for policy makers to make changes early, so that a smoother, lower value-at-risk transition can be made in which some concessions to existing players can be afforded.

Implications of climate change value creation opportunity and risk analysis

Tackling climate change could cause significant shifts in value. Our findings have significance for investors – both shorter horizon and long-term investors, for companies themselves and for policy makers.

Shorter horizon (0-3 year) 'stock picking' asset managers

We define these investors as seeking to invest in outperforming companies, looking for positive returns over a 1-3 year period. There are two key components of an investment strategy based on the climate change challenge in the short term:

- Invest in companies likely to outperform (and avoid underperformance) over the short term due to climate change drivers.
- Invest in companies likely to outperform significantly (and avoid underperformance) over the long term and where the drivers of superior long-term performance are likely to be recognised in the short term by the wider market. The extent of recognition of a change in long-term prospects will depend on the evolution of market 'triggers' which enable the market to form a new consensus on the operating environment of different companies.

Short-term drivers of change to watch for:

- **Regulation:** there are a number of sectors which may be affected by new climate change-related regulations in the near term, for example Automotive (e.g. proposed EU regulations in 2012, imposing fines calculated to have a potential of up to $13,000 per vehicle for failure to comply with average fleet emissions requirements) or the inclusion of the Aluminium industry in cap and trade schemes in different regions of the world.
- **Technology:** breakthroughs in the consumer electronics sector could enable a rise in short-term sales of devices which meet a desire for lower personal carbon footprints, for example small business/consumer-friendly video-conferencing devices, or home control systems which manage energy efficiency. Similarly, breakthroughs in thin insulation could transform sales of higher value-add buildings insulation.
- **Consumption:** consumers may continue to move away from certain higher carbon products, affecting revenues. For example, a shift to smaller, more efficient vehicles could continue to reduce average margins in the Automotive industry above analyst consensus rates, but favour smaller car manufacturers. A wave of popularity for low carbon food products could give low carbon beers a boost.

Potential triggers of a new consensus on long-term prospects include:

- **A new 'Global Deal':** the next 1-2 years will be a crucial period for international negotiations on climate change. The much anticipated UNFCCC Conference of the Parties in Copenhagen in December 2009 could herald a new 'Global Deal' on climate change as a successor to the Kyoto Protocol. This would set the overall level of ambition and global framework for policies tackling climate change. It should enable the range of scenarios to be narrowed and may cause a market correction in terms of ambition of policy across sectors to tackle climate change.
- **Regional/national regulatory developments:** there are ongoing efforts in many regions to put in place framework legislation by which to regulate industries – examples include the potential introduction of cap and trade systems in the US, Australia and New Zealand and new building efficiency legislation in Europe, the US, China and the Middle East.
- **Technology developments:** significant breakthroughs in renewable energy supply or improved demand efficiency could have an effect on the overall shape of a low carbon economy and the performance of different sectors. For example, a successful pilot of Carbon Capture and Storage could improve the prospects of coal-powered electricity generation and reduce the demand for coal-gas switching, reducing gas demand overall. Low-cost solar technology would improve the prospects for locally generated electricity to power plug-in electric vehicles. Similarly, breakthroughs in low carbon second generation biofuels would ease some of the pressure to improve vehicle fuel efficiency and the switch to electric vehicles.

For both short-term and long-term trends, the next five years are likely to prove a period of rapid change in our understanding of how to tackle climate change. As news flow unfolds, this will likely cause significant increased volatility in sensitive sectors as markets seek to re-adjust to a new consensus of the impact on value. Those investors that have a deep intrinsic understanding of the drivers of value should be able to profit from these opportunities.

Longer term (5-10+ year) 'universal' asset managers

We define long-term 'universal' investors as typically holding positions across many sectors in most of the largest companies sometimes with little variance in the portfolio over 5-10 years or more. Large parts of the shareholding might track an index of the entire market rather than being actively managed. Investors' key concern is to manage the risk-weighted return of the entire portfolio over the long term.

In the light of this report, the key implications for long-term investors are as follows:

- **Review portfolio risk/return profiles:** the risk/return profile of different sectors will likely change in the light of the transition to a low carbon economy. In several sectors (e.g. Automotive, Aluminium, potentially Oil & Gas) we anticipate higher volatility as the market adjusts to new regulations, technology and consumer shifts. In addition, certain sectors look likely on average to gain more from climate change, for example Building insulation looks likely to gain from an upwards shift in demand or Consumer electronics could gain in certain circumstances. Meanwhile Oil & Gas in core operations could suffer an overall reduction in long-term demand. Other more carbon (energy) intensive industries may suffer in the consumption scenario. This may require some readjustment in the balance of equities within a long term portfolio.
- **Become more active in managing investments:** the pressure created by the shift to a low carbon economy will unleash a greater 'creative destruction' effect in which new, low carbon technologies succeed in growing value at the expense of a value-shift away from incumbent higher carbon businesses. A portfolio substantially weighted to the large cap companies of today is likely to be relatively underweight in the new, upcoming smaller companies of the future. Greater exposure to a range of companies which may perform well at the relative expense of other companies will be important to achieving superior returns from a climate change perspective. This requires a more active approach to portfolio management and may require a shift away from indexed funds and towards greater smaller, private equities type investments.
- **Increase shareholder dialogue and activism:** long-term universal owners are increasingly discovering the role that they can play as owners in challenging companies to plan and invest for the long term, not only to seek reward for the short term. The move to a low carbon economy is well suited to such a dialogue. However, investors need to define the types of questions worth asking of companies and build expertise in judging whether or not companies are responding in meaningful ways.
- **Increase dialogue with policy makers:** policy makers will need to more actively influence economic activity in order to succeed in tackling climate change. This will increase the risk of regulatory interference in markets and increased dialogue will assist in understanding this risk. In similar fashion, long-term universal owners' perspective should be well aligned with the long-term societal aims of policy makers. As asset holders gain an increasing understanding of the drivers of value relating to the climate change challenge, they should be capable of increasingly contributing to the debate with policy makers to find optimal policy approaches which can succeed in both tackling climate change, and also in preserving and creating shareholder value.

Market and sector analysts

Analysts in all sectors need to understand the consequences of climate change and the appropriate action in terms of valuation. We recommend the following:

- **Develop a comprehensive framework for appraising climate change risk and reward:** analysts should apply a comprehensive framework to consider from all angles the potential impact on value of the move to a low carbon economy. The framework described in this report is just one way of addressing the key questions and identifying the issues.
- **Test the impact on valuation via scenarios:** given present uncertainty as to how the global economy will tackle climate change, it is important to run a number of scenarios to test the implications of climate change. Major advisory establishments and asset managers should form their own 'house' views on alternative evolutions of the move to a low carbon economy and the likely impact on value, and regularly test these against expert opinion.
- **Appraise companies' climate change strategies:** our analysis has shown that there is considerable scope for differential performance as companies adapt to the climate change challenge. As this could be one of the key strategic drivers of company value, analysts will need to assess how a company's core strategy has adapted to meet this challenge, as well as understanding the more business-as-usual competitive pressures faced.
- **Watch for short-term 'triggers' of a new market perspective on climate change:** having identified potential value-at-risk it is then necessary to watch for triggers of a change in value by monitoring developments in the key areas of regulation, technology and consumer behaviour. Given the holistic nature of the issue, the key areas to watch may be outside the sector of concern – for example breakthroughs in battery technology may be key to the development of the electric vehicle; similarly, improved vehicle efficiency and a move to electric vehicles may be key to the long-term level of demand for oil.

