

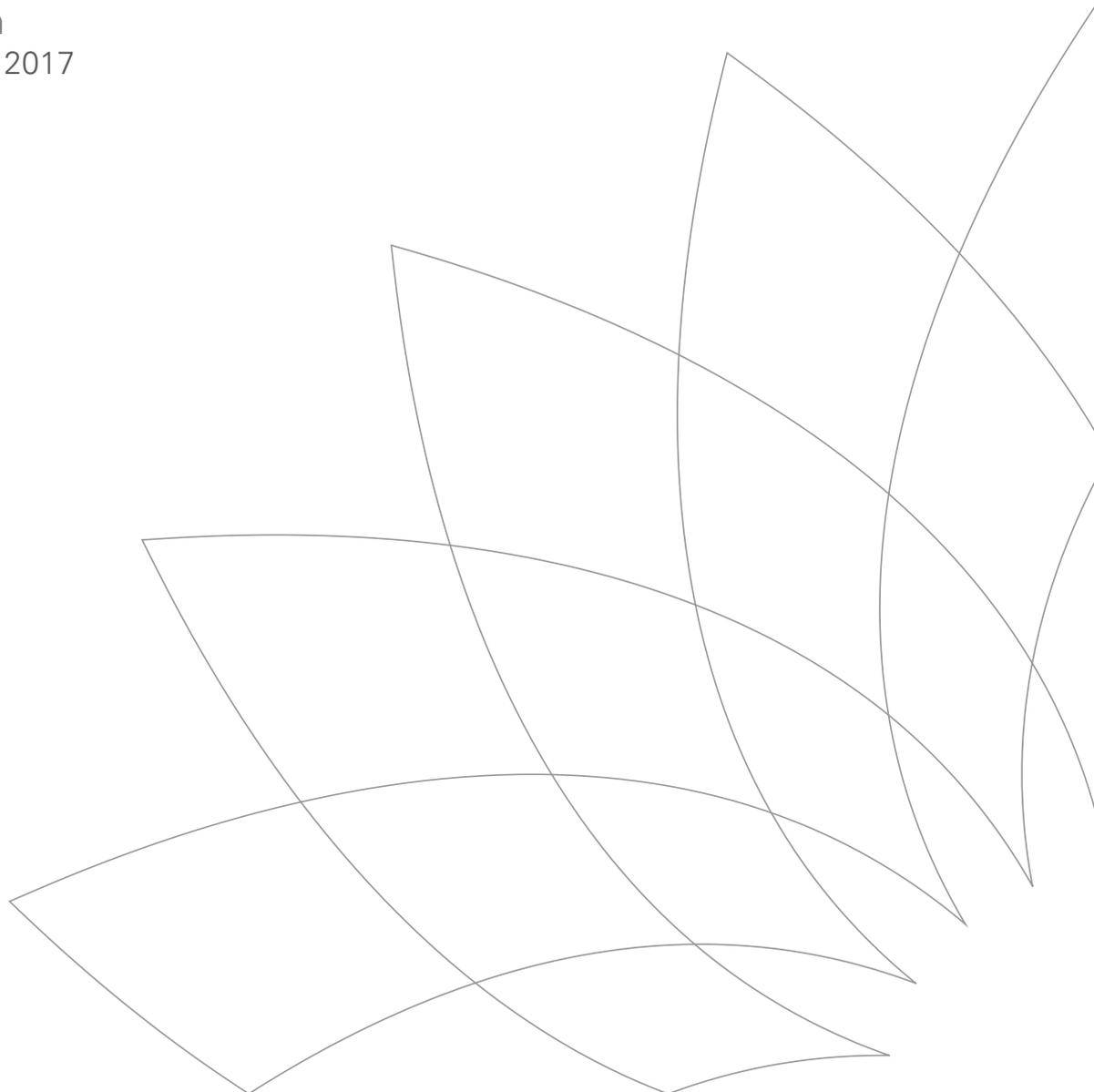


# Energy in 2016: short-run adjustments and long-run transition

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London  
13 June 2017





## 1. Introduction

This is the third Statistical Review that I have managed. And I must admit I approach the task with equal amounts of honour and trepidation.

