HSBC Climate Change
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Climate Change
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Keeping it cool

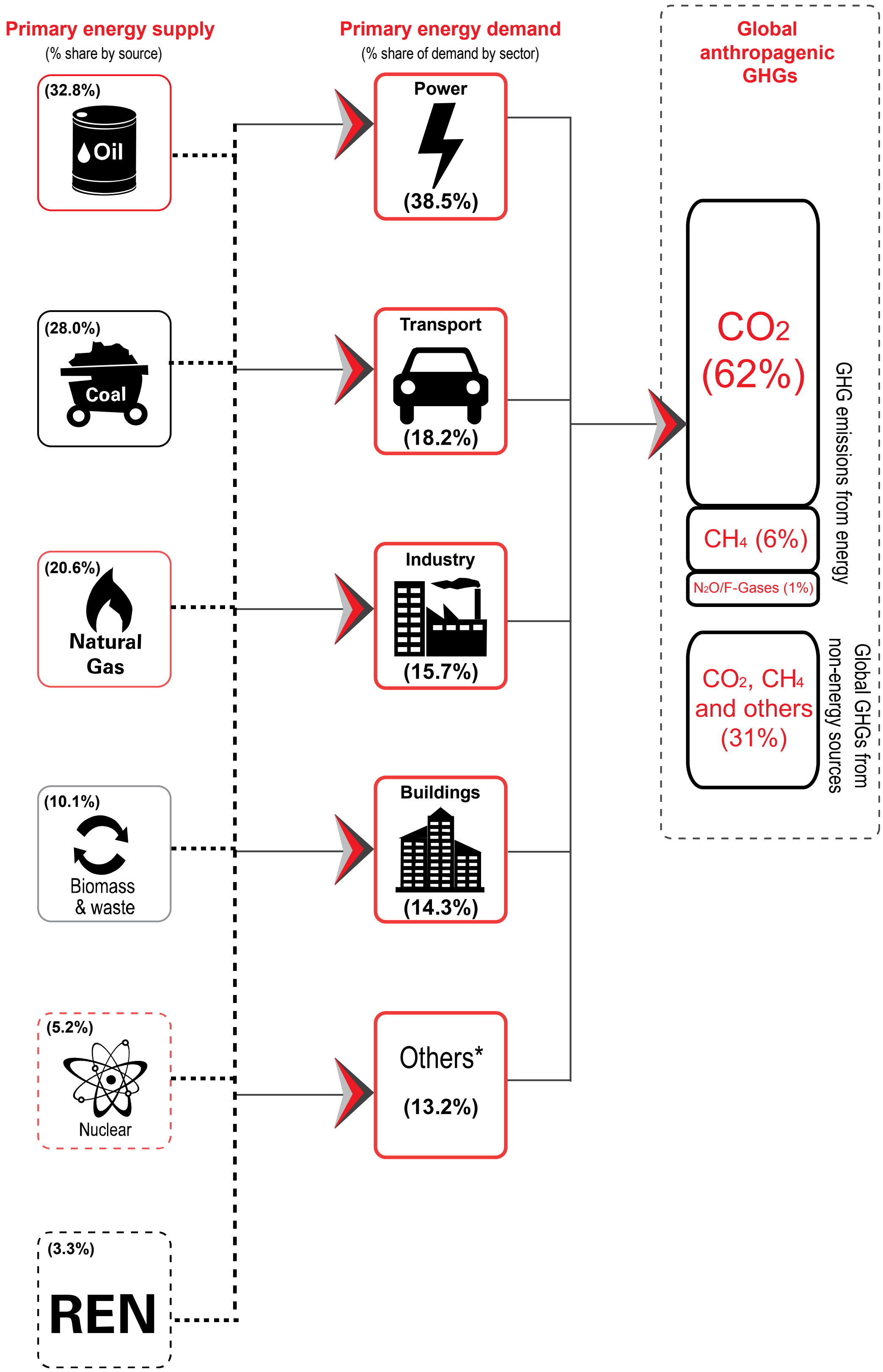
Oil, CO_2 and the carbon budget

- Scientists have set out a carbon budget to assess if the world is on track to keep temperature rises under 2°C
- Lower oil prices alter the economics of investment spend across the energy mix, thereby changing CO_2 levels and time available until carbon budget expiry
- Drivers that buy time to spend the carbon budget are regulation, technology and innovation in the gas industry

By Zoe Knight, Wai-Shin Chan and Ashim Paun

Play Interview with Zoe Knight

The energy economy and climate



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Summary

- Events and policy that extend the time available to spend the carbon budget are positive from a climate perspective
- Read across from oil price moves to other energy commodities determine how energy and CO_2 trends might change
- Regulation, technology and gas drivers are disrupters that could speed up the energy transition and buy time for CO_2 spend

Keeping it cool

This is the second report in our 'Keeping it cool' series, which focuses on the most important themes for the climate agenda. Here we assess the wider implications of lower oil prices on CO_2 by looking at the carbon budget framework, and energy system factors which extend or deplete the time available to spend the budget. In *Keeping it cool - Financing a 2°C world*, September 2014, we noted that a positive driver for shifting to a low-carbon economy was the regional price competitiveness of cleaner energy sources. Now, lower oil prices change the economics of investment spend across the energy mix, in turn changing the carbon intensity of the energy mix. For instance, gas prices have fallen faster than coal prices. Since for the most part gas is less carbon intensive in electricity generation than coal, this is positive for buying more time to scale up lower carbon alternatives for power such as renewables.

Saving CO_2 in the carbon budget

A central climate change focus is whether or not CO_2 emissions are being kept in check at levels consistent with temperature rises less than 2°C higher than pre-industrial levels. To assess this, scientists developed a carbon budget which outlines the levels of carbon, and hence CO_2, associated with various probabilities of staying below 2°C.

The carbon budget is an important tool to assess whether the world is on or off track to have a good chance of keeping temperature rises under 2°C. Events that result in a net reduction in CO_2 are positive because they extend the time available to implement policy, invest in low-carbon energy infrastructure and buy time for the scale up of emerging technologies that facilitate the transition to a low carbon economy more quickly. Conversely, events that speed up the depletion of the budget are negative from a climate perspective.

The amount of CO_2 spend is influenced by a variety of natural and man-made factors, but in this piece we look at CO_2 relating to the supply and demand of energy, the climate dynamics of oil in particular and the

wider consequences of oil price levels that can impact the time available to spend the carbon budget, including broader economic backdrop and the read across of lower oil prices through the energy system.

Spending CO_2 in the carbon budget

For investors the most important point to understand is how CO_2 flows through the energy system, how price signals might result in a shift to a lower carbon intensity energy mix and which primary energy sources are likely to be targeted first by climate policy. We look at this in the first chapter on carbon budget constraints. We focus on the oil specifics in chapter 2.

Recently debate has increased among investors and academics on how and whether fossil fuels can be burned in the future to enable consistency with CO_2 boundaries for a 2°C world. The argument was initially based on policy – that if CO_2 constraints translated into stringent climate policy, then certain fossil fuel assets would be left unburned in the ground, effectively 'stranded'. Lower prices add an economic dimension to the policy drivers, meaning that assets are now at risk of being stranded, both due to policy curbs and unprofitable production curbs.

Oil and the carbon budget

Oil production and consumption were responsible for around a third of global CO_2 emissions in 2012. The carbon intensity of oil production varies widely – from 6.75gCO_2/MJ for largest oil producer Saudi Arabia to around 20gCO_2/MJ for Canadian oil sands. Carbon intensity depends on the location of reserves / deposits as well as the energy and material needs for extraction, and distance travelled from well to refinery and from refinery to end use, as well as refining and treatment.

In our view future oil supply growth from high cost areas such as Canadian oil sands is likely to be curtailed at sustained lower prices because the economics are no longer as compelling, a view validated by company capex cut announcements and by the widespread deferral of new project sanctions. This could mean the average CO_2 intensity from oil production could fall if the marginal producer at low prices is increasingly the likes of Saudi Arabia or Iraq (which has possibly the greatest volume upside potential in the coming years), both of which have below average carbon intensity of production.

On the demand side only 53% of total oil supply is used in transportation, (but within transport 95% of energy consumed is oil), and the pass through of lower prices to consumers can be slow so that the CO_2 impact is muted in our view, as there is limited global evidence that consumers drive significantly more in relation to lower oil prices. The larger effect for CO_2 is how consumers spend the cash freed up by lower pump prices. HSBC economists re-visited global growth and inflation forecasts in relation to lower oil prices in *Global Forecast Update*, 3 February 2015, concluding that the growth outlook for the developed world mostly improves (which would mean more CO_2) but worsens for emerging markets (less CO_2).

As oil prices have fallen, so have gas prices which have fallen faster than coal prices. Gas fired power is around half as carbon intense as coal fired, thus an uptick in gas replacing coal in the power generation mix would be beneficial for CO_2. When the economics work, this can happen quickly, as demonstrated by the shale boom in the US. US CO_2 from energy fell -2.3% and -3.7% year-on-year in 2011 and 2012 respectively, against a global CO_2 increase of 2.7% and 2.1% respectively.

Global disrupters: regulation, technology, innovation in the gas industry

Meeting the 2°C goal means making changes to the supply and demand side of the energy economy and involves moving from high carbon towards low-carbon sources. We think there are three disruptive catalysts that if realised could change the status quo in the energy economy.

Regulation

We expect regulation to continue to be an important driver to tackle CO_2 reduction. Global and national climate policy lays the foundation for the extent to which the energy economy tips towards de-carbonisation. Countries will publish 'intended nationally determined contributions' (INDCs) detailing proposals for emission cuts post 2020, likely from March onwards. Our central view is that countries will deliver a Universal Climate Agreement in Paris in December, but that the individual country goals will not be ambitious enough at the aggregate level to keep temperature rises below 2°C. Stronger than expected policy drivers would drive faster de-carbonisation. We expect policy ambition to be revealed through country INDCs.

Technology

The speed at which de-carbonisation technologies are deployed is a crucial point for delaying carbon budget expiry. Technologies that help low-carbon, such as energy storage and carbon capture and storage already exist but the challenge now is to make them commercially viable and scale them up. A step-change in the cost of existent technologies, particularly renewable energy, batteries and carbon capture and storage would also dramatically disrupt the existent energy economy. HSBC sector analysts looked at this in *Seismic Shifts – Trends set to reshape the investment landscape*, November 2014.

Innovation in the gas industry

In our view gas price moves provide a good indication of the likelihood of lower-carbon energy transition. If gas prices fall dramatically, and especially if the falls are due to developments which bring cheap unconventional gas to countries outside the US, the energy mix can change quickly. The climate benefit is that gas is around half as carbon intense as coal for electricity. However, there are considerations to take into account such as other negative environmental consequences, and in our view gas is helpful for lowering emissions in the short term, but is not a long-term fix to decarbonise the economy to the degree set out by the fifth assessment report of the Intergovernmental Panel on Climate Change.

A note on terminology

Scientists have modelled a carbon framework consistent with different likelihoods of hitting the 2°C goal. In this report we use the term "carbon budget" as shorthand to refer to the amount of CO_2 available to spend to have a 50:50 chance of keeping temperature rises to below 2°C.

Did you know?

Talks are in progress for a universal climate agreement to be signed in Paris in December 2015

In 2012 countries agreed to aim to limit temperature rises to less than 2°C compared with pre-industrial levels (i.e. 1880). So far 0.85°C of warming has occurred since then.