Pension trustees

Pension trustees are ultimately responsible for the long-term performance of the funds under their care. Given the potential for a significant long-term impact on fund performance, pension trustees should increasingly scrutinise investment advice and services from a climate change perspective. This includes:

- **Request briefings from investment managers** of their understanding of the short, medium and long-term implications of climate change on fund value, including 'what-if' type and scenario analyses on potential shifts of valuations within or between sectors.
- **Instruct investment consultants** to give a full briefing on the consequences of climate change including: a) the implications for fund value over the short, medium and long term; b) whether current mandates are under or over exposed to climate change risks; c) a benchmarking of fund managers' capabilities in understanding the impact of climate change for fund valuations.
- **Build an engagement plan** with both companies and policy makers to ensure that long-term strategies and policy are put in place with sufficient lead-time to enable a smooth transition to a low carbon economy.

Investment consultants and actuaries

As advisers to long-term asset managers such as pension trustees, investment consultants and actuaries need to be able to respond to the key issues arising from the impact of climate change on shareholder value. Key responses could include the following:

- Create scenarios for the transition to a low carbon economy and determine the implications for macro-performance of different sectors.
- Review the long-term risk/reward profile of industry sectors in the light of value-at-risk/stake analysis.
- Benchmark fund manager capability to manage risks and rewards attributable to climate change as a key investment theme and advise pension trustees on the best choice of mandates.

Companies

Companies are themselves investors in new R&D and capital equipment and need to make these investment decisions in the light of the climate change challenge in the interests of the long-term future of the company. Similar to investors, companies need to ensure they have a thorough understanding of the risks and opportunities from a climate change perspective. We recommend the following:

- **Develop a detailed understanding of the strategic issues arising from the climate change challenge:** every company will need to be able to respond to investor concern over the impact of climate change on the company's prospects. The framework described in this report is one way of identifying the key issues applicable to an industry player from climate change.
- **Create different scenarios for the industry in the light of climate change:** the scenarios in this report are just one view of how the global economy may adjust in the light of the climate change challenge. Companies should take both a global view and then a more detailed industry view to identify the range of different outcomes and the key drivers of change. These should be regularly tested with emerging expert views on how to tackle climate change.
- **Ensure corporate strategy is robust from a climate change perspective:** where tackling climate change may have a significant effect on company value, it is necessary to then have a strategy that is well placed to capture the opportunities and mitigate the threats arising. Key features of such a strategy are likely to include:
  - Ensuring at least minimum compliance with any regulations affecting the industry, and seeking to future-proof against further regulatory developments, for example compliance with emerging power consumption requirements for Consumer electronics players.
  - Implementing 'no regrets' moves – for example improving the efficiency of operations and of products where such changes require little or no investment but which reduce energy costs.
  - Developing strategic flexibility to the evolution of different approaches to tackling climate change, including building a portfolio of options and 'hedges'. Examples could include an Auto player having access to emerging technologies in electric or hydrogen vehicles; Oil & Gas players developing interests in new business ventures connected to carbon capture and storage or renewable energy.
  - Improving reputation for leadership on climate change, through developing innovative products and services and contributing to the public debate on how to tackle climate change.
- **Increasing policy and regulatory engagement:** as regulation will be the key driver of change in many industries, companies should increase their dialogue with policy makers and regulators to ensure optimal regulation which succeeds in both tackling climate change and in preserving and creating shareholder value. This may require a change in stance for industry players, from a more adversarial approach to new regulations and a preference for industry self-regulation to working constructively to find the optimal regulatory framework which can give public assurance of a commitment to tackling climate change and preserve and create shareholder value.
- **Increase investor relations communication on climate change:** companies will increasingly need to invest in new R&D and capital expenditure to tackle climate change. This will require increased dialogue with investors to explain the long-term benefits of such investments.

Public policy makers

Public policy makers (including regulators) will need to take an increasingly active approach in order to tackle climate change, which we have shown could have large effects for the economy. Our study of the value-at-risk for shareholders gives some steers to the approach of public policy in order to optimise both successfully tackling climate change and creating and preserving shareholder value:

- **Develop a long-term vision of climate change policy:** the level of uncertainty over both the level of ambition and likely approach of policy to tackle climate change has limited the incentive for companies (and investors) to focus on climate change as a major driver of value. Setting a long-term vision of the level of ambition for emissions reduction and also the types of policy frameworks (for example, use of cap and trade, or support for technologies) is vital to giving the certainty required to react early to climate change.

- **Maintain consistency of policy:** companies and investors are able to contribute most to policy aims in a predictable, stable policy environment. Advanced warning of new policies and stable, long-lasting policy frameworks enable companies to react with confidence by investing for the future. For example, if Auto companies know the likely long-term emissions profile of vehicle fleet efficiency over the next 10-20 years, this assists greatly in making the necessary R&D investment in product development. It also gives the greatest opportunity to all players to adapt to change and reduces any likely push-back by industry against regulations which might create short-term winners and losers.
- **Understand the value impact of alternative regulations:** policy makers need to appraise the impact on value of different measures to understand the effect of regulation on companies and investors. In principle, they should choose the policy that is most likely both to achieve the goal of tackling climate change and to preserve and create shareholder value. Frequently, encouraging the development of new technology will create the most value for society, although it will often create a greater disparity of winners and losers.
- **Beware unintended consequences of regulations:** conducting a value impact assessment of proposed policy enables an analysis of underlying economics. This should help to identify unintended consequences. For example, a failure to tackle 'leakage' in a cap and trade system such as the EU ETS can lead to higher carbon intensity foreign imports from unregulated regions flourishing at the expense of the lower carbon indigenous production. Targeted regulations may impose additional costs without delivering carbon savings or meeting with consumer approval. In one of our Auto industry scenarios, significant value is at risk from a requirement to produce hybrid cars, whereas under our assumptions the introduction of electric vehicles combined with improvements in the standard internal combustion engine are a lower cost solution. On the other hand, strong regulation to improve consumer electronic products' power efficiency looks appropriate, being low cost and yet having significant impact.
- **Activate consumers:** policies which encourage consumers to purchase in a 'green' fashion are likely to assist positively in the move to a low carbon economy by ensuring consumers recognise and reward lower carbon products and services. For example, this should help auto companies achieve price pass through on more efficient vehicle features or stimulate the purchase of increasing quantities of Building insulation.

Policy makers, investors and business should collaborate to ensure an efficient transition

This report highlights the importance of the climate change challenge to a number of major industries. It highlights the significant value-at-risk and value creation opportunity for different companies. These depend significantly on the level of preparation of companies for the changes ahead. We identify that regulation will primarily drive the move to a low carbon economy. Policy makers have the significant responsibility to find the optimal regulatory path that minimises value-at-risk whilst maximising opportunities. This requires early leadership from policy makers and carefully crafted policy.

This is a significant challenge. The policy makers' task is complicated by the broad nature of the climate change challenge. Frequently the industries affected are global in nature. Policy must be coordinated so as to sustain global trade. Change is also required across a diverse range of activities, including buildings, transport, commodities and industry production. The efforts to reduce emissions in one industry group will affect the extent of change required by another. This requires a coordinated approach across sectors and geographies.

To successfully and rapidly design a broad sweep of policy across multiple sectors and geographies will require significant interaction and openness between policy makers, investors and industry representatives at national, regional and international levels. This will require a new platform for policy development. In pursuit of its mission to accelerate the transition to a low carbon economy, the Carbon Trust is committed to catalysing the interaction of governments and business at all levels to achieve a smooth transition to a low carbon economy.