The Stats Review has a well-earned reputation, built up over many years, for being THE reference source for comprehensive, accurate and timely global energy data.

It has been serving this role for far longer than I have been alive and will carry on long after me.

My job is not to change or revamp the Stats Review; rather it's to maintain the commitment to accuracy and objectivity for which it has become known.

I saw an advert for an expensive watch recently, which had the tag line that "you never actually own the watch, you merely look after it for the next generation".

That's exactly what it feels like leading the Stats Review. We may polish the face occasionally or buy a new strap, but we don't mess around with its core values and purpose.

My role as guardian of this valued asset is made hugely easier by the work of the Economics team who, as always, have worked tirelessly over the past couple of months to produce this year's Review.

And by the team from Heriot-Watt University, led by Mark Schaffer and Erkal Ersoy, who yet again provided great help and support.

A huge thanks to all of them – this is very much a team effort.

Stability and energy markets don't go together. It's like England and summer or, perhaps after last week, predictability and elections.

Booms and busts; rebounds and reversals are the norm.

But the movements and volatility seen last year in energy markets were particularly interesting since they were driven by two separate forces: the continued adjustment to the short-run – cyclical – shocks that have rocked energy markets in recent years; overlaid by the growing gravitational pull from the longer-run energy transition that is underway.



Short-run adjustments and long-run transition.

The need for near-term adjustment was most obvious within the oil market; the coal market – as we shall see – also faced its own near-term surprises.

Documenting these adjustment processes, learning how industry and markets adapt and adjust to these cyclical disturbances, is meat and drink to the Statistical Review. It's what we do.

But these cyclical adjustment mechanisms are being increasingly affected by the longer-run transition that is shaping global energy markets. On the demand side: the shift in the centre of gravity to fast-growing developing economies, led by China and India; together with a slowing in overall energy growth as it is used ever more efficiently. And on the supply side, the secular movement towards cleaner, lower-carbon energy, led by renewable energy, driven by environmental needs and technological advances.

This year's Stats Review shines a light on both factors driving energy markets in 2016: short-run adjustments and long-run transition.

## 2. Key features of 2016

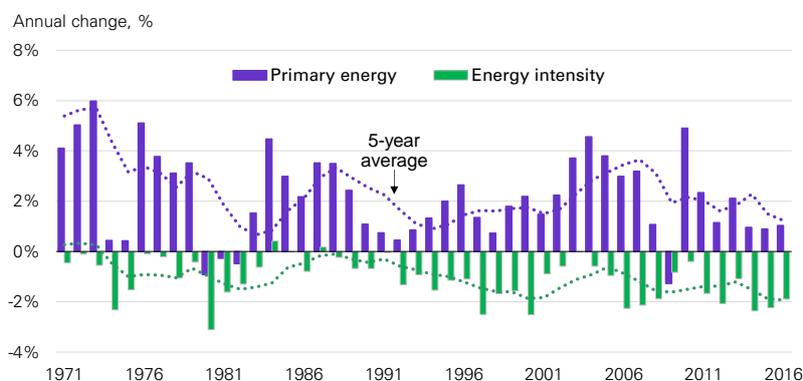
The confluence of these two forces can be seen clearly in the headline numbers.

Primary energy grew by just 1% (171 Mtoe) in 2016, almost half the average rate seen over the previous 10 years.

Some of this weakness reflected short-run factors: global GDP grew by just 3% last year, its slowest rate since 2002, other than at the time of the financial crisis, driven in part by a slowdown in industrial production, the most energy-intensive sector of the economy.

But the weakness is also indicative of the longer-run trend towards slower energy growth driven by gains in energy efficiency. This is the third consecutive year in which energy consumption has grown by 1% or less, with the 5-year average growth rate at its lowest level for over 20 years. This slowing has gone hand-in-hand with falls in energy intensity – the average amount of energy needed to produce a unit of GDP – which has also improved at historically rapid rates.