For a 50:50 chance of keeping temperature rises under 2°C, the carbon budget is 305GtC, which equates to 1,100GtCO_2. At current rates of emission growth the budget expires around 2040.

CO_2 comprises 74% of the six Greenhouse Gases (GHG) monitored by the UN Framework Convention on Climate Change (UNFCCC).

If existing climate policy is fully implemented, there is a shortfall of 7-10GtCO_2e compared with an emissions trajectory consistent with the 2°C goal.

CO_2 emissions from primary energy totalled Gt31.6 in 2013. 44% came from coal, 36% from oil and 20% from gas.

Power generation is the most CO_2 hungry sector, representing 42% of total CO_2 emissions in 2012. Transport was 23%, while buildings and industry together comprised 26%.

Oil contributes 33% to the primary energy mix. 53% of oil is used for transport and 6% for power generation. The rest is used in industry, buildings and is refining losses.

Coal contributes 28% to the primary energy mix. 64% of coal is used for power generation. It is the most carbon intense energy generator, producing between 750 and 1300gCO_2 / KWh of electricity produced.

Gas contributes 21% to the primary energy mix. 42% of gas is used for power generation. It is mostly less carbon intensive than coal, producing between 360 and 890gCO_2/KWh of electricity produced

The shale gas boom in the US resulted in CO_2 falls of -2.3% and -3.7% year-on-year in 2011 and 2012 respectively, against a global CO_2 increase of 2.7% and 2.1%.

Contents

What is the carbon budget?

- The available carbon budget for a 50% chance of keeping temperature rises to under 2°C is 305GtC or 1,100Gt CO_2
- At current rates of CO_2 emissions, this budget expires by around 2040 – highlighting the importance of addressing CO_2 spend now
- The climate concern is whether trends and events prolong or shorten the time available to spend the carbon budget

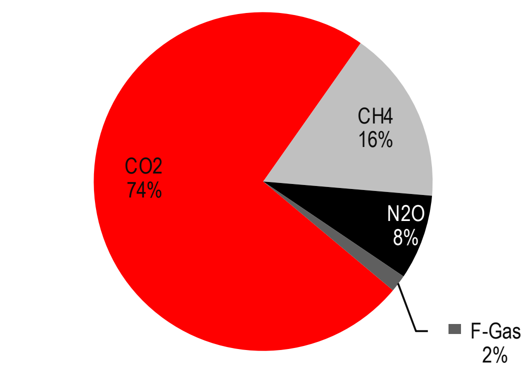
Living within CO_2 means

Many gases and particles contribute to climate change, but six greenhouse gases (GHGs) are classified for monitoring and policy purposes under the UN climate change framework convention (UNFCCC). The largest by far is carbon dioxide (CO_2), which represents almost three quarters of total GHGs as shown in Chart 1.

Excluding land use change and forestry (LUCF), electricity and heat processes was the largest contributor by sector towards the 32.3Gt CO_2 emitted in 2011 (Chart 2).

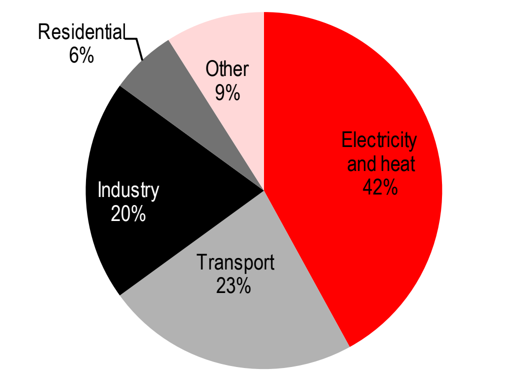
Communication around the linkages between the levels of CO_2 consistent with the 2°C goal has evolved so that the notion of a carbon budget is becoming the norm. In the trilogy of reports that comprised the fifth assessment report on climate change (AR5), by the Intergovernmental Panel on Climate Change (IPCC), the first working group (WG1) published conclusions on 'The Physical Science Basis of Climate Change', (see our report '*IPCC: Science, Impact, Forecasts*', 27 September 2013). It stated that "continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system". In

Chart 1: Split of greenhouse gas emissions in 2011



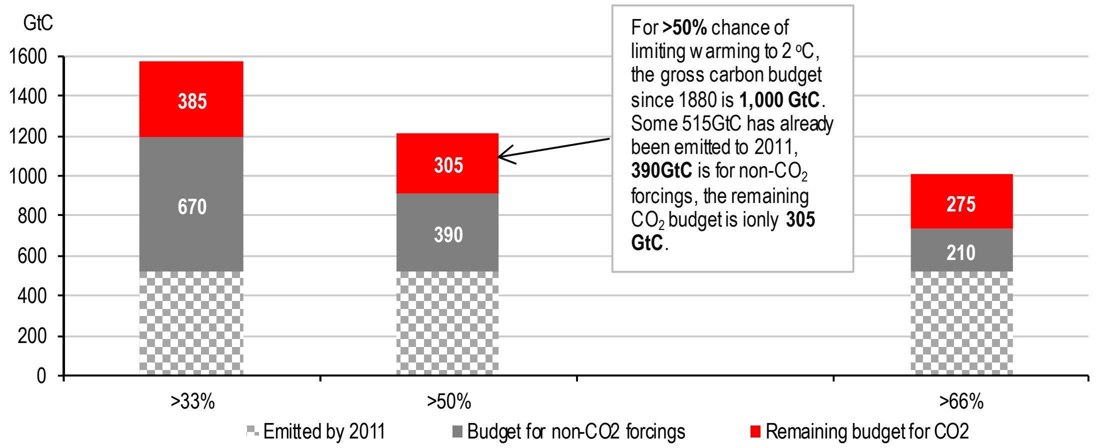
Note: Excludes LUCF; Source: World Resource Institute

Chart 2: Sector breakdown of CO_2 emissions in 2012



Source: CO_2 emissions from fuel combustion - highlights (2014), IEA

Chart 3: The global carbon budget (CO_2 & non-CO_2) for given changes of meeting the 2°C target under RCP2.6



Note: 1tC = 3.67tCO_2. Source: WG1 (SPM) IPCC AR5.

addition, the report presented the concept of a carbon budget: i.e. how much carbon may be emitted in order to stay within a given chance of achieving the 2°C target.

This apparently simple number contains three important dimensions: **1)** it is measured in tonnes of *carbon* – not *carbon dioxide* (which is how most climate targets are communicated); **2)** non-CO_2 GHGs such as methane may be broken out from the budget; **3)** it gives various chances of meeting the 2°C target according to risk scenarios (i.e. the higher the budget, the lower the chances of meeting the target).

Box 1: The methodology behind the budget is based on specific starting frames of reference for climate modelling. In AR5, scientists used Representative Concentration Pathways (RCP). The RCPs reflect four pathways of approximate total radiative forcing in year 2100 relative to 1750. *RCP2.6* includes a significant mitigation scenario leading to a low forcing level, *RCP 4.5* and *RCP6* represent two stabilisation scenarios and *RCP 8.5* simulates very high greenhouse gas emissions.

Chart 3 shows that for a greater than two-thirds chance of keeping temperature rises below <2.0°C, we can only emit 275GtC for CO_2 emissions. GHG emissions from oil are mainly in the form of CO_2. Loosening the budget to just a 50:50 chance of remaining below 2°C means 305GtC, or 1,100GtCO_2, is available to spend.

Advances in low-carbon technologies before the carbon budget runs out could be crucial in keeping temperature rises down and preventing the more severe impacts from climate change. We consider extending or prolonging the time available to spend the carbon budget to be important because it buys more time for these technologies to mature, to be deployed and scaled-up; to further innovate and to bring in new policies to channel energy markets and related infrastructure towards low-carbon.

A central climate question therefore is whether the CO_2 consequences of a given event, such as lower than expected GDP, strong commodity price moves or a change in climate policy prolongs or shortens the time available to spend this carbon budget.

Short term: mind the gap

The IPCC's AR5 concludes that on current political ambition for emissions reduction, global mean surface temperature rises by 2100 will be between 3.7°C and 4.8°C versus pre-industrial times. The universal climate agreement (UCA) will shape the framework for emission reduction goals from 2020 onwards, but between now and then there is a shortfall of ambition versus an emissions trajectory consistent with the 2°C goal.

A series of reports published by the UN Environment Programme (UNEP) examine whether government pledges for emission reductions are consistent with the 2°C goal. The most recent 'Emissions Gap Report' from November 2014, found there was a gap of around 8-10 GtCO_2e for 2020; in other words, we are on track to overshoot the 2020 emissions levels consistent with the 2°C goal by 8-10GtCO_2e, which is roughly equivalent to China's total CO_2 emissions from energy use in 2013. The trajectories for business-as-usual versus what is consistent with keeping temperatures down is depicted in chart 4.

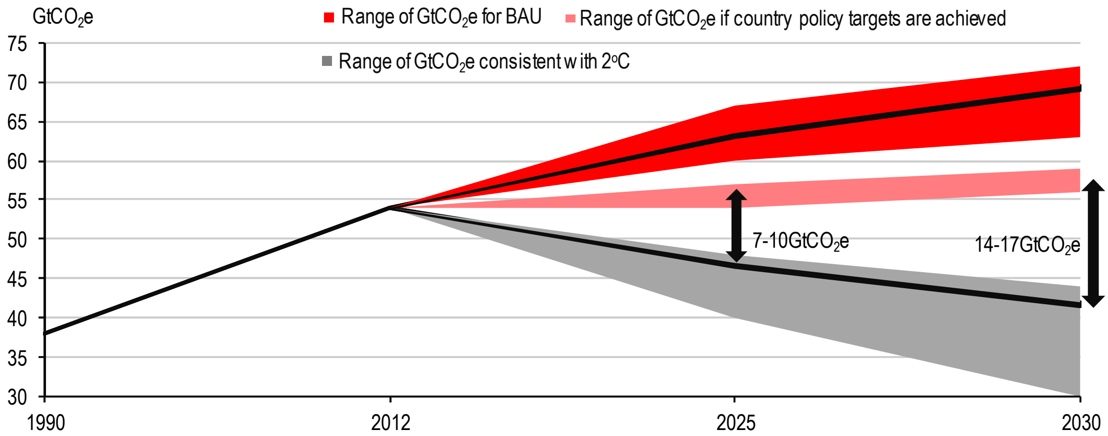
There is an urgency to scale-up ambition since scaling up in the *short term* means less cost over the *long term* both in terms of additional mitigation required and the costs from the resulting impacts. To put it another way, being "off-track" by 2020 would mean even harder work in the post-2020 years to get back "on-track" and to close the emissions gap by 2025 or 2030 etc.

Therefore, anything that reduces emissions more quickly in the short term, for instance, less energy use as a result of slower economic growth, is a good thing from a global climate change perspective since fewer emissions reach the atmosphere and therefore the time available to spend the carbon budget is extended.

Long term: Avoid overspend

The universal climate agreement negotiations are focussed on reduction aims starting in 2020, but any investment in energy systems now will 'lock-in' the carbon intensity of economies, overspending the carbon budget and increasing the chance of the unpalatable effects of climate changes, such as droughts and floods (see our report *Scoring Climate Change Risk*, 24 September 2013).