Appendix 1: Further detail on the Carbon Trust 2050 scenarios

Carbon markets scenario

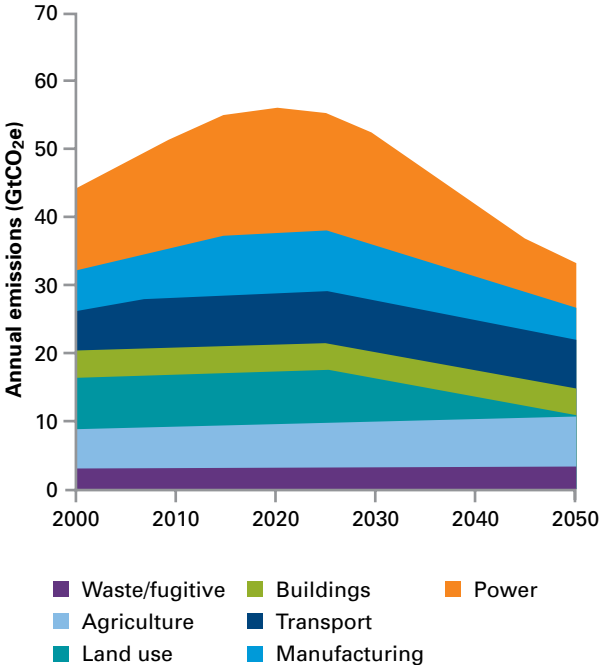
A cost of carbon on emissions applies across most of the economy (either via a cap and trade system or a carbon tax) which provides a broad economic incentive to reduce emissions in most sectors, although it will have differential effects depending on price sensitivity and opportunity for abatement. Key features of this scenario include:

- Most investment is in the deployment of existing available technology with more reductions from the power and industry sectors due to their higher price sensitivity and ready opportunities to abate than the buildings, transport or agriculture sectors.
- Some new technologies struggle to compete on a level playing field with other, existing lower carbon technologies without additional incentives.
- There is large differentiation between returns from high and low carbon intensity competitors. Players with existing capital delivering below average carbon intensity operations will make abnormally high returns on capital, whilst those with higher than average carbon intensity operations will tend to be adversely affected.

Typical news flow for this scenario that should be of concern to investors includes:

- National or regional announcements of policy frameworks which include the setting up of carbon markets, typically on a cap and trade basis or, potentially, based on a carbon tax.
- International agreements which herald the widening of scope of carbon markets, for example by linking cap and trade schemes.
- Changes to caps on carbon emissions for example due to the evolving understanding of the science of climate change.

Chart 36 *Evolution of emissions by major industrial category for Carbon markets scenario*



Source: Carbon Trust and Oxera analysis.

Targeted regulation scenario

In this scenario, the key driver is the use of specific targeted policy instruments which are typically designed to encourage the deployment of new capital based on known available and existing technologies. Regulation is specifically designed to avoid giving more than the minimum incentive to achieve change and seeks to avoid any reward for existing capital deployed, but may seek to accelerate the demise of capital that does not meet specific standards. Examples of types of regulation falling into this category include:

- Feed-in tariffs and renewable energy quotas.
- Fuel economy standards or lower speed limits.
- Minimum emissions standards/energy efficiency for plant and machinery.

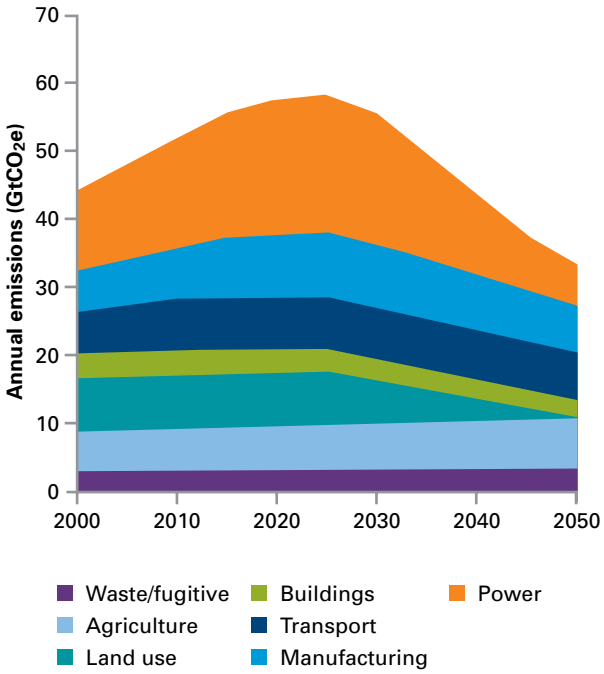
The typical results of such regulations could include:

- Rapid deployment of existing technologies which may deliver more short-term reductions from the power sector, buildings and transport.
- Investment opportunities potentially difficult to identify because of the need to anticipate both winning technologies and attractive regulatory environments.
- Risk of low returns on existing capital in high carbon sectors, even for low carbon companies.

Typical news flow for this scenario of concern to investors includes:

- Announcements that market failures in particular sectors will be tackled by specific measures, for example the prohibition of sale of certain types of high energy light bulb.
- Announcements of new initiatives and policies designed to promote certain technologies, e.g. lower vehicle excise duty for hybrid cars.
- Reductions in global commodity and carbon prices as targeted instruments shift demand away from fossil fuel and carbon-intensive technologies.

Chart 37 *Evolution of emissions by major industrial category for Targeted regulation scenario*



Source: Carbon Trust and Oxera analysis.

Technology scenario

In this scenario, climate change is tackled through the deployment of new technology, including some key breakthroughs in low carbon technology such as electric vehicles or cheap forms of renewable power, for example, solar or marine. Whilst this involves some lucky breaks in research, the policy environment is designed to encourage technology innovation. Key features of policy include:

- Capital grants and subsidies for the deployment of new technologies which are not yet cost effective.
- Government budget allocations for R&D on low carbon innovative technologies.
- Public/private partnerships for R&D of new technology.

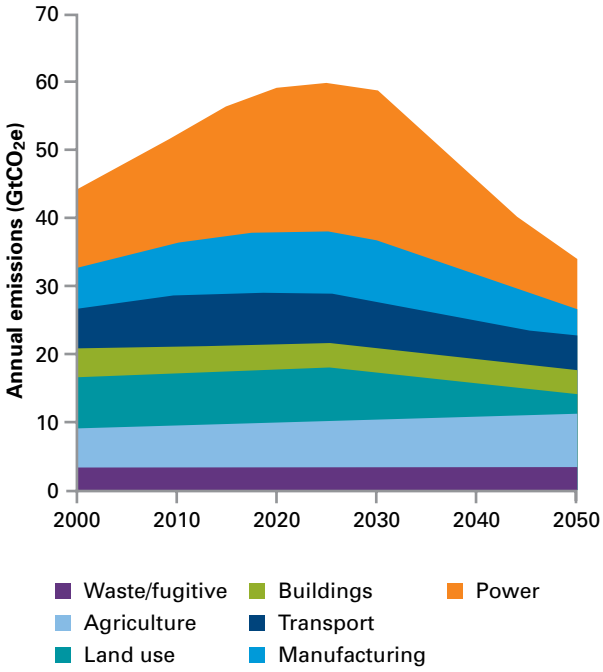
Key features of this environment include:

- Significant reductions achieved in the transport sector, together with new low carbon power generation such as solar or marine.
- Higher deployment of technology reduces pressure for such rapid reductions in difficult areas such as land-use change.
- Reductions in emissions are likely to occur later than in Carbon markets or Targeted instruments scenarios, given the time for new technology adoption.
- The risks may initially appear more benign for high carbon companies in the near term, but there is a risk of a collapse in value later following breakthroughs in technology.

Typical news flow for this scenario of concern to investors includes:

- Government announcements of tax breaks for R&D in low carbon technologies.
- Greater intellectual property right protection.
- Major government-backed research initiatives, potentially with an international partnership perspective or involving public/private partnerships.