## Primary energy and energy intensity

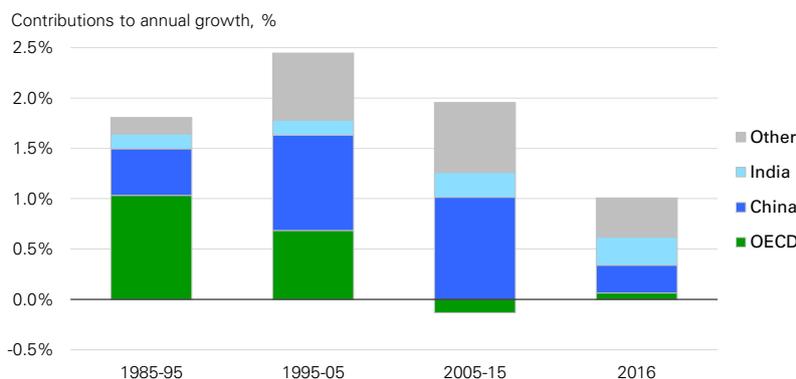


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As is now the new normal, almost all of the growth in energy consumption came from developing economies: energy demand in the OECD was essentially flat (0.2%, 24 Mtoe). China (1.3%, 47 Mtoe) and India (5.4%, 39 Mtoe) once again led the way, contributing similar increments, and together accounting for around half of the increase in global demand.

But these similar contributions disguise sharply contrasting trends. India's energy consumption grew at a similar rate to the recent past, underpinned by solid economic growth and a relatively stable economic structure. In contrast, China's energy consumption grew at less than a quarter of the rate seen over the previous 10 years.

## Energy consumption growth



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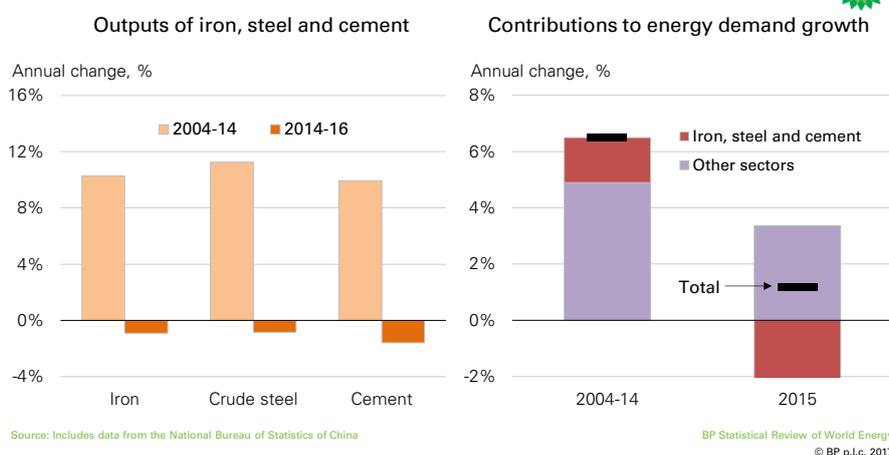
This brake in China's energy consumption partly reflects the general slowdown in economic growth. But it has been greatly compounded by the particularly pronounced weakness in China's most energy-intensive sectors, particularly iron, steel and cement,

whose outputs have fallen in absolute terms in recent years. The key point here is that these sectors account for around a quarter of China's total energy consumption and have played a major role in the recent slowing in China's energy demand.

Some of the weakness in these sectors, which were the powerhouse of China's rapid growth and industrialization over much of the past 20 years, reflects the structural rebalancing of the economy towards more consumer and service facing sectors. But the scale of the slowdown suggests that some bounce-back is perhaps likely.

Short-run adjustments and long-run transition.