Chart 4: Country emission reduction goals are not aligned with scientists views on delivering 2°C, the gap is 7-10GtCO_2e in 2025



Source: Synthesis Report, AR5, IPCC; Emissions Gap Report 2014, UNEP. Note the chart shows the ranges of CO_2 that would be consistent with keeping temperature rises below 2°C.

High-carbon infrastructure assets

Over the long term, avoiding high carbon lock-in is important from a climate perspective. Infrastructure is usually designed to last many decades. This is particularly true for energy infrastructure, where power stations can operate for over 40 years. Notwithstanding high cost retrofits, the emissions profile of infrastructure is likely to remain fixed throughout its lifetime. Thus a high-carbon asset is likely to be a high emitter for 40 years, similarly a low-carbon asset is likely to be a low emitter for 40 years. When the differences are accumulated across the world, over a long time frame, the incremental emissions can be very large.

Therefore, unless newer technologies are developed to levels where they are priced competitively, there is a risk that cheaper and older technologies which are more carbon intense remain the norm for energy infrastructure – thus locking-in higher emissions for a longer period. We look at this in more detail in chapter 3.

What influences CO_2 spend?

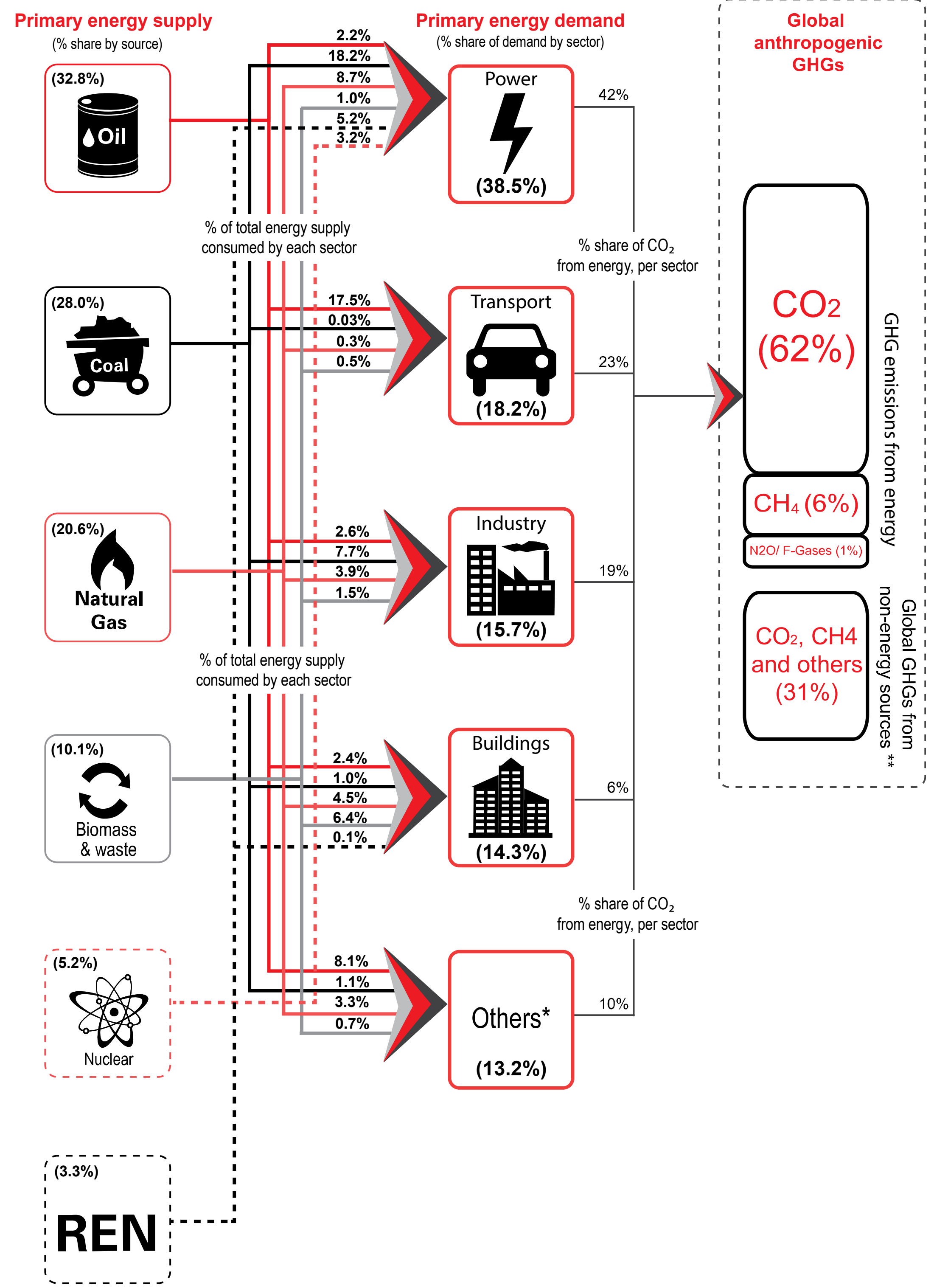
The level of anthropogenic CO_2 in the atmosphere is influenced by a variety of factors. In our view, the most important areas for investors to be aware of can be generalised into two main drivers – sources and uses of energy.

Figure 1 on page 11 describes the energy economy. On the supply side, the largest primary energy source is oil at 33% of the mix, followed by coal at 28%. Currently renewables contribute just 3% of the mix.

Figure 1 also shows that on the demand side power is the dominant consumer of primary energy, followed by transportation, industry and building use. The IEA estimates that of the total energy consumed in 2012, which equated to 31.6GtCO_2, 13.2GtCO_2 came from power generation from coal, oil and gas, compared with 16.7GtCO_2 from transport, industry, buildings and others.

The energy economy and climate

Figure 1: The Climate and Energy Economy



Source: HSBC

Primary energy supply

The fossil fuels oil, coal and natural gas together comprise 82% of the current primary energy supply. From a CO_2 perspective the choice of fuel as the main supplier of energy has a large impact, since gas is around half as CO_2 intensive as coal, as shown in chart 5 overleaf. Coal itself comes in different grades which vary in carbon, sulphur and oxygen content, energy content and therefore use. With gas, although there is wide variation in source, the end product is essentially close to homogenous.

Some countries have legislation in place targeting the closure or clean-up of coal fired power stations. For example, China is trying to reduce the share of fossil fuels in primary energy consumption to 85% by 2020, and 80% by 2030. In addition, it is trying to reduce the share of coal (the most carbon intense fuel) to below 65% by 2017. In the US, the clean power plan proposal from the EPA aims to reduce carbon from power generation by 30% by 2030 from 2005 levels (see our report *USA: climate boost for Paris 2015*, 3 June 2014). Meanwhile the EU is aiming to reduce CO_2 by 40% under the 2030 climate and energy package (see our report, *EU: Three pronged attack on 2°C,* 25 July 2014).

Uses of energy

In very broad terms, anthropogenic CO_2 output is determined by energy demand, which fluctuates with economic activity. Historically, there has been a positive correlation between GDP growth and energy growth (Charts 7 and 8).

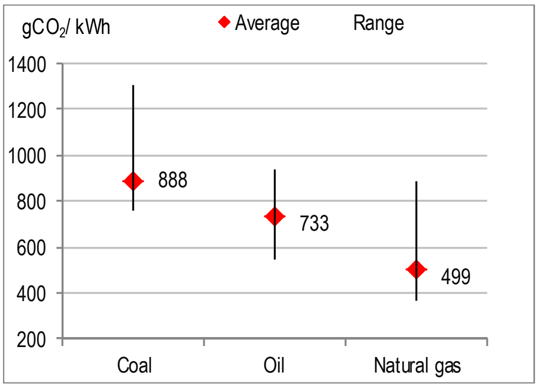
As policy makers have become more concerned about the conservation of resources as well as climate change, the world has become more efficient at generating output using less energy (chart 9). However, in recent years the rate of efficiency improvement has plateaued. From a climate perspective speeding up energy efficiency gains will help close the emissions gap.

Conclusions

The carbon budget is an important tool to monitor whether the world is on or off track to have a good chance of keeping temperature rises under 2°C. Events that result in a net reduction in CO_2 are positive because they extend the time available to implement policy, invest in low-carbon energy infrastructure and buy time for the scale up of emerging technologies that facilitate the transition to a low carbon economy more quickly. Conversely, events that speed up the depletion of the budget are negative from a climate perspective.

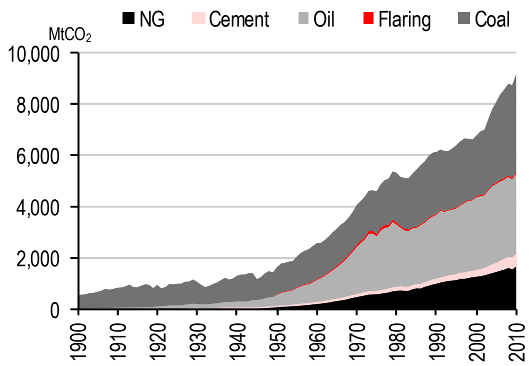
For investors, the most important issue to be aware of is the how CO_2 flows through the energy system. This demonstrates which areas are likely to be targeted first by policy. In addition, price moves change the economics of investment and can speed up or slow down the low-carbon transition. In the next chapter, we look more closely at climate and oil dynamics.

Chart 5: Lifecycle GHG emissions for electricity generation



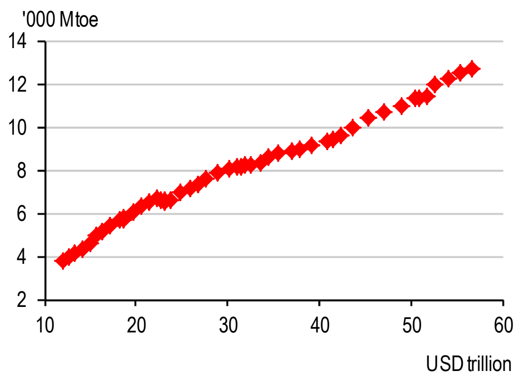
Sources: Comparison of lifecycle greenhouse gas emissions of various electricity generation sources, World Nuclear Association

Chart 6: World CO_2 emissions from fossil fuel



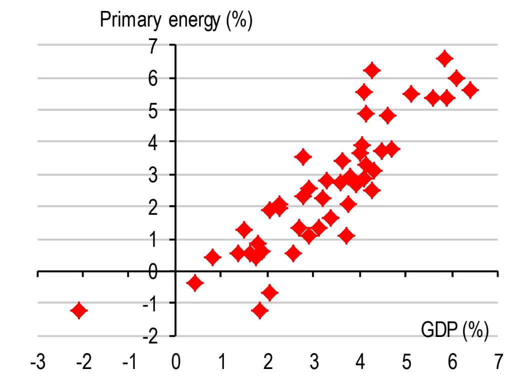
Source: Carbon Dioxide Information Analysis Center

Chart 7: GDP versus primary energy consumption



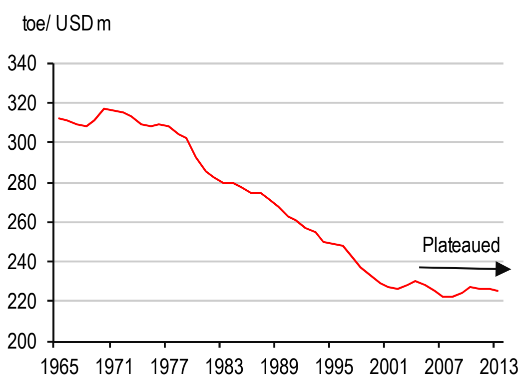
Source: BP Statistical Review 2014, World Bank; GDP is at constant 2005 USD

Chart 8: GDP growth vs growth in energy use



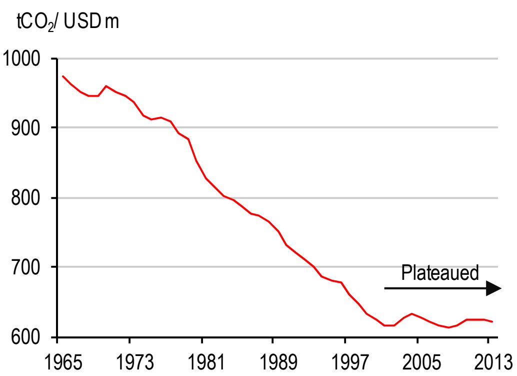
Source: BP Statistical Review 2014, World Bank; GDP is at constant 2005 USD

Chart 9: World energy use per unit of GDP



Source: BP Statistical Review 2014, World Bank; GDP is at constant 2005 USD

Chart 10: World CO_2 emissions per unit of GDP



Source: BP Statistical Review 2014, World Bank; GDP is at constant 2005 USD

How does oil fit in?