Chart 38 *Evolution of emissions by major industrial category for Technology scenario*



Source: Carbon Trust and Oxera analysis.

Consumption scenario

In this scenario, consumers become a significant force in the move to a low carbon economy, amending their consumption to reduce their personal carbon footprint. Demand shifts to product and service categories more compatible with a low carbon economy, for example increasingly preferring entertainment to (physical) goods or telecommunications rather than physical travel.

The conditions for such a change could be in part reflective of a shift in societal concerns, perhaps triggered by a natural disaster. Government policy can also play a role in shifting perception, focussing on mechanisms to shift behaviour. Key features of this environment could include:

- Campaigns on the threat of climate change and potential for consumers to make a difference.
- Increased product labelling of emissions to enable consumer choice.
- Financial penalties on high carbon goods and services, for example a carbon 'super tax' on high emission vehicles or flights.

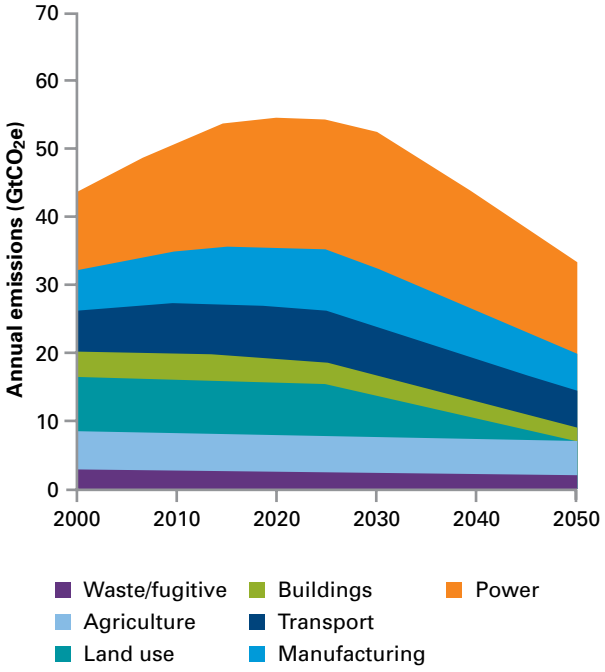
Key features of the environment for investors include:

- Reductions in emissions focused in the transport sector and in manufacturing and services prompting less need for zero carbon power generation.
- Changes in demand for goods based on their perceived carbon content or use characteristics.
- Significant expenditure by companies on marketing and communicating the low carbon features of their products.

Typical news flow for this scenario of concern to investors includes:

- Increased awareness and leadership by societal leaders of the threat posed by climate change.
- Government awareness campaigns to shift behaviour.
- Announcements of mandatory product labelling standards.

Chart 39 *Evolution of emissions by major industrial category for Consumption scenario*



Source: Carbon Trust and Oxera analysis.

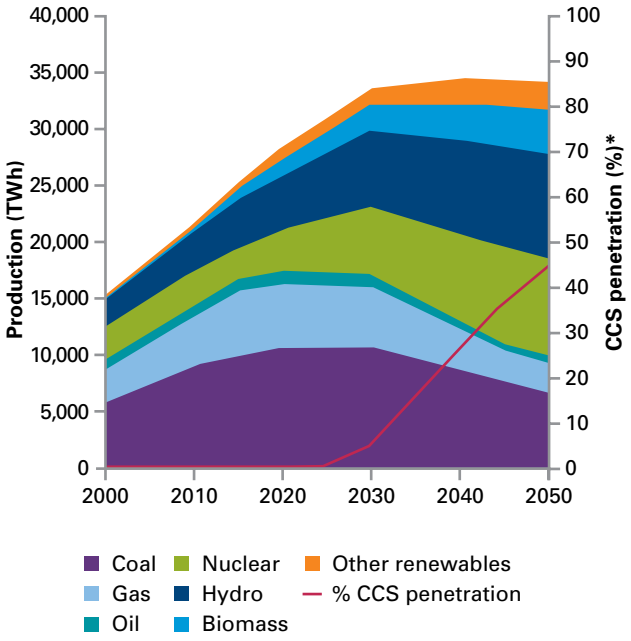
Transition paths for the power sector

Carbon markets

Across the scenarios, global electricity demand doubles in the next 20 years, then stabilises or falls

- A high carbon price alters the relative profitability of fuels.
- Initially new generating capacity uses more gas than coal.
- Fossil fuel usage peaks in 2020, then falls as large scale nuclear, hydro and biomass investments start to operate.
- Even without targeted subsidies, it becomes cost-effective to fit carbon capture and storage on some new fossil fuel installations.
- Without targeted subsidies, new forms of renewable energy (e.g. solar, wind, marine) do not achieve significant penetration.

Chart 40 *Evolution of power generation by type (Carbon markets scenario)*



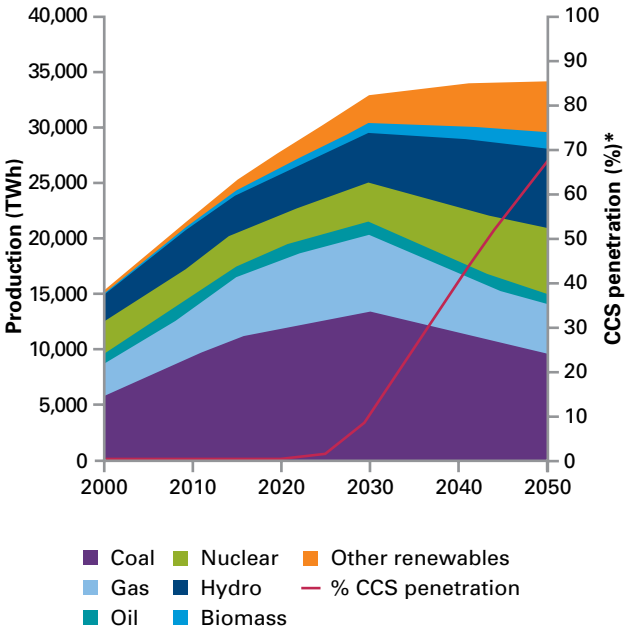
Source: Carbon Trust and Oxera analysis.

* CCS penetration defined as the percentage of fossil fuel generated power using carbon capture and storage.

Targeted regulation

- Government intervention via targeted regulations promotes particular fuel types, including strong carbon capture and storage.
- Countries with access to cheap fossil fuels use carbon capture and storage, retrofitted to existing plants where required.
- Other countries move strongly towards nuclear or hydro depending on availability of resource.
- Renewable energy becomes significant as a result of targeted regulations.

Chart 41 *Evolution of power generation by type (Targeted regulation scenario)*



Source: Carbon Trust and Oxera analysis.

* CCS penetration defined as the percentage of fossil fuel generated power using carbon capture and storage.

Technology

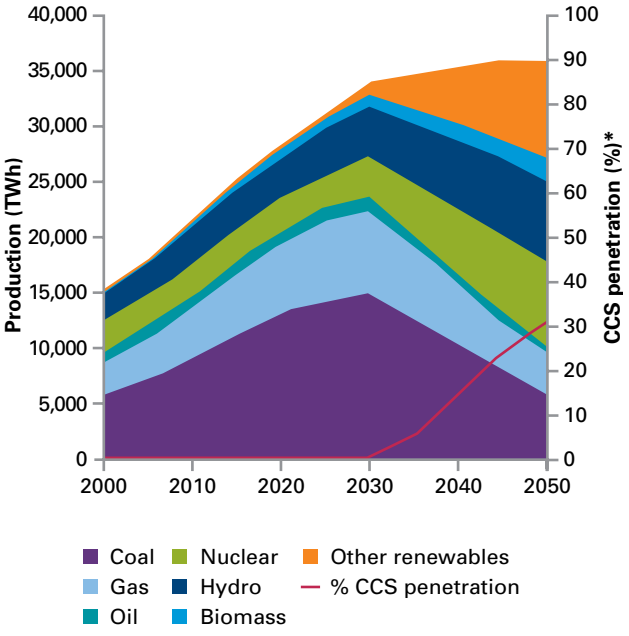
- Prior to 2030, there is little change in the overall mix of fuels.
- A breakthrough in renewable energy (e.g. solar-electric or marine) triggers a surge in its deployment from around 2030.
- The technology breakthrough causes a more rapid decline in fossil fuel use, especially coal.
- Carbon capture and storage achieves lower penetration due to widespread renewable energy.