### China industrial output and energy demand

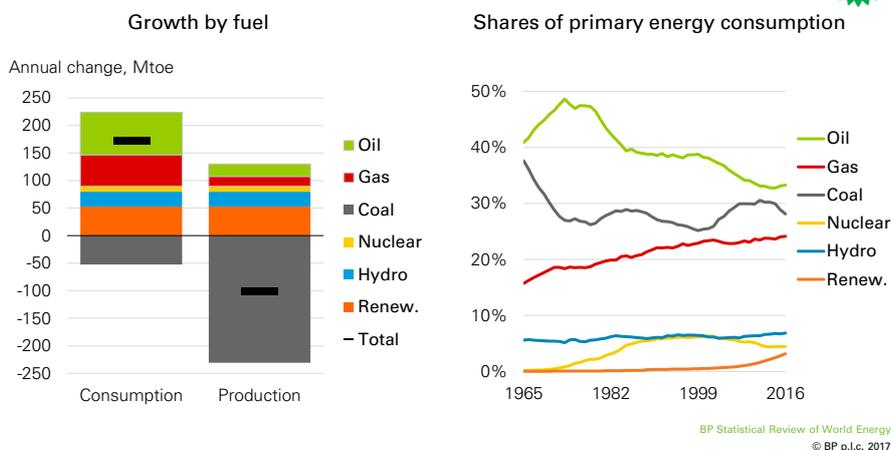


The story in terms of individual fuels also reflects a mix of these two forces.

One symptom of the short-run adjustment was that consumption of oil, natural gas and coal all grew more quickly than production in 2016, as markets responded to excess supplies.

Renewable energy (including biofuels) (12%, 55 Mtoe) was again the fastest growing energy source, accounting for nearly a third of the increase in primary energy, despite having a share of only 4%. That said, oil (1.5%, 77 Mtoe) actually provided the largest contribution to growth, boosted by low oil prices. Natural gas (1.5%, 57 Mtoe) grew at the same rate as oil, although for gas this was slower than its 10-year average.

## Fuel mix: growth and shares in primary energy



Perhaps the most striking feature across the different fuels was the continuing rapid descent of coal, with consumption (-1.7%, -53 Mtoe) falling sharply for the second consecutive year and the share of coal within primary energy declining to its lowest level since 2004.

The speed of deterioration in the fortunes of coal over the past few years has been stark: it's only four years ago that coal was the largest source of global demand growth. I'm sure there will be further ups and downs in the fortunes of coal over coming years, but the scale of the declines in recent years do seem to signal a fairly decisive break from the past.

That's the big picture for 2016.

The plan now is to peer in a little closer and consider each of the main fuels in turn.

### 3. Fuel by fuel

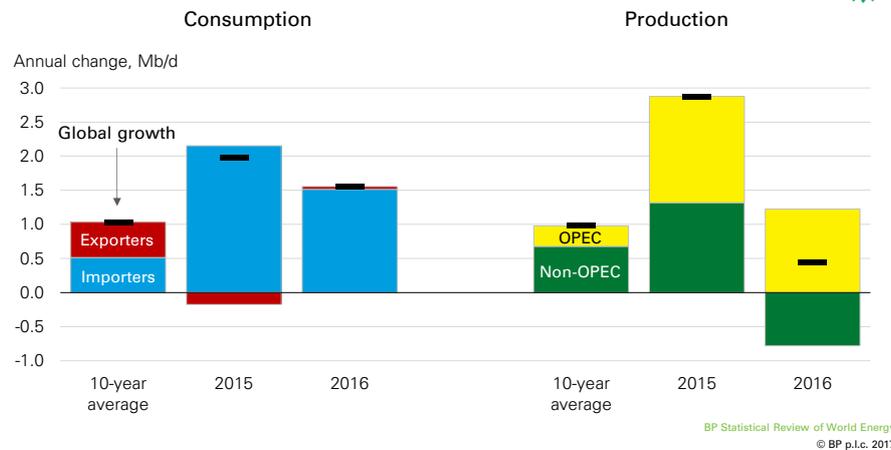
#### Oil

The need for the oil market to adjust to excess supplies is well known.

As some of you may recall, the adjustment of the oil market in 2015 – two years ago – was thwarted. The market responded to the collapse in prices, with strong demand growth and a marked slowing in non-OPEC output, but this adjustment was more than offset by a sharp increase in production by Iraq and Saudi Arabia.