- Lower oil prices affect the economics of projects so that supply cuts change the average carbon intensity of global oil production
- Only 53% of oil is used for transport, so broader economic trends are as big a driver of CO_2 changes from oil as price in isolation
- Read across from oil price moves to other energy commodities determine how energy and CO_2 trends might change

Linkages with CO_2

Producing and consuming oil both emit CO_2 so there are many aspects to consider in determining whether the net effect of low oil prices is positive (i.e. extends the time available to spend the carbon budget) or negative (shortens the time available) for climate change. Therefore, to examine how the drivers of CO_2 are affected by lower oil prices, we broadly split them into: production and consumption and short and long term drivers.

The IEA estimates that CO_2 from oil production and consumption was $GtCO_2$11.2 in 2012 (which is roughly a third of global CO_2 emissions or a quarter of total GHG emissions). The CO_2 emissions from oil in transport equated to $GtCO_2$9.6 in 2012 (compared with $GtCO_2$0.94 for power generation) according to the IEA.

Studies have looked at the carbon intensity of oil *over a life-cycle basis,* and the Congressional Research Service (CRS), found that the carbon intensity varies between 87-108 gCO_2/MJ, depending on the complexity of extraction. On a life-cycle basis, the *consumption* of oil is where most of the CO_2 is emitted – accounting for 70-80%.

Figure 2 overleaf shows how oil fits into the energy system. Oil provides 33% of primary energy. Of that, most (79%) comes from conventional crude. Crude oil represents 66% of CO_2 from oil according to our estimates, whereas the 4% of other unconventional sources is 8% of CO_2. This highlights that a production shift away from unconventional sources would improve the CO_2 mix.

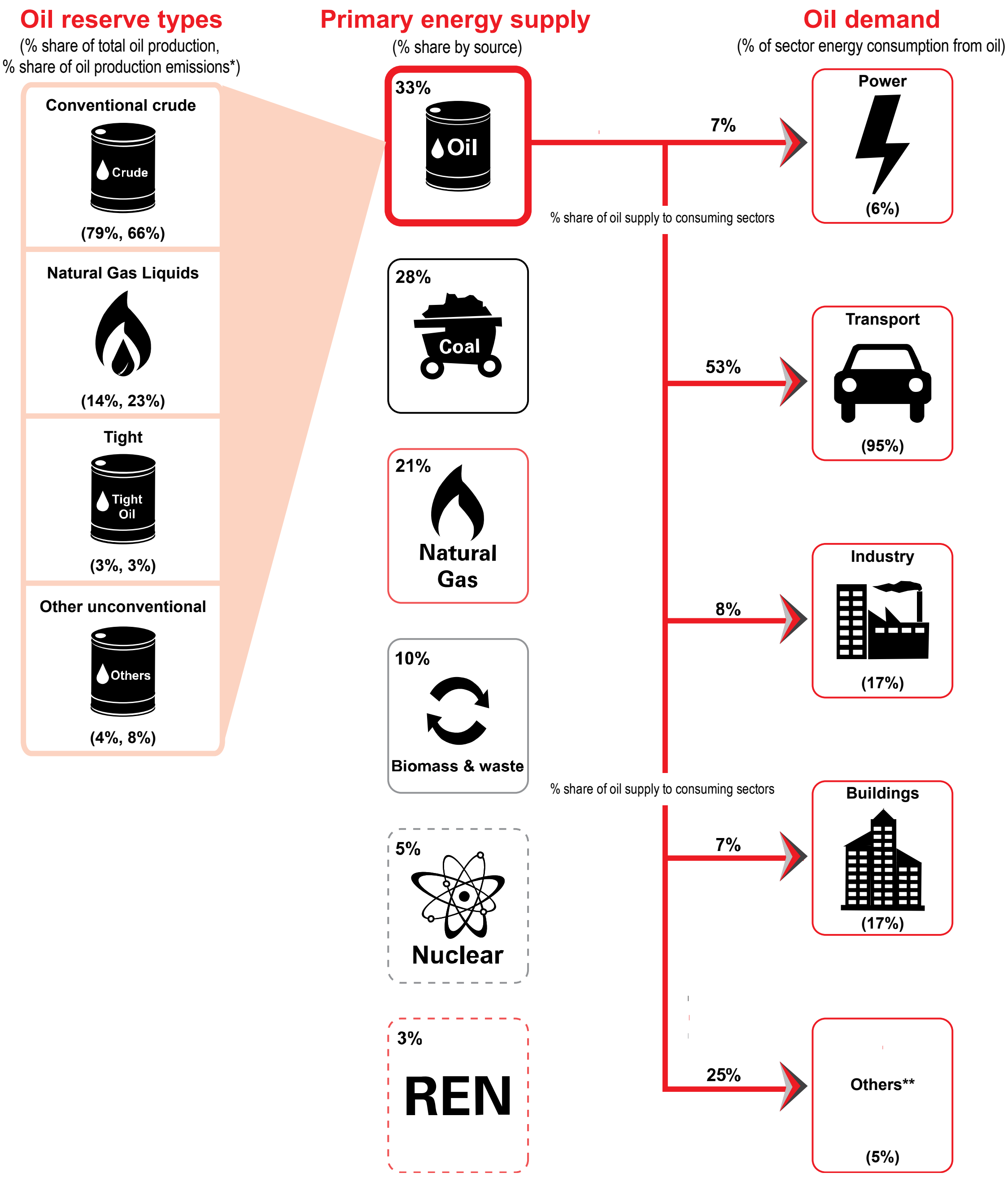
The majority of oil use is for transport, at 53%, but other uses include power generation, industry and buildings, as well as refining losses.

From a sector perspective, most oil demand comes from transport, where 95% of energy consumed is oil. The power generation sector only consumes 6% of total energy used from oil (the main energy input for power generation is coal).

In our view, the climate dynamics of oil price moves are dependent on the net effect of the supply side CO_2 changes versus the demand side CO_2 changes which result from the changing price signal.

Oil, climate and the energy economy

Figure 2: Oil and the energy economy



Source: HSBC

Climate dynamic and supply

***Climate dynamic**: Changes to volume and regional diversity of change the global carbon intensity of production. Low oil prices change the economics of supply, which means some emissions might not be realised. The amount of CO_2 avoided depends on the carbon intensity of the marginal supply that is stopped, as well as the carbon intensity of supply that could only be realised at higher prices.*

The two main factors to consider in relation to oil prices, supply and the carbon budget are, in our view:

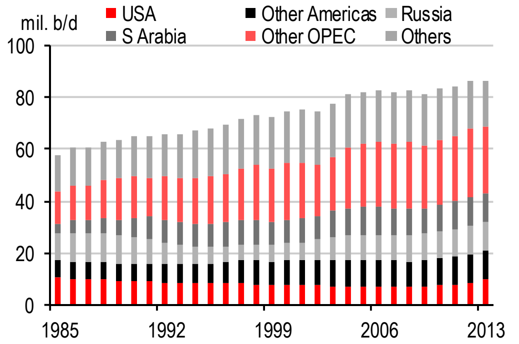
- The carbon intensity of oil production, especially that of curtailed supply
- The price at which regional supply is disrupted, and the rate of curtailment (i.e. now or future)

How carbon intense is oil production?

Current production volumes are around 90mbd, with Saudi Arabia the largest single country producer at 11.5mbd. At the end of 2013 the OPEC group were responsible for 42% of daily volumes. Outside OPEC, Russia is the largest single country contributor (Chart 11).

The carbon intensity of oil *production* depends on the location of the deposits/reserves and varies widely depending on the energy and materials needed for extraction, the distances travelled from well to refinery and from refinery to end use, as well as refining and treatment. The location and complexity of extraction are thus important determinants in assessing how much CO_2 can be avoided from production cuts.

Chart 11: Annual production of crude oil

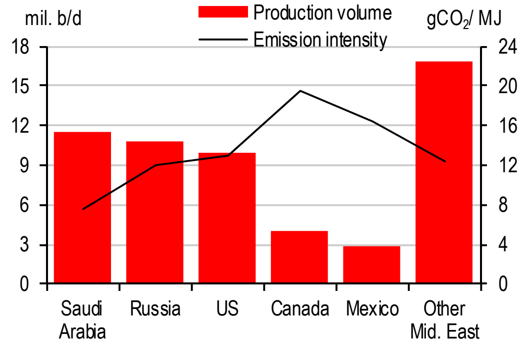


Source: BP Statistical Review 2014

In our view, the most comprehensive and robust carbon intensity estimates are published by the California Air Resources Board who estimate that the 2013 average carbon intensity of world oil *production* was 11.36gCO_2/MJ. This is estimated from calculations of countries who export to California.

Even within countries, the carbon intensity of oil production can vary greatly. In California alone, the range for producers is between 1.64gCO_2/MJ and 31.66 gCO_2/MJ. Outside of the US, carbon intensities range between 5.59 gCO_2/MJ (Eocene, Middle East) and 24.49 gCO_2/MJ (Suncor, Canada). For a complete breakdown and comparison of the studies available on the carbon intensity of production please see Appendix 1. The chart below shows average carbon intensity of country oil production, selected on the basis of importance to daily volumes.

Chart 12: Est. emissions intensity of the key producers

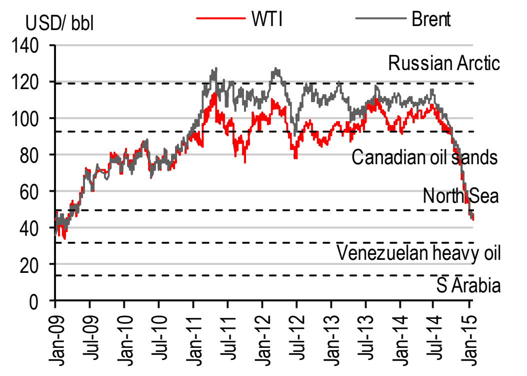


Source: Air Resource Board, California; BP Statistical Review 2014 Note: emissions intensity average is a weighted against volume of crude oil supplied to the refineries in California; crude production of the countries in the chart total c64% of global value

How flexible is short-term supply?