Consumption

- Technology fails to deliver a major breakthrough either in carbon capture and storage or significant renewable energy sources.
- Electricity generation continues to rely on fossil fuels which focus increasingly on gas to reduce carbon intensity.
- Hydro electricity and conventional renewable sources (e.g. wind) provide a reasonable contribution to low carbon power generation.
- Shifts in consumer behaviour eventually cause electricity demand to fall in order to meet reductions in emissions.

Across the scenarios, global electricity demand doubles in the next 20 years, then stabilises or falls

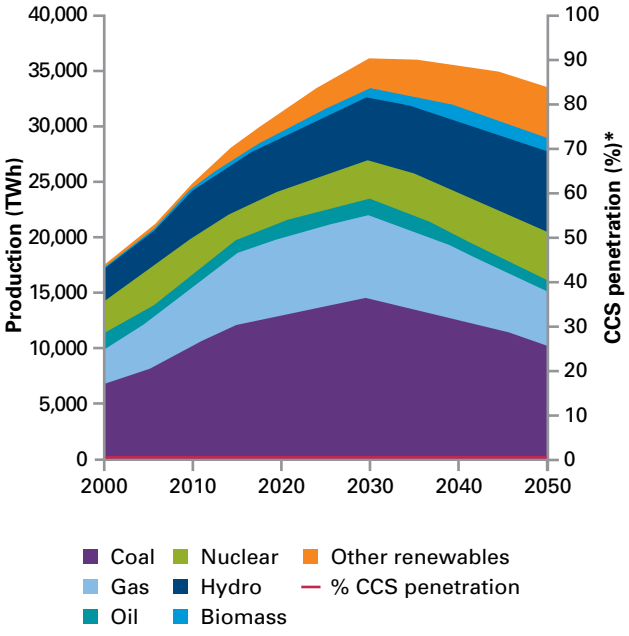
Chart 42 *Evolution of power generation by type (Technology scenario)*



Source: Carbon Trust and Oxera analysis.

* CCS penetration defined as the percentage of fossil fuel generated power using carbon capture and storage.

Chart 43 *Evolution of power generation by type (Consumption scenario)*



Source: Carbon Trust and Oxera analysis.

* CCS penetration defined as the percentage of fossil fuel generated power using carbon capture and storage.

Transition paths for the transport sector

Carbon markets

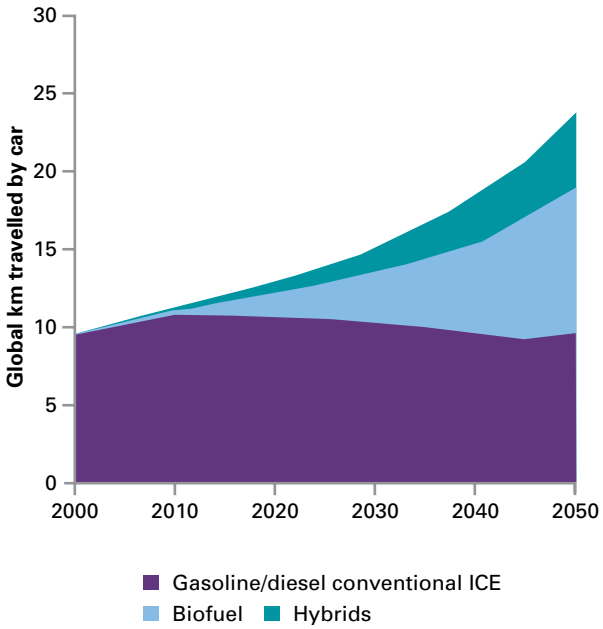
Targeted regulation

Across the scenarios, car ownership grows and conventional internal combustion engines become twice as efficient

- Carbon prices and associated high fuel costs are enough to drive incremental change to more efficient engines and to some hybrid cars.
- The high cost of carbon encourages greater deployment of second generation biofuels which deliver carbon and cost savings over conventional oil.
- The relatively weak regulatory environment does not drive significant innovation in electric vehicles which achieve a low overall penetration.

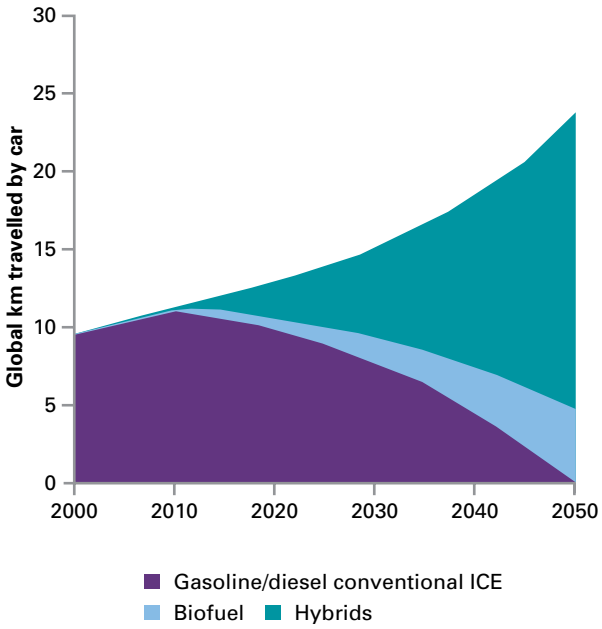
- Governments, in an effort to be seen to be taking action, intervene with targeted regulations to promote hybrid vehicles.
- The intervention may be through incentives to owners or through tailored fuel efficiency standards.
- Initially these may be 'light' hybrids with small batteries that allow engines to be stopped in traffic and enable regenerative braking.
- Later a significant proportion may have large batteries to allow them to be 'plugged in' to the grid and make some journeys without burning fuel.

Chart 44 *Evolution of share of passenger transport (Carbon markets scenario)*



Source: Carbon Trust and Oxera analysis.

Chart 45 *Evolution of share of passenger transport (Targeted regulation scenario)*



Source: Carbon Trust and Oxera analysis.

Technology

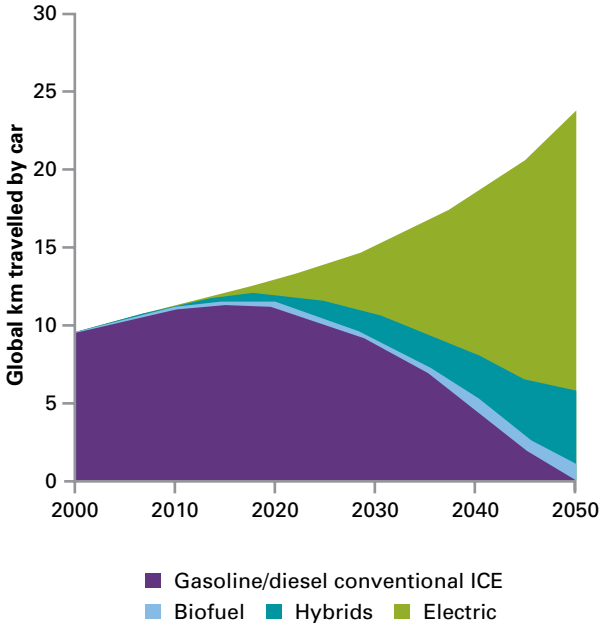
- A breakthrough in energy storage technology makes fully electric cars a commercial reality from 2020 and dominant by 2050.
- Hybrid technology is also increasingly deployed, although this is less significant compared to electric vehicles.