In contrast, 2016 was the year of adjustment for the oil market, with oil demand again increasing robustly and production growth slowing further.

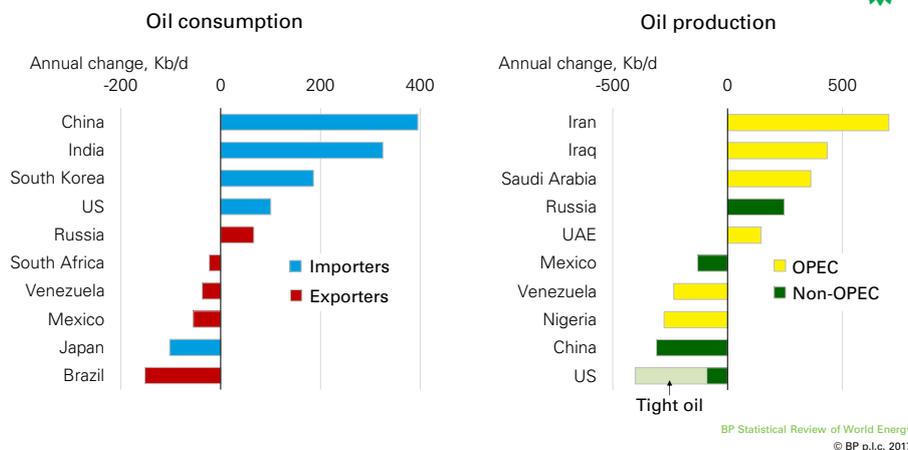
## Oil market in 2015 and 2016



Global oil demand is estimated to have grown by 1.6 Mb/d last year. As in 2015, this strength was almost entirely due to oil importers, with both India (0.3 Mb/d) and Europe (0.3 Mb/d) posting unusually strong increases. Growth in China (0.4 Mb/d) and the US (0.1 Mb/d) – the world’s two largest oil consumers – was more subdued relative to recent averages.

As in 2015, the strength in overall oil demand disguised a tale of two products. Consumption growth was concentrated in consumer-led fuels, such as gasoline and jet fuel, buoyed by low prices. In contrast, diesel demand, which was more exposed to the weakness in industrial activity, including in the US and China, declined for the first time since 2009.

## Largest changes to oil demand and supply



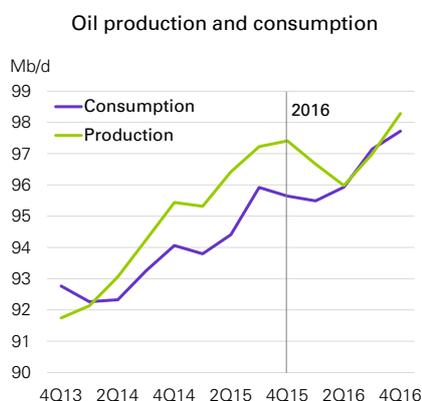
The adjustment on the supply side was driven by non-OPEC production which fell by 0.8 Mb/d, its largest decline for almost 25 years. This fall was led by US tight oil, whose

production fell by 0.3 Mb/d, a swing of almost 1 Mb/d relative to the growth seen in 2015. The other area of conspicuous weakness was China, which saw its largest ever decline in oil production (-0.3 Mb/d).

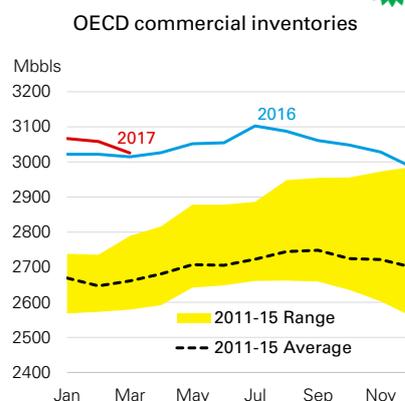
In contrast, OPEC production recorded another year of solid growth (1.2 Mb/d), with Iran (0.7 Mb/d), Iraq (0.4 Mb/d) and Saudi Arabia (0.4 Mb/d) more than accounting for the increase. Iran's production recovered more quickly following the lifting of international sanctions than many commentators had expected, with its level of production and share of OPEC output now back to around pre-sanction levels.