The scale and speed of the fall in oil prices took most market participants by surprise last year. Such a significant slide inevitably makes some high cost projects unprofitable. Chart 13 shows oil prices and break-even price of projects.

Chart 13: Project break-even and crude price



Source: Resources to Reserves, IEA, 2013, Thomson Reuters Datastream

In these circumstances, producers have a choice: continue to operate and take losses in the hope that prices will recover, or cut losses and shut down facilities. The ability and timeframe to withstand losses will depend on the type of producer (e.g. state owned or private) and diversification of reserves across the cost curve. The crucial point for assessing whether expiry of the carbon budget is brought forward or pushed back is how long it takes to curtail supply, and how this alters the average carbon intensity for global oil.

If supply can be curtailed quickly and that supply is high carbon, then this is positive for extending the time available to spend the carbon budget. For example, in HSBC's latest *Crude oil market insights* (10 February 2015), our Oil & Gas team writes that US oil rig count (the amount of rigs active in drilling liquid wells as compiled by Baker Hughes International) rose from 200 in early 2009 to a peak of 1609 in October 2014. Since then, it has fallen some 29%, pointing to a deceleration in the rate of growth of US output. However, the team highlights the need to be cautious of extrapolating the scale of the rig count decline to potential changes in expected US output growth.

HSBC

Table 1: Oil and Gas company's announcement on capital expenditure

Company	Announcement	Capital Expenditure 2013a	2014a	2015e	2016e	2017e	HSBC Commentary
BP (USDbn) Y-O-Y (%)	3-Feb	30.03 -	23.19 -23%	20.3 -12%	21.12 4%	22.67 7%	1) Organic capex to remain in the USD24–27bn range up to 2020. 2) 2015 guidance is now USD20bn, 12% y-o-y, 17% below previous guidance. 3) The cuts have been made to exploration spend and deferral of projects. 4) On 02 Feb 2015 HSBC revised the 2015e capex down by 12% compared to the 2014a
BG (USD bn) Y-O-Y (%)	3-Feb	12.17 -	9.41 -23%	5.91 -37%	6.68 13%	6.74 1%	1) Guidance midpoint is a cut of 31% y-o-y and 42% vs 2013 (USD11.2bn) 2) Spending in Brazil and on exploration are likely to stay flat. 3) Expenses in Australia and on operations are likely to be halved. 4) On 02 Feb 2015 HSBC revised the 2015e capex down by 37% compared to the 2014a
Statoil (USD bn) Y-O-Y (%)	6-Feb	15.56 -	16.58 7%	17.15 3%	17.79 4%	18.47 4%	1) Organic capex guidance was cut to USD18bn from the 2014-16 guidance of USD20bn and 2014's USD19.6bn. 2) A further reduction of USD5-7bn p.a. of capex flexibility from onshore and non-sanctioned projects can be expected if need be. 3) On 09 Feb 2015 HSBC revised the 2015e capex up by 3% compared to the 2014a
Total (USD bn) Y-O-Y (%)	2-Feb	31.5 -	27.27 -13%	23 -16%	23.74 3%	23.49 -1%	1) Increasing capex flexibility in 2016. 2) Capex will fall to USD20bn if Brent remains around USD60/bbl. 3) On 13 Jan 2015 HSBC revised the 2015e capex down by 16% compared to the 2014a
Chevron (USD bn) Y-O-Y (%)	30-Jan	37.66 -	36.82 -2%	31 -16%	30.01 -3%	30.55 2%	1) Capital and exploratory budget for 2015-USD35bn, 13%, lower than 2014. 2) Spending could be flexible in and beyond 2015 if crude prices remain low. 3) On 02 Feb 2015 HSBC cut its 2015e capex by 16% compared to 2014a
Royal Dutch Shell A/B (USD bn) Y-O-Y (%)	29-Jan	41.15 -	33.28 -19%	32.88 -1%	33.64 2%	33.77 0%	1) Capex to stay high at little below the 2014 levels. 2) Operating costs in 2015 to be reduced by over USD15bn over the next 3yrs. 3) Cuts declared are relative to 2015's potential spend and not 2014's actual. 4) Exploration spend to remain at USD40bn. 5) Restructuring global resource in the North Sea and Asia. 6) On 30 Jan 2015 HSBC revised the 2015e capex down by 1% compared to the 2014a

Source: Company Websites, HSBC

What about long-term factors?

In the long term, oil price declines could affect supply in two ways. Firstly, insufficient revenue generation implies a weaker ability to cover future costs on existing production pipelines which could result in mothballing, and secondly, projects that are no longer expected to be profitable at lower prices may not be started.

The recent company reporting season has given some indication of future investment flows for projects. It is difficult to assess the root cause of cuts in capex announced by companies i.e. whether they are due to mothballing existing projects or whether projects are shelved before they start. HSBC's Oil & Gas team believes that for the major oils, the easy area to hit is exploration spend, followed by new project sanctions.

Table 1 shows company announcements on capex cuts from oil and gas majors in HSBC coverage.

The largest cuts to 2015 guidance were at Total and Chevron, both expected to be down 16% in 2015 from 2014.

In addition, a number of service companies to the industry have announced cuts in employee numbers and capital expenditure. In January 2015, Schlumberger announced its decision to reduce its overall headcount by approximately 9,000. Halliburton announced that, as a result of declining activity in the sector and the weakening outlook during the fourth quarter of 2014, the company took a USD129m restructuring charge.

Box 2: A perfect storm

Climate policy + low prices = "stranded assets"

The carbon budget analysis sparked a debate among investors and academics on how and whether fossil fuels can be burned in the future to enable consistency with the CO_2 boundaries for a 2°C world. The argument was initially based on policy – that if CO_2 constraints translated into stringent climate policy, fossil fuels would be left in the ground and assets would be stranded, resulting in valuation downgrades. Now lower prices also add an economic dimension to the policy driver. Coal, the most carbon intensive form of electricity generation, is the key loser against a backdrop of tougher carbon constraints as well as pollution control. However, oil reserves are also exposed on both fronts.

Oil price declines have seen oil majors pull investment from high-cost oil projects.

Climate dynamic and demand

Climate dynamic*: Low oil prices stimulate end user demand for oil-based products, which would increase CO_2 release into the atmosphere in the short term. However, this depends on how much the demand for oil-based products increases at lower prices. It also depends on the carbon intensity of substitutes.*

The climate dynamic of oil demand is more difficult to assess than the supply side dynamic, in our view. This is because, in addition to change to CO_2 release during use of oil-based products (e.g. driving the car more because it's cheaper), there is also a CO_2 impact from the associated benefits that lower oil prices bring to consumers, such as freeing up disposable income to buy other goods and services indirectly linked to oil.

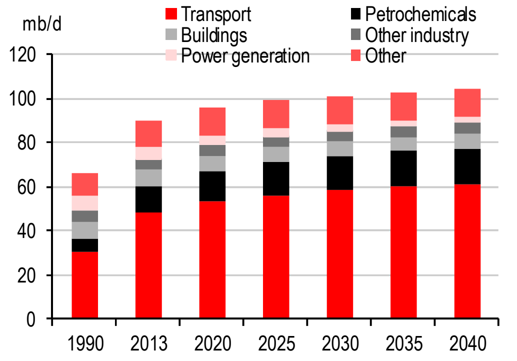
In our opinion, the two main factors to consider in relation to oil prices and demand for oil-based products in isolation (i.e. outside the wider economic ramifications) are:

- The price elasticity of demand for oil-based products
- The carbon intensity of oil use compared with oil substitutes (e.g. LNG or ethane feedstocks) and the ease of substitution

Price elasticity factors

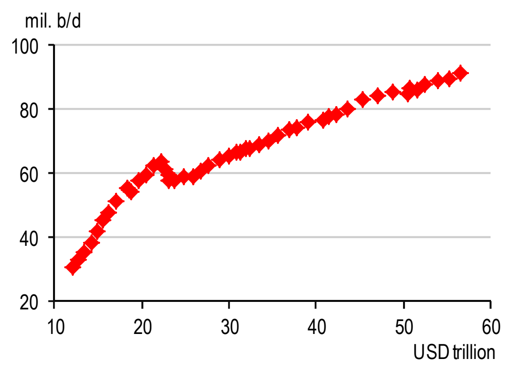
The demand for oil is dominated by the transport sector, which consumes over half (54% according to the IEA or 59% according to OPEC) of total oil, but it is also used in petrochemicals and other industries, as is shown in Figure 2. Here we focus on the largest end markets of transportation and petrochemicals, together comprising two-thirds of oil use, according to the IEA.

Chart 14: Oil demand by sector in the New Policies Scenario



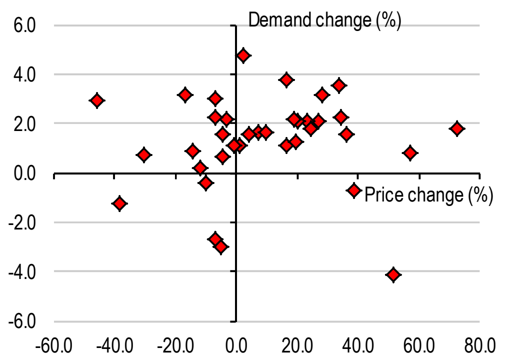
Source: World Energy Outlook 2014, IEA

Chart 15: Oil consumption vs GDP



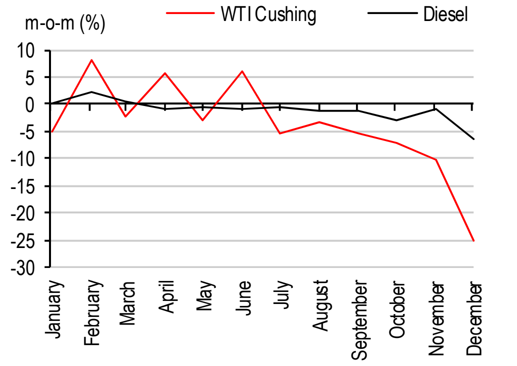
Source: BP Statistical Review 2014, World Bank

Chart 16: Price elasticity of oil



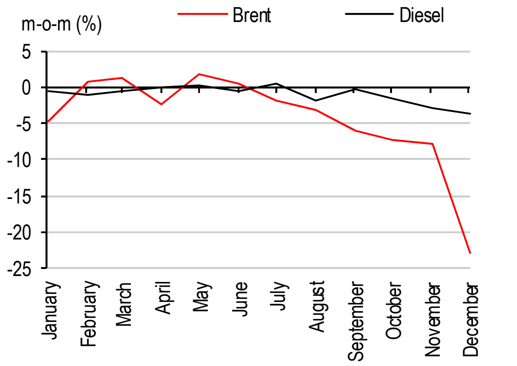
Source: BP Statistical Review 2014

Chart 17: Diesel pump price vs benchmark crude price: USA



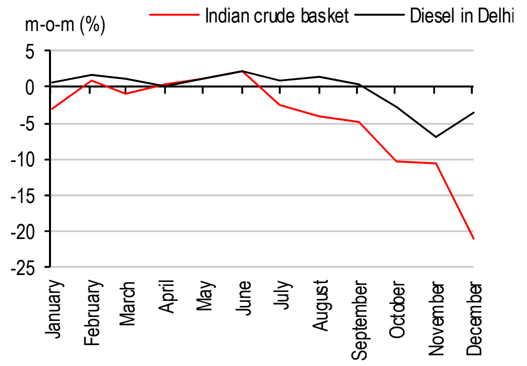
Source: EIA, Thomson Reuters Datastream

Chart 18: Diesel pump price vs benchmark crude price: UK



Source: DECC, Thomson Reuters Datastream

Chart 19: Diesel pump price vs benchmark crude price: India



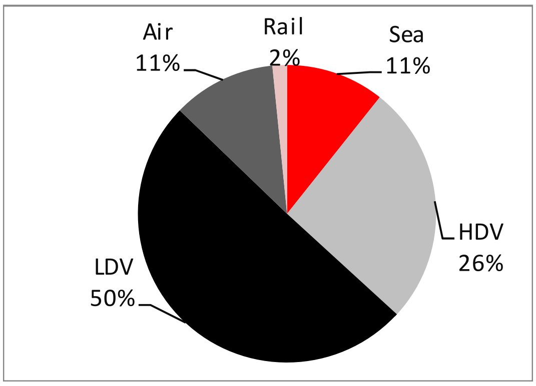
Source: Petroleum Planning & Analysis Cell, India

Transport

Within the transport sector, road (gasoline and diesel combined) is the largest user, followed by aviation and marine transport, as seen in Chart 20.