Consumption

Across the scenarios, car ownership grows and conventional internal combustion engines become twice as efficient

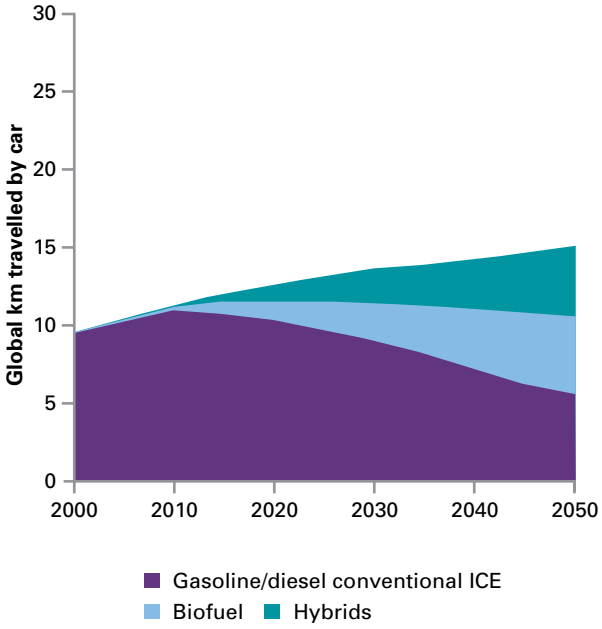
- Consumers take the lead in tackling climate change, finding alternatives to car travel and shifting travel habits to either use public transport or find ways to reduce travel overall.
- As a consequence of avoiding car travel, car ownership grows much more slowly than expected under business-as-usual.
- Consumer preference is otherwise more significantly concerned with being visibly 'green', preferring cars either powered by a biofuel or hybrid.
- There is no breakthrough in battery technology.

Chart 46 *Evolution of share of passenger transport (Technology scenario)*



Source: Carton Trust and Oxera analysis.

Chart 47 *Evolution of share of passenger transport (Consumption scenario)*



Source: Carbon Trust and Oxera analysis.

Transition paths for the manufacturing sectors

Carbon markets

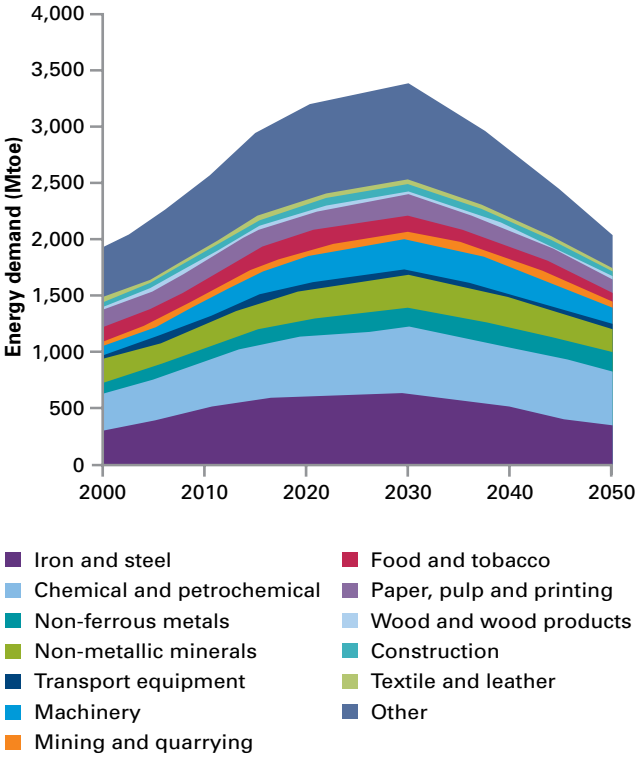
Targeted regulation

Across the scenarios, demand for manufactured goods at least doubles to 2050. Improvements in energy efficiency exceed growth in demand from 2030

- High fuel prices drive energy efficiency (e.g. efficient motor systems, furnaces and lighting, as well as process integration and the use of cogeneration).
- High carbon prices are factored into investment decisions and drive the switch from coal to gas or biofuels for process energy.
- Some plants in some sectors (e.g. iron and steel, chemicals) find it profitable to capture and store their direct carbon emissions.

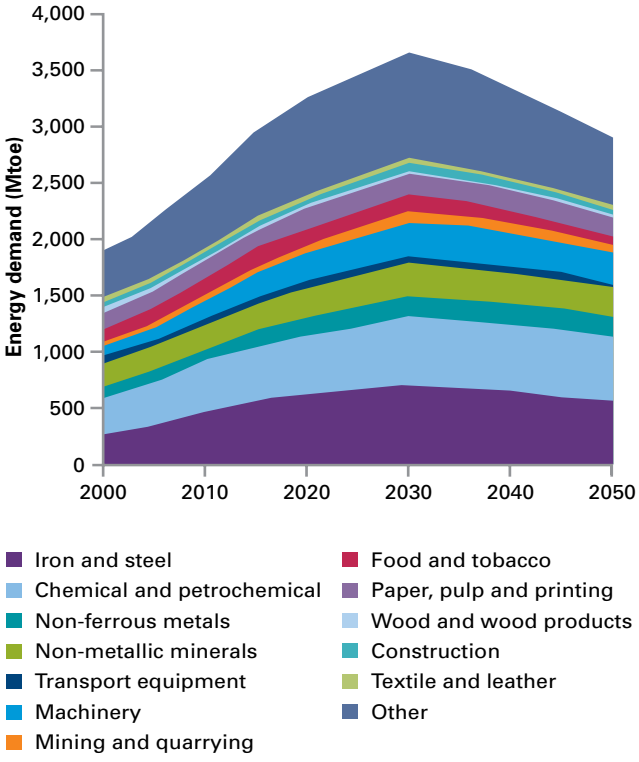
- Government standards and regulation require the use of more energy efficient equipment whenever it is replaced.
- Government promoted carbon capture and storage in the power generation sector leads to national networks of carbon pipes to storage sites that are also widely used by industry processes.
- Despite regulatory efforts, the complexity of change means many parts of manufacturing are not incentivised to change, achieving less reduction in energy demand than carbon markets.

Chart 48 *Evolution of energy demand by manufacturing sector (Carbon markets scenario)*



Source: Carbon Trust and Oxera analysis

Chart 49 *Evolution of energy demand by manufacturing sector (Targeted regulation scenario)*



Source: Carbon Trust and Oxera analysis.