The combination of strong demand and weak supply was sufficient for the excess supply that had persisted since the middle of 2014 to be gradually absorbed, with the oil market moving broadly into balance by the middle of the year. But not before inventories had increased even further from their already elevated levels, such that the level of OECD commercial inventories by the end of 2016 was around 300 Mbbls above their 5-year average.

## Oil market: balance and inventories



Source: includes data from the International Energy Agency © OECD/IEA 2017



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The drama and intrigue that has characterized the oil market since the price collapse in 2014 have been dominated by two principal actors: US tight oil and OPEC. As the market moves into balance, this year's Stats Review provides a good opportunity to consider what have we learnt about the behaviour of both during this cycle.

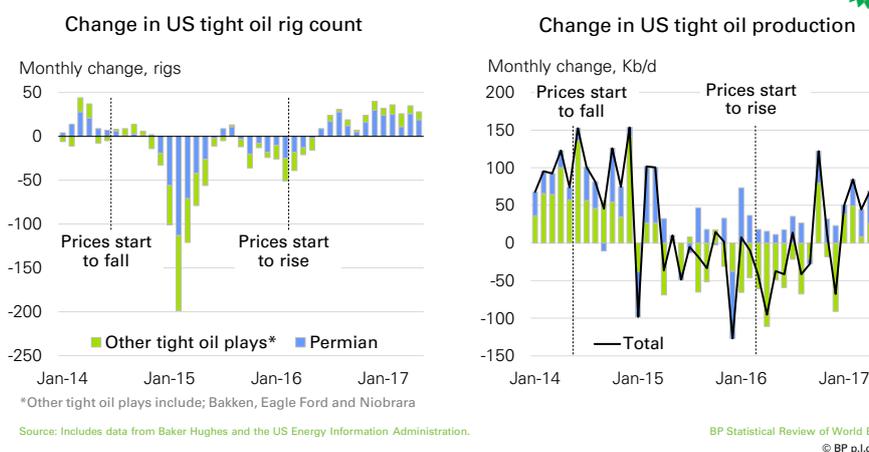
Consider first US tight oil, which didn't exist during the last oil price cycle, and so we are learning about it in real time.

What can we say on the basis of the past few years?

Perhaps the most important thing is that there is no such thing as the behaviour of “US tight oil”: the Permian is very different to Eagle Ford which is different to Bakken. So beware generalizations.

Notwithstanding that, the short-cycle nature of fracking meant US tight oil did respond far more quickly to price signals than global conventional oil. Rigs started to fall around 4 to 6 months after oil prices peaked in the middle of 2014, and picked up even more quickly – within 3 or 4 months – once prices started to turn at the beginning of last year.

## US tight oil rigs and production



And this lower activity fed through quickly into slower output growth. In the first half of 2015 – so less than a year after the peak in oil prices – tight oil production grew by just 0.1 Mb/d, compared with over 0.5 Mb/d in the same period a year earlier – a swing in annualized terms of 0.8 Mb/d. Similarly, US tight oil has grown solidly in the first half of this year, following the trough in prices in the spring of 2016.

Some commentators have talked about the surprising resilience of US tight oil. But it’s important to be clear about what we mean by resilience. Tight oil lived up to its billing: it did respond far more quickly to price changes than global conventional oil and, as such, dampened price volatility on both the downside and, more recently, the upside.

For me, the resilience is better described in terms of a toy I used to have when I was growing up called a Weeble. Weeble’s had the slogan: “Weebles wobble but they don’t fall down!” The short cycle nature of US tight oil means that, in response to price movements, it falls back far more quickly than conventional oil. But tight oil is not the marginal barrel in the longer-run – other types of oil have higher all-in costs. As such, as the market adjusts and prices recover, it will spring back – just like the Weeble – exactly as we are seeing.



That's the resilience of tight oil: it may fall over but it will bounce back.