However, we think the main driver of demand for transportation is economic backdrop rather than the price of oil, since there is little reason to demand more travel in isolation of other factors. For instance, a commuter is unlikely to drive a longer route to work simply because it is cheaper to do, (i.e. number of kilometres driven does not go up and therefore no extra oil is used because of cheaper prices) but could spend the saved cash on other things. However, this can also be a culturally and regionally specific factor. Similarly, freight companies will not materially increase shipments as the fuel input costs of doing so have decreased.

Chart 20: Transport Consumption of oil, 2011



Source: ETP 2014, IEA

Road: Transport by road falls into two categories: passenger vehicles and freight vehicles.

For *passenger vehicles*, more people took public transportation when oil prices went up, but we think the switch back to road may not be as straightforward. This is because it depends on passenger vehicle ownership (i.e. train commuters would need to buy a car) which is more determined by overall economic backdrop than the price of oil, in our view. In addition, for those that own passenger vehicles, we think lower oil prices mean more discretionary income rather than burning more oil – because road trips are usually made out of necessity (to get to work or school etc.) rather than for fun i.e. spending your weekends driving around aimlessly just because the cost of petrol is low. We believe oil consumption from passenger vehicles is more about fuel efficiency over time and the overall demand for cars rather than the price of oil.

For *heavy duty vehicles* which transport freight, we do not think that a decrease in oil prices leads to more freight transported by road since the demand for freight logistics is based more on the economic backdrop than freight costs.

It is important to note that a 50% drop in the oil price does not translate to a corresponding drop in the 'pump price' - the cost of gasoline or petroleum at service stations. The taxes put on these oil derivatives are a major component of the pump price. In the UK, for instance, tax is applied per litre sold and currently accounts for just over half the pump price.

Fossil fuel subsidies also affect the pump price although, unlike taxes, subsidies at the retail level will *reduce* the pump price. Subsidies are a major expense to many governments and recent months have seen the removal of subsidies in Thailand, Malaysia, India, Egypt, Morocco and Indonesia. With lower oil prices, the impact to countries and consumers of the removals is reduced. However, this also means that the pump price has failed to drop with the oil price.

Graphs 17, 18 and 19 illustrate the relationship between the falling oil price and local pump price and the fact that this is far from 1 to 1. Graph 16 shows change in demand for oil against change in price.

Aviation: According to HSBC transport analyst Mark Webb, passenger air travel is extremely price elastic – when prices drop, travel goes up. Airlines have been suffering under high oil prices for a decade and so most likely welcome lower prices, however, it does not mean that they will lower total fares in light of oil price declines. For freight, again the demand is based more on economic conditions than freight costs.

Marine: Container shipping lines collectively slowed steaming speeds to save fuel when oil prices were high. HSBC's container shipping analyst, Parash Jain, believes that the industry is unlikely to increase speeds (i.e use more fuel) given the sustained overcapacity in the system. Most long-haul routes have organised into alliances (with container lines each putting forward a specific number of vessels) and this is difficult to unwind given regular port calls and port capacity.

Petrochemicals

The petrochemical sector is the second largest user of oil, but at just over a tenth of oil demand, this is far behind transportation. Some 90% of the oil used in the petrochemical industry is as a feedstock for producing other chemical products. The balance is used for energy and operational needs.

Naphtha is one of the most important feedstocks for the petrochemical industry and is derived from oil. It is used to make important base chemicals, which in turn are used to make olefins and aromatics.

The overall demand for petrochemical products is more generally linked to the general economy than oil prices. As economies become more wealthy, consumption of plastics and fibres increase. We do not believe that the petrochemical industry would make more product just because oil prices are low – without first assessing the demand or ensuring the cost effectiveness of storage and inventory build-up.

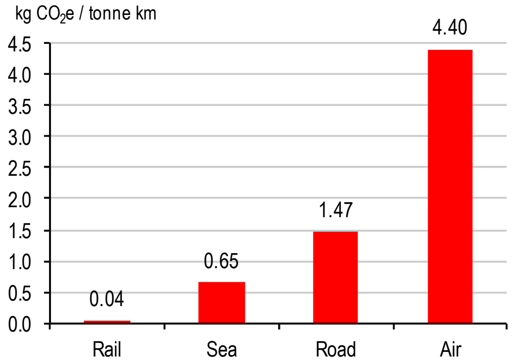
In general, petrochemical plants are configured to use a specific type of feedstock i.e. either oil-based or gas-based such that switching would require a reconfiguration. However, some newer plants have been designed to be able to take any feedstock.

Lower carbon substitutes

Besides the overall economic backdrop and its influence on demand for transportation and petrochemicals, over the long term, there is the potential to shift towards less carbon intense substitutes.

Transport

Chart 21: GHG intensity of UK freight (2011)



Source: Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting

Given the logistical requirements of transporting certain goods, it is not always simple to switch between the modes of transportation. Instead, we look at the long-term shift potential and the alternatives to burning oil in combustion engines.

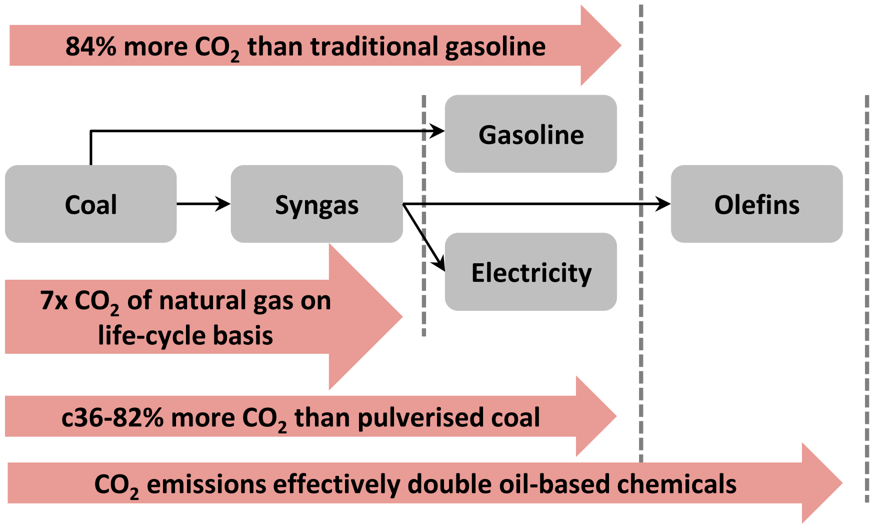
Gas, in the form of liquefied natural gas (LNG) is already being used to power ships engines, while LNG and compressed natural gas (CNG) can be used in trucks. However, we think gas-powered engine adoption needs to be incentivised – either by policy or by price. The economic rationale for investment in gas-infrastructure for transport became firmer over the last decade or so when oil prices climbed and gas prices rose less steeply or even dropped, as in the US. Now that oil has lost more than half its recent market price, from a purely economic perspective, infrastructure investment may make less sense.
In addition, supporting infrastructure such as refilling stations in ports and alongside highways has been a hurdle to more widespread conversion.

The development of electric vehicles (EVs) has gathered pace and provides another alternative to oil-dominated fleets. In parts of the US, networks of charging points are dense enough to allow electric vehicles to compete with traditional gasoline cars in terms of practicality and performance locally. However, similar to gas engines, supporting infrastructure is holding back more rapid development across the world.

Petrochemicals

Although naphtha is oil-based, feedstocks can also be derived from coal and natural gas. The development of non-oil-based feedstocks has advanced in recent decades – more to do with the location of oil reserves and only in part because of the oil price. Ethane, which is easily derived from natural gas, has become a more important feedstock, especially in the US where the shale gas boom and the resulting lower cost of gas has caused a shift towards ethane over naphtha. Elsewhere however, naphtha remains the dominant feedstock.

Chart 22: Oil-based petrochemicals are much less carbon intense than coal-based petrochemicals



Source: HSBC estimates (based on Yang et Jackson, Zhu et al, Ren et Patel)

China has much less oil and gas reserves in comparison to its vast abundance of coal reserves. As it seeks to become more self-sufficient in basic chemical products, it has needed a steady supply of feedstocks. This has resulted in the development of a coal-to-chemicals (CTC) industry although this has been fraught with other environmental problems (see our report *Coal-to-chemicals*, 25 March 2014). In short, CTC requires a lot more water and releases much more CO_2 than traditional oil-based processes (Chart 22).

HSBC's chemicals analyst, Geoff Haire, believes that the falling oil price is a further hindrance to the beleaguered CTC industry in China. We believe this is positive from a climate change perspective since oil-based petrochemicals are less carbon intense than coal-based ones.

Other uses of oil

According to OPEC, oil's share of power generation has fallen from 13% in 1990 to below 6% in 2011 (World Energy Outlook 2014). This is mainly as a result of growing use of other fossil fuels (coal, gas) but also nuclear and renewables. Globally, the use of oil has been growing in certain other areas, especially in developing countries. In agriculture, there has been a move towards mechanisation (tractors as well as diesel pumps for irrigation). There is also a trend of increasingly burning oil instead of biomass for cooking. For other industries, the high price of oil over the last decade has stimulated research into alternatives.

Climate dynamic and wider impacts

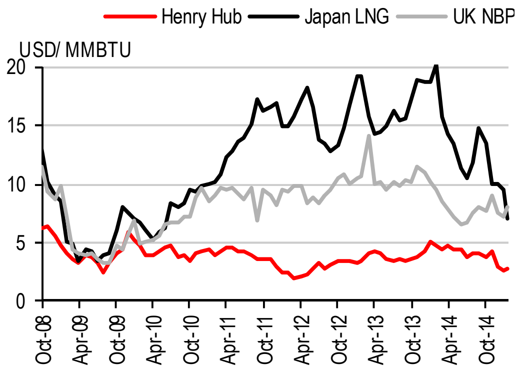
The broader state of the economy and country dependence on fossil fuels for power generation are also important. Global economic output is a key determinant of CO_2 output from one year to the next, but there are also regional drivers. In a broader economic context, the repercussions of lower oil prices will impact the current account surplus/deficit, employment, inflation and growth, and HSBC economists have looked at this in detail. Their reports are listed in the references section. Oil prices are connected to how economies will perform in the short term, and the circular effect of prices, demand and CO_2 is difficult to disaggregate in our view.