Technology

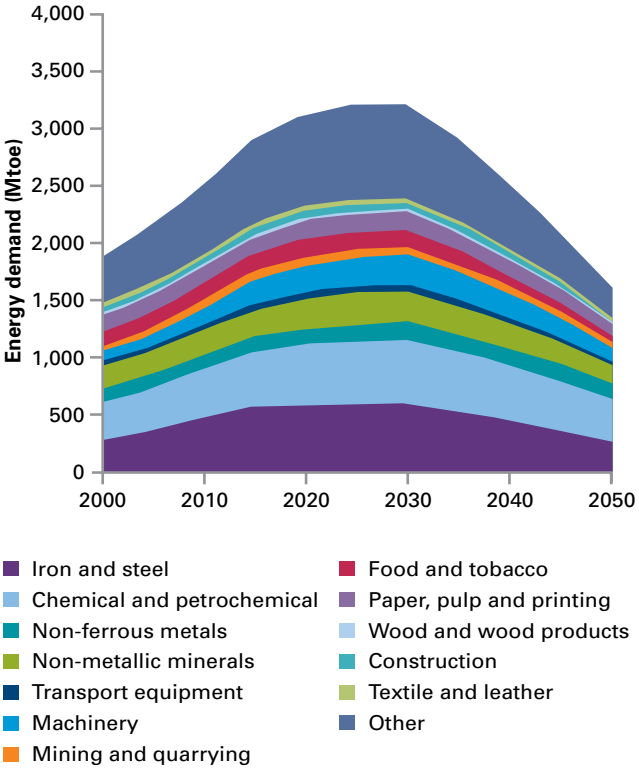
Consumption

Across the scenarios, demand for manufactured goods at least doubles to 2050. Improvements in energy efficiency exceed growth in demand from 2030

- Early research and development leads to technical breakthroughs required for more rapid improvements in energy efficiency later.
- Government collaboration to ensure rapid diffusion of new technologies means there is a smaller difference between OECD and non-OECD energy efficiency.

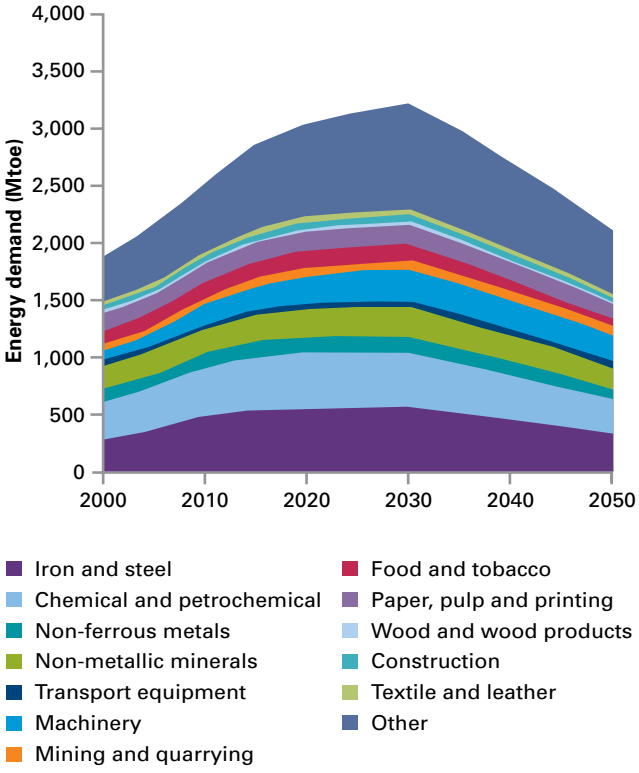
- The shift in consumption from goods to services is more rapid, leading to slower growth in manufacturing and much slower growth in raw materials manufacturing (e.g. iron, aluminium, chemicals, cement).

Chart 50 *Evolution of energy demand by manufacturing sector (Technology scenario)*



Source: Carbon Trust and Oxera analysis.

Chart 51 *Evolution of energy demand by manufacturing sector (Consumption scenario)*



Source: Carbon Trust and Oxera analysis.

Transition paths for the buildings sectors

Carbon markets

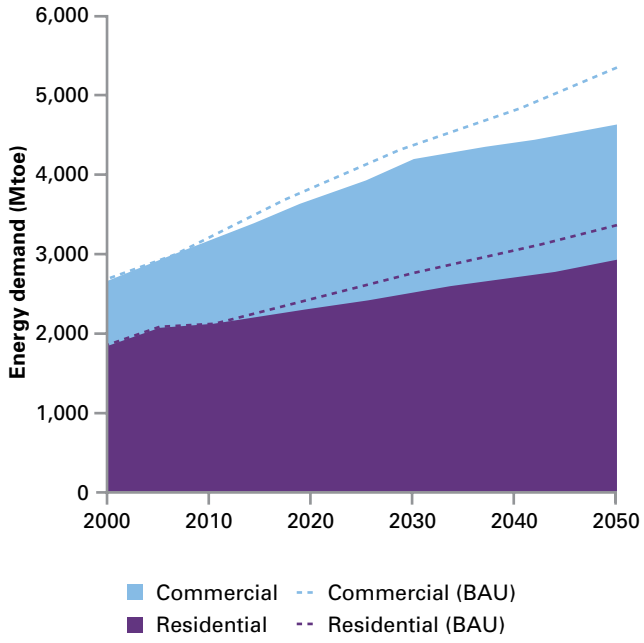
Targeted regulation

Across the scenarios, construction of houses grows in line with population, construction of commercial buildings grow in line with GDP growth and energy efficiency of all buildings increases by at least 20%. By 2050, at least 40% of building energy use is electricity

- Efficiency improvements are limited to some new building stock as there is little incentive to otherwise overcome the costs of retrofitting existing buildings.
- The incentives of building owners and occupiers to better insulate houses remain misaligned.

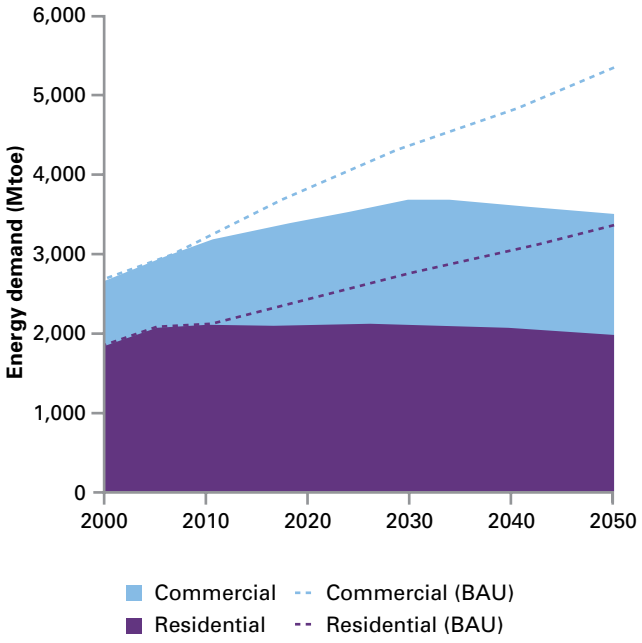
- Government intervention through targeted regulations aligns the incentives of building owners and occupiers and forces improvements in the energy efficiency of existing buildings.
- Incentives and public-sector leadership increases the use of on-site renewable energy (e.g. community combined heat and power, solar hot water).

Chart 52 *Evolution of buildings energy demand (Carbon markets scenario)*



Source: Carbon Trust and Oxera analysis.

Chart 53 *Evolution of buildings energy demand (Targeted regulation scenario)*



Source: Carbon Trust and Oxera analysis.