The final point to note about US tight oil is that the amazing gains in productivity that have characterized these operations since the beginning of the shale revolution, continued through the cycle, with new well production per rig increasing by around 40% per year in both 2015 and 2016. Despite rigs in the Permian falling by over 75%, output continued to grow. Put differently, a rig operating in the Permian today is equivalent to more than 3 rigs at the end of 2014.

So what about the other principal actor in this drama: OPEC?

As with many great characters in literature, OPEC took some decisive actions which caught many observers by surprise and dramatically changed the course of events. First by not cutting production in November 2014, triggering a collapse in prices, and then last November agreeing, along with ten non-OPEC producers, to a production cut totalling 1.8 Mb/d.

How should we think about these actions?

To cut or not to cut?

For me, the clearest explanation of these actions was given by HE Khalid Al-Falih, the Saudi Arabian Minister for energy, industry and mineral resources. To quote Minister Al-Falih:

*"OPEC remains an important catalyst to the stability and sustainability of the market....but history has also demonstrated that intervention in response to structural shifts is largely ineffective... that's why Saudi Arabia does not support OPEC intervening to alleviate the impacts of long-term structural imbalances, as opposed to addressing short-term aberrations...."*

*Speech given at CERAWEEK, March 2017*

To unpack this a bit: OPEC's power stems from its ability to shift oil production from one period to another. As such, it has the ability to smooth through the effects of temporary shocks to the oil market, lowering or raising production until the shock subsides. But its ability to respond to permanent or structural shocks is far more limited: shifting supply from one period to another makes little difference if the underlying shock persists. Consider, for example, the unsuccessful attempts by OPEC to support the oil market in the first half of the 1980s as new structural sources of production from the North Sea, Mexico and Alaska came on stream.

The underlying source of the supply imbalance that emerged in 2014 was the growth of US tight oil. To use the Minister's words, this was not a short-term aberration; it was the emergence of a new source of intra-marginal supply – remember the Weeble.

In contrast, the focus of OPEC's current actions is on increasing the pace at which oil stocks return to more normal levels. This is exactly the type of temporary aberration in which OPEC intervention can be effective – reducing supply until stocks have adjusted.

So perhaps like all the best stories, the actions of the main characters make perfect sense when seen in the right context. It is understandable that OPEC didn't cut in November 2014 because the emergence of tight oil was a structural shock, over which it had little power. In contrast, the most recent cuts are focussed on the temporary issue of how quickly stocks unwind, where OPEC's actions can be effective.

Finally for oil, what has all this meant for prices?

The persistent supply imbalance and growing inventory levels caused prices to fall towards the end of 2015 and into 2016. Prices stabilized through the middle of the year as the market moved into balance and inventories levelled off, before firming somewhat towards the end of the year in the wake of the OPEC/non-OPEC agreement. Dated Brent averaged \$44 in 2016, down from \$52 in 2015, its lowest (nominal) average since 2004. So far this year, prices have averaged about \$53 as the OPEC cuts have started to take effect, albeit partially offset by the strong recovery in US tight oil.

## Oil prices



Source: includes data from Platts

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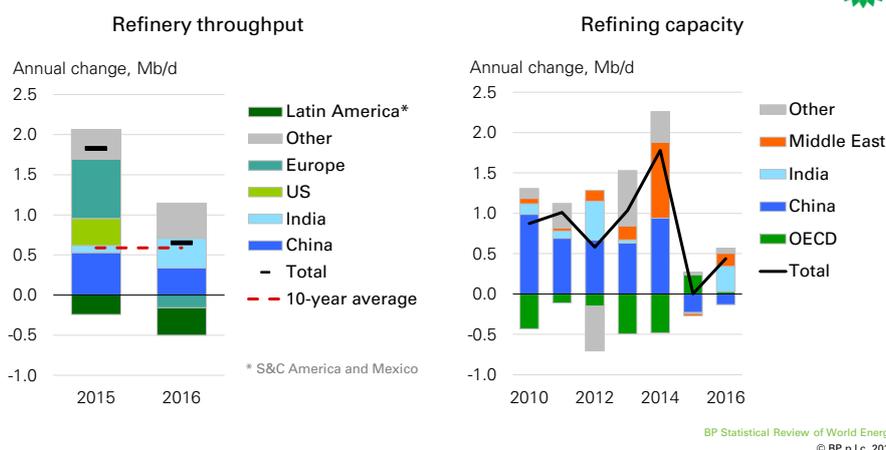
## Refining

Refining is going through its own inventory adjustment.