Oil read across to gas

Although oil is not in direct competition with coal, gas and renewables in power generation (it is only used for 6% of electricity), price moves in oil have read across for the comparative price economics across coal, gas and renewables. This is important for assessing the potential speed of transition to lower carbon sources.

Oil, as a global commodity, can be shipped cheaply. While day to day the WTI/Brent benchmark spread narrows and widens depending on local demand and the cost of transport – over the long term they are essentially correlated. Gas, on the other hand, is mostly used locally, as storage and transport is costly, so there can be significant variation in prices between the hubs, as shown in chart 23.

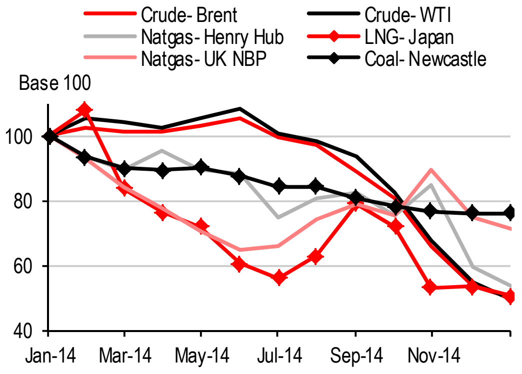
Chart 23: Gas prices



Source: Thomson Reuters Datastream

In Asia, most gas used is imported as LNG, with the Tokyo LNG price commonly quoted. This is linked to the Japan oil price, by a formula with a cap and a collar. Oil price moves are therefore directly relevant for the economics of gas as an electricity feedstock in Japan. This is not the case in many jurisdictions. Meanwhile in the UK the National Balancing Point (NBP) is the key measure of UK while Henry Hub is the main US benchmark.

Chart 24: Fossil fuel prices, (rebased on 1st January 2014)



Source: IMF, Thomson Reuters Datastream

The US experience of declining coal share in the power mix shows that a price signal prompts change which can be quite quick. Natural gas took most of the coal share as shale gas has moved from a fringe

technology to a major contributor to the US gas supply. Chart 25 shows this momentum away from coal and also how coal-to-gas switching is the most apparent dynamic.

US gas prices dropped with the boom in shale gas, but the switch from coal has also been supported by environmental policy limiting coal-fired power.

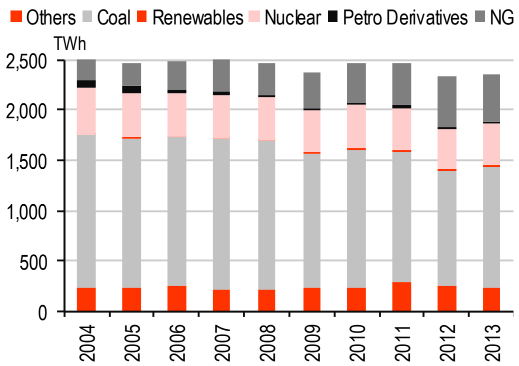
Conclusions

Isolating the global CO_2 impact (i.e. positive or negative from a climate perspective) from oil price changes means aggregating the supply, demand and wider effects and establishing if the net balance is an increase or reduction in CO_2.

From a pure consideration of supply and direct oil related use, we think that *in the short term* lower oil prices are beneficial for CO_2 (i.e. less emitted), because the marginal supply of oil is from lower carbon intensity sources and it will take time for demand changes to filter into the wider economy.

We think the read across from oil price falls to gas prices makes gas more competitive with coal for power generation which would be beneficial for the carbon intensity of the energy mix. However, there is still a gap between business as usual emissions and the emission reduction goals set out by the carbon budget so catalysts that extend the time before budget expiry are beneficial. We look at this in the next chapter.

Chart 25: USA – Electricity generation by energy source



Source: EIA

HSBC

Drivers that buy time

- Regulation: Country submissions for the global deal will demonstrate ambition for tackling climate change
- Technology: scale up of low carbon technology deployment
- Innovation in the gas industry: coal to gas switch is lower carbon

Meeting 2°C means change

In the first chapter we set out that the long-term climate goal is to keep temperature rises under 2°C, and that monitoring the carbon budget shows whether the world is moving closer to or further away from achieving that goal. In chapter 2, we looked at climate and oil dynamics, and noted there are also many other factors to take into account outside the pure oil and climate dynamic that influence whether time available before budget expiry is extended or depleted. Here we look forward at the catalysts that could trigger changes in the energy system, and identify the industries that have exposure.

Meeting the 2°C goal means making changes to the way energy is supplied and consumed, by moving away from high carbon towards low-carbon sources. We think there are three main drivers – regulatory, technology and cost (gas industry specific) that if realised could change the status quo in the energy economy and would be positive for climate change. To be clear, by positive for climate change we mean extending the time frame until carbon budget expiry.

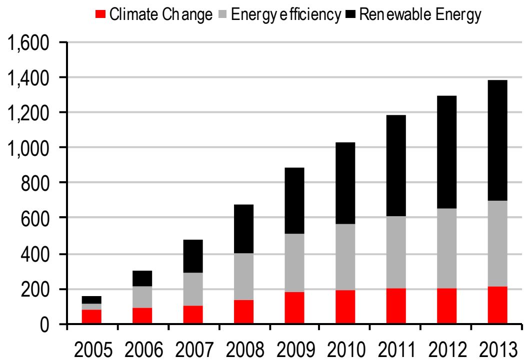
What are the drivers?

Regulation

In 2015 climate focus is on the delivery of a universal climate agreement (UCA) in December (see our reports *2015*: *Dissect, Debate, Deliver*, 7 January 2015 and *Geneva climate talks deliver*, 18 February 2015). The aim is to deliver a UCA that will come into force from 2020. We expect an agreement in Paris at the end of the year but are currently doubtful that the individual country emission reduction goals will be sufficient, when aggregated, to be consistent with the carbon budget set out for the 2°C goal.

Country policy to tackle climate change can take shape in a variety of formats, such as subsidies, standards or target levels, but they are in essence designed to tackle the same problem, which is enabling the transition to a low-carbon economy by using less energy and decarbonising the energy mix. So far, legislation has been a key driver because energy price signals have not been compelling as a market driver – coal was the cheapest fuel for power generation and also the most carbon intense (see our report *Keeping it cool*, September 2014).

Chart 26: Total number of Climate policies since 2005



Source: IEA Policies and Measures Database

Lower oil prices don't change our view that a UCA will be signed, but they do have implications for individual country ability to implement domestic climate policy in our view. For instance, oil importing countries now have more funds freed up for other purposes, whereas net exporters are likely to be more resistant to low-carbon policies such as decarbonising transport infrastructure for example.

Most countries are currently preparing intended nationally determined contribution schemes (INDCs) in preparation for a universal climate agreement. These will set out what countries plan to achieve in terms of emission reduction and embedding resilience to the consequences of warmer temperatures. The idea is that the INDC aims will be delivered through national legislation.

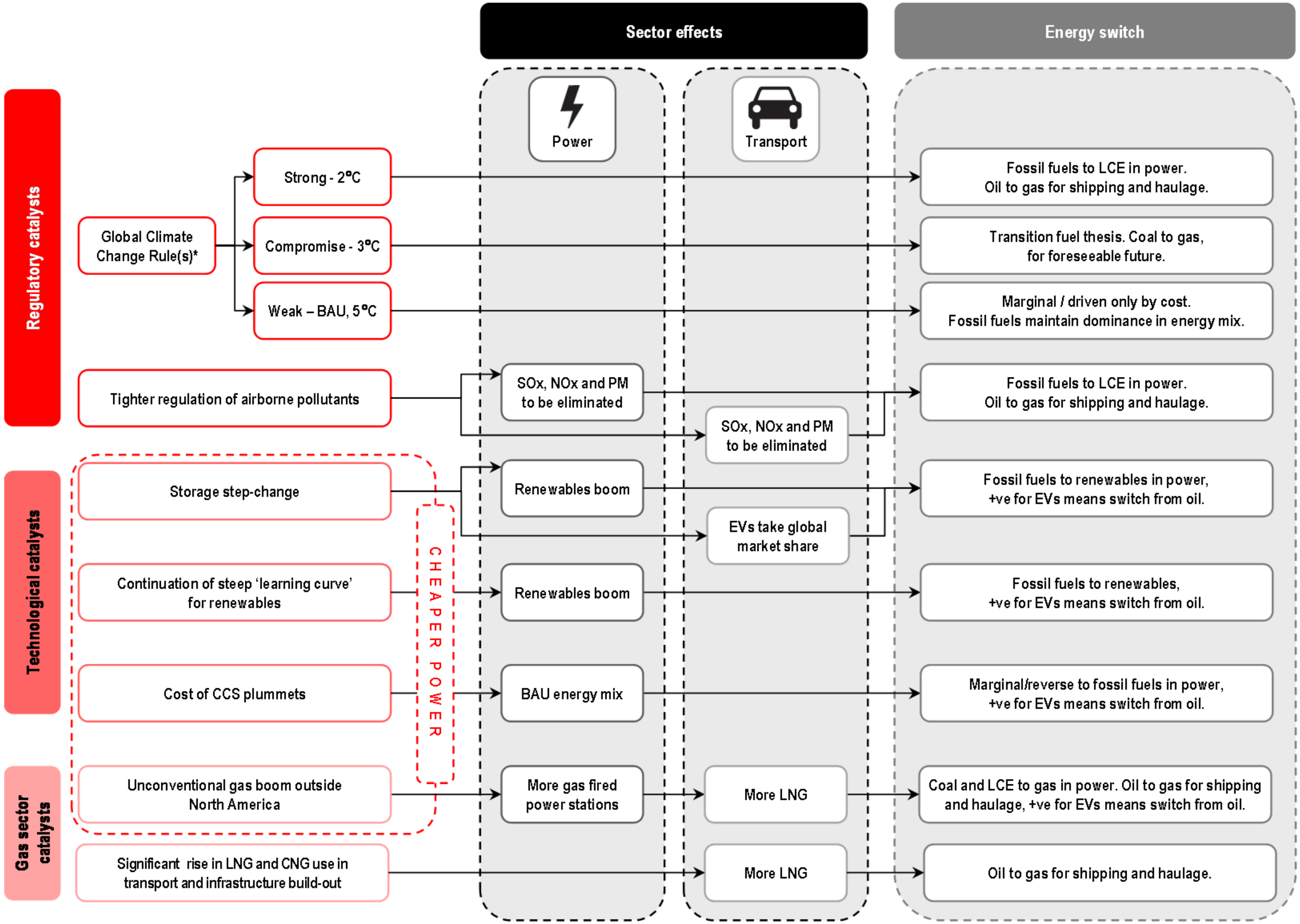
The level of ambition put forward in the INDCs will be, in our view, at least in part dependent on the relative economic strength of the country and its dependency on high carbon assets for national income generation. In any case, we expect a regulatory driven shift away from the highest carbon fossil fuel sources in power generation – what is difficult to determine is the scale and speed of the shift. Regulation implementation can be slow however, so price signals that speed up the transition are beneficial.

Figure 3 shows how different regulatory outcomes would disrupt the energy economy. Strong climate change regulation which targets a 2°C world would bring significant decarbonisation. This would require a switch from burning fossil fuels to low carbon energy forms in power generation, and a switch from oil to gas in transport.