Technology

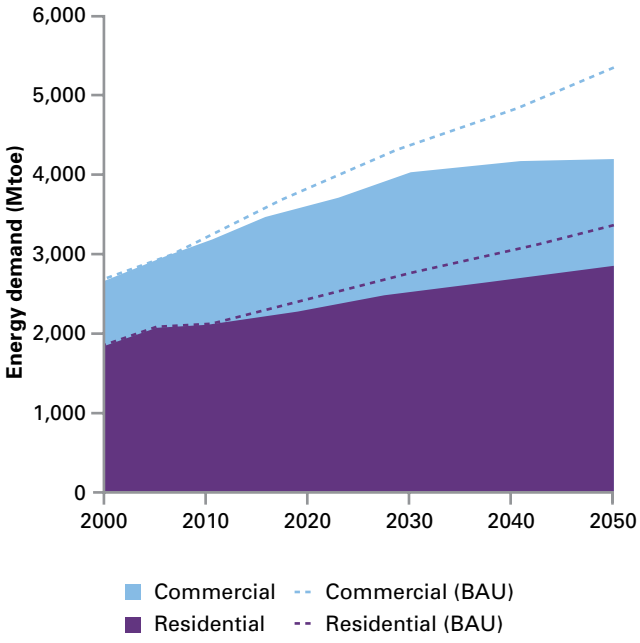
Consumption

Across the scenarios, construction of houses grows in line with population, construction of commercial buildings grow in line with GDP growth and energy efficiency of all buildings increases by at least 20%. By 2050, at least 40% of building energy use is electricity

- As with Carbon markets, efficiency improvements are limited by obstacles to retrofitting.
- However, early investment in research (e.g. in retro-fit insulation and low-cost solar electric) mean that, where alterations are possible, greater efficiency improvements are made.

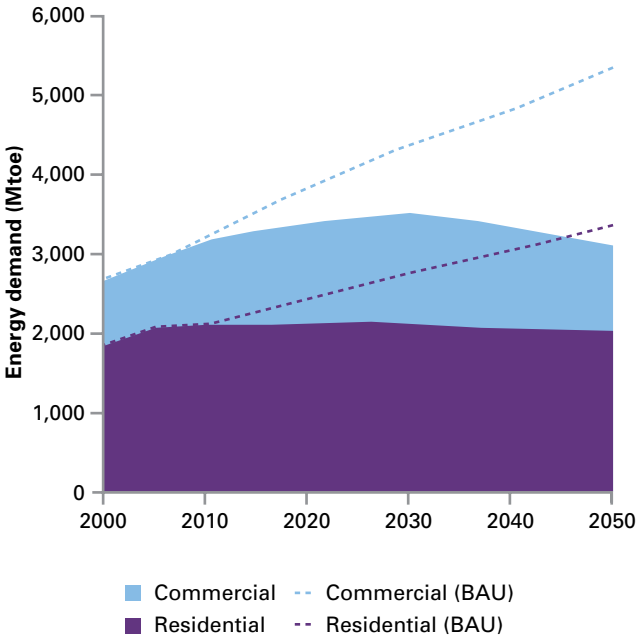
- Behaviour change, supported by clear labelling of the energy performance of different buildings and technologies, leads to a doubling of average building energy efficiency.
- This is, in part, enabled by consumers' willingness to trade off other aspects of building design in favour of efficiency.

Chart 54 *Evolution of buildings energy demand (Technology scenario)*



Source: Carbon Trust and Oxera analysis.

Chart 55 *Evolution of buildings energy demand (Consumption scenario)*



Source: Carbon Trust and Oxera analysis.

Appendix 2: Questions that help identify drivers of shareholder value-at-risk from climate change

Targeted regulations

Direct effect on industry

- Any new technology deployment subsidies made available (e.g. feed-in tariff)?
- Any taxes/subsidies applied in a targeted fashion to the manufacture or sale of goods or services (e.g. vehicle excise duty)?
- Any minimum quotas on the use of low carbon energy of other products (e.g. minimum biofuels use)?
- Any minimum product standards imposed (e.g. minimum efficiency performance)?
- Any absolute prohibition on sale or use of types of product (e.g. no incandescent light bulbs)?
- Any prevalent or mandatory information requirement (e.g. product labelling), which might cause a difference in demand?

Indirect effect on other industries

- Is an adjacent industry regulated by one of the above measures, which in turn causes an effect in this industry? For example:
  - Imposition of a cost on goods supplied to the industry from another industry.
  - Reduced demand for goods due to new competition from substitute products.

Cost of carbon

Direct effect on industry

- Is a cost of carbon imposed on the industry's direct emissions (e.g. cap and trade, or carbon tax)?
- Is a cost of carbon imposed on the industry's product emissions (e.g. fuel tax, emissions tax)?
- Are there any transitional subsidies permitted (e.g. free allowances of carbon emissions or special treatment of existing assets ('grandfathering'))?

Indirect effect on other industries

- What effect might the imposition of a cost of carbon in other industries have?
  - A rise in input costs?
  - A change in competitiveness of suppliers or customers?

Consumer behaviour

Will awareness of the risk of climate change be likely to cause consumers to shift their intrinsic demand up or down for either:

- A product in the industry in question?
- A product of another industry?

Are there any likely catalysers of a shift in consumer behaviour? For example, moral leadership being established by campaign groups or government policy seeking to stimulate consumers via a range of measures. Examples include:

- Financial penalty measures such as high vehicle excise duty on higher-emitting vehicles?
- Specific subsidies for certain goods or services (e.g. installation of solar panels)?
- Mandatory product information standards?
- Leading awareness campaigns designed to shift behaviour (e.g. highlighting the anti-social nature of a high carbon lifestyle)?

Technology development

Direct effect on industry

Will the prospect of a low carbon economy stimulate:

- Increased deployment of existing, but lower carbon technology?
- Further innovation of new low carbon technologies?

Indirect effect of technological development via other industries

- How might either of the above effects in another industry affect costs and demand?
- Could substitute products reduce demand?

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CTC734

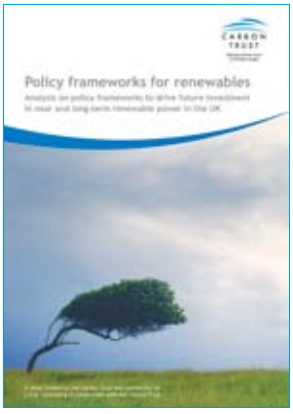
Cutting Carbon in Europe: The 2020 plans and the future of the EU ETS

CTC715

EU ETS Phase II allocation: implications and lessons

CTC519

The UK Climate Change Programme: Potential evolution for business and the public sector



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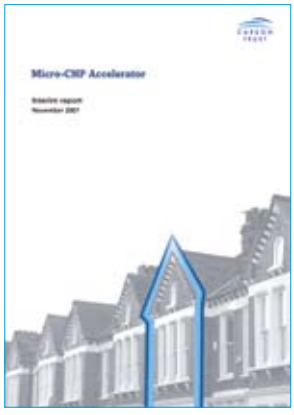

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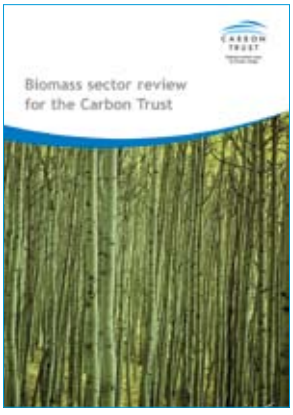

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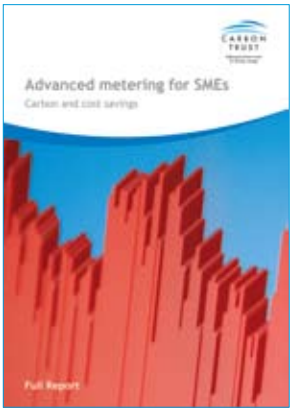

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The Carbon Trust was set up by Government in 2001 as a private company.

Our mission is to accelerate the move to a low carbon economy by working with organisations to reduce carbon emissions and develop commercial low carbon technologies.

We do this through five complementary business areas:

Insights – explains the opportunities surrounding climate change
Solutions – delivers carbon reduction solutions
Innovations – develops low carbon technologies
Enterprises – creates low carbon businesses
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ACT ON CO_2 is the Government's initiative to help individuals understand and reduce their carbon footprint. Visit http://actonco2.direct.gov.uk for more information.

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