Inventories of products rose sharply in 2015, as refiners responded to near-record high margins by increasing refinery throughput by 1.8 Mb/d, triple its 10-year average. But as is so often the case, this splurge created its own downfall. The build-up of inventories dampened margins in 2016 causing refineries to reduce the growth in crude runs to more normal levels (0.6 Mb/d). After strong growth in 2015, European refiners, often the marginal producers, reduced runs by close to 0.2 Mb/d, and multiple refinery shutdowns in Mexico, Venezuela and Brazil caused throughput in these countries to fall by a combined 0.4 Mb/d. India bucked the global trend, with its throughput rising by almost 0.4 Mb/d – more than China for the first time since 2001.

Despite the slower growth in crude runs, refinery utilization increased last year, as refining capacity expanded by just 0.4 Mb/d, less than half its 10-year average. This was the second successive year of weak growth in refining capacity, much of which can be attributed to actions by China to limit the build-up of domestic spare refining capacity.

## Refinery throughput and capacity



The lifting of the US export restrictions on US crude oil, combined with ample onshore pipeline capacity, enabled US domestic crudes to be priced on a global basis. The Brent-WTI differential narrowed to \$0.4/bbl, down from \$3.7/bbl in 2015. Although the differential periodically widened sufficiently to encourage exports to Europe, the fall in US crude production meant that US crude exports in 2016 were relatively unchanged from the previous year.

## Coal

As I mentioned, the fortunes of coal appear to have taken a decisive break from the past. At the heart of this shift are structural, long-term, factors: the increasing availability and competitiveness of natural gas and renewable energy; combined with mounting

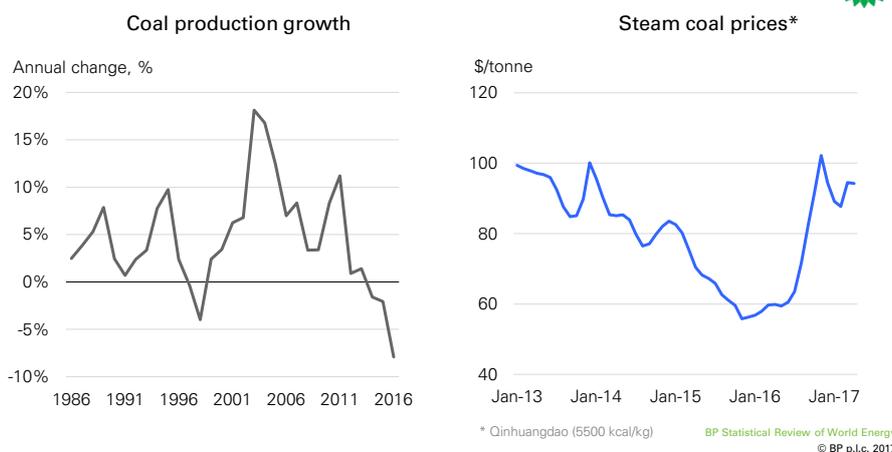
government and societal pressure to shift away from coal towards cleaner, lower-carbon fuels. These long-term forces in turn have given rise to policy responses that have often added even greater momentum.

This was particularly the case in China last year, which at the beginning of 2016 introduced a series of measures to reduce the scale of excess capacity in the domestic coal sector and improve the productivity and profitability of the remaining mines. These measures were focussed on reducing capacity amongst the smallest, least productive mines and encouraging greater consolidation. In addition, the government further constrained production by restricting coal mines to operate for a maximum of 276 days, down from 330 days.

The impact of these measures was