Regulation which entails a less stretching temperature increase target would catalyse a switch from coal to gas, while a business-as-usual outcome to the current push towards a Universal Climate Agreement to the growing patchwork of national level regulations would mean that fossil fuels maintain dominance of the energy economy, with low carbon alternatives able to compete only on cost and convenience.

Strong regulation of local air pollution, often driven by health concerns, typically targets nitrogen oxides, sulphur oxides and particulate matter. Compliance can be achieved by switching to low carbon power generation and from oil to gas in the transport sector.

Figure 3: Potential disrupters to the carbon budget



Source: HSBC

Innovation in the gas industry

If extraction of shale or other unconventional gas sources becomes widespread in other geographies, this would catalyse switching to gas in power and transport. This is shown in the outcomes column on figure 3 and could occur if known gas reserves become economically viable or if new reserves are discovered.

Figure 3 illustrates how gas takes energy market share from oil and coal. As well as oil price falls, natural gas and coal have also fallen in the last 12 months as shown in chart 24. The crucial point from a climate perspective is whether the price differential between primary energy sources makes lower carbon more favourable economically. Coal prices have not fallen as far recently as natural gas and oil so the price differential is now in favour of gas. This is positive in a climate context because gas is less carbon intense than coal.

Cheaper gas is supportive of switching from coal to gas as power feedstocks in the short to medium term. Cheaper power is supportive of uptake of electric vehicles (EVs). In the medium to long term, we believe investment in LNG and compressed natural gas (CNG) in shipping and heavy goods vehicles will also grow substantially in a lower oil and gas price environment, supported by climate and pollution policies.

The levelised cost of electricity (LCOE) measures the average cost of producing a unit of electricity over the source's lifetime. Total quantity of electricity generated is effectively divided by the sum of the capital expenditure, operational expenditure, cost of energy and transport.

The global central LCOE scenarios are based on a blend of inputs from competitive projects in mature markets, as well as a range from the lowest to highest LCOEs for major energy technologies. For coal, gas and nuclear, the data is available to split out central scenarios for China, the US and the EU. While LCOE range for coal is marginally lower than gas, the US central scenarios make clear the economic rationale for its recent coal-to-gas switching.

Technology scale up

Advancements in technology have, over time, provided major catalysts to the supply and demand sides of the energy economy. Examples include the rapid switch from steam to diesel trains and from fossil fuel and hydro energy to nuclear in France's energy mix

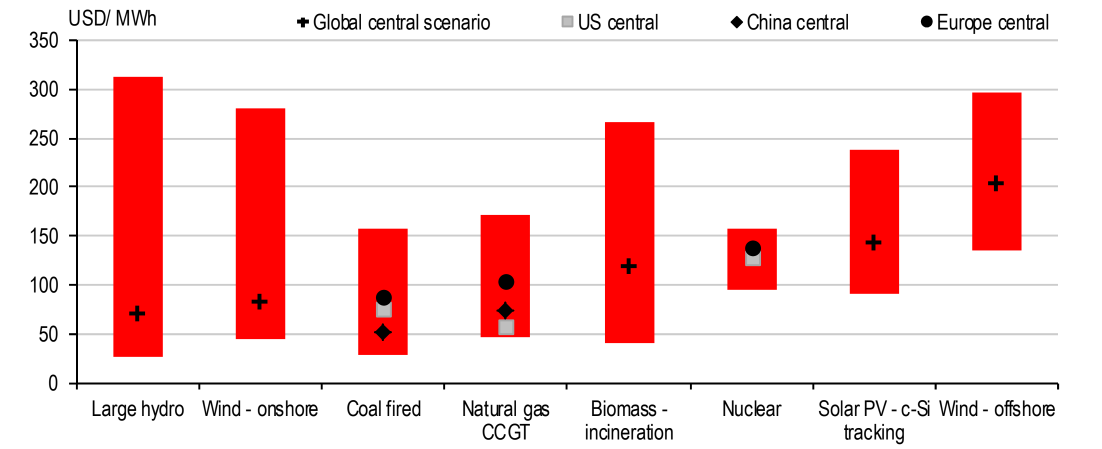
Such advancements can disrupt the relationships illustrated in the earlier flowcharts which depict the energy economy. Key areas where we foresee potential for disrupting technological advancements, which are included in figure 3, are as follows:

Renewables

Many countries have adopted climate policy frameworks which explicitly support renewables via subsidies or feed-in-tariffs until the industry becomes established. Renewables may also experience policy support implicitly, via decarbonisation targets. Increasing the share of renewables in the energy mix also largely separates the cost of energy from the volatility of energy commodity markets, which is attractive to energy importing nations in particular.

Renewable energy costs have come down over time. The trend to cheaper renewables contrasts with oil, where harder-to-access reserves are more costly to develop. If this trend continues or were to accelerate

Chart 27: Levelised cost of electricity

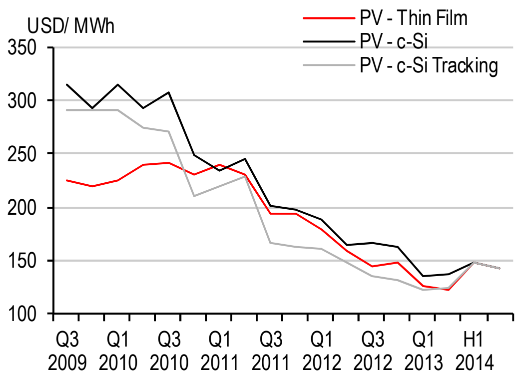


Source: BNEF, Global LCOE xls, 14 August 2014

dramatically, this would trigger an economically-driven decarbonisation of the power sector, the section of the energy economy which contributes most towards carbon emissions.

Onshore wind is already competitive with fossil fuels as is shown in the LCOE graph. The graph also shows that solar remains more expensive at the central scenario than its fossil fuel competitors. However, chart 28 shows how quickly the solar price has come down in recent years. If this trend continues, we can expect to see increases in its competitiveness.

Chart 28: Falling cost of solar PV



Source: BNEF, Global LCOE xls, 14 August 2014

Electricity storage

A dramatic advancement in battery storage would transform the energy economy, catalysing the growth of renewables in the energy mix as the energy produced could be stored until needed. Storage also has important implications for the transport sector. Currently, batteries are an expensive and bulky component in electric vehicles (EVs). A step-change would clear an important hurdle in their ability to take significant market share from traditional petroleum-burning engines.

Carbon capture and storage

Carbon capture and storage (CCS) refers to technologies which capture carbon dioxide generated by burning fossil fuels, usually in power generation and industry, and sequestering it so that it does not enter

the atmosphere. It is technically feasible in certain scenarios. However, it is currently very expensive. If costs were to plummet, in theory CCS could allow continuation of burning fossil fuels in power. Power would then continue to benefit from the ability to use all potential feedstocks, reducing costs and further catalysing EVs.

These technological drivers are all in existence today. Cost reductions and technical improvements would increase their potential as disruptive catalysts to the power sector.

Conclusions

Meeting the 2°C goal means making changes to the energy economy. Changes can happen both on the supply and demand sides. Most will involve moving from high carbon towards low-carbon sources. We think there are three disruptive areas – regulatory, technology and gas-industry specific – that if realised could change the status quo in the energy economy. We expect regulation to continue to be an important driver for change. Global and national climate policies will lay the foundations for the extent to which the energy economy tips towards de-carbonisation. The next policy catalyst will be when countries publish 'intended nationally determined contributions' (INDCs) detailing proposals for emission cuts post 2020. These are due in March and we expect them to set out country positioning on mitigation and adaptation.

The gas industry boom in the US has shown that if the economics of energy production change significantly, a transition to lower carbon sources can happen quickly, which is good news for climate as it extends the time frame before carbon budget expiry. Price and technology signals that make this happen quicker are positive from a climate perspective.

Step changes leading to dramatic reductions in the cost of existent technologies, particularly renewable energy, batteries and carbon capture and storage would also disrupt the existing energy economy and be positive from a climate perspective.

References

Selected HSBC climate change reports:

EU: climate strategy on track, February 2014, Zoe Knight, Wai-Shin Chan and Ashim Paun

Geneva climate talks deliver, February 2014, Zoe Knight, Wai-Shin Chan and Ashim Paun

EU: Saving energy, February 2014, Zoe Knight, Wai-Shin Chan and Ashim Paun

India & US: Courting consensus, February 2015, Zoe Knight, Wai-Shin Chan and Ashim Paun

Pollution control in shipping, January 2015, Zoe Knight, Wai-Shin Chan and Ashim Paun

Feverish planet, January 2015, Zoe Knight and Wai-Shin Chan

US to regulate methane emissions, January 2015, Zoe Knight and Wai-Shin Chan

Korea's emissions trading begins, January 2015, Zoe Knight and Wai-Shin Chan

2015: Dissect, debate, deliver, January 2015, Zoe Knight and Wai-Shin Chan

Elaborating the elements of Lima, December 2014, Zoe Knight and Wai-Shin Chan

Letter from Lima, December 2014, Zoe Knight and Wai-Shin Chan

Elements of Lima, December 2014, Zoe Knight and Wai-Shin Chan

GCF: Gained Cash Fast, November 2014, Zoe Knight and Wai-Shin Chan

China-US agree emissions deal, November 2014, Zoe Knight and Wai-Shin Chan

IPCC: The time for action is now, November 2014, Zoe Knight and Wai-Shin Chan

A busy week at the climate B&B, October 2014, Zoe Knight and Wai-Shin Chan

Oil price falls, October 2014, Zoe Knight and Wai-Shin Chan

BASIC: Finance is still key, October 2014, Zoe Knight and Wai-Shin Chan

China: Turning the cleaner heat on, October 2014, Zoe Knight and Wai-Shin Chan

AUM CO_2: info and action, October 2014, Zoe Knight and Wai-Shin Chan

It's up to you, New York, September 2014, Zoe Knight and Wai-Shin Chan

Keeping it cool: Financing a 2°C World, September 2014, Zoe Knight and Wai-Shin Chan

Selected HSBC Oil and Gas company reports:

BG (BG/ LN) OW: disposals, capex cuts help offset balance sheet risks, 04-Feb-15

BP (BP/ LN) OW: Capex cuts underpin support for the dividend, 04-Feb-15

Chevron (CVX US) OW: Promising signs of falling capital intensity, 02-Feb-15

Crude oil market insights: Inventory builds, spending falls, February 2015

Royal Dutch Shell B (RDSB LN) Downgrade to N: Dividend outlook robust, but capex guidance disappointing and shares have outperformed, 30-Jan-15

Statoil (STL NO) OW: raising TP on greater confidence in free cash outlook, 09-Feb-15

Total (FP FP) OW: Strategy update - free cash outlook remains solid, 13-Feb-15

Other references

Ad hoc working group on the Durban platform for enhanced action, Negotiating text, Advance unedited version, 12 February 2015

Carbon Intensity of Crude Oil in Europe, The International Council on Clean Transportation, Dec 2010

Canadian Oil Sands: Life-Cycle Assessments of Greenhouse Gas Emissions, Congressional Research Service, March 10, 2014

CO_2 emissions from fuel combustion highlights (2013 edition), IEA

Emissions Gap Report 2014, United Nations Environment Programme (UNEP)

International Energy Agency, Energy Technology Perspectives 2014 - www.iea.org/etp

World Energy Outlook 2014, IEA

World Oil Outlook 2014, OPEC

World Resource institute, CAIT, GHG and CO_2 emission data - www.wri.org

Notes

Disclosure appendix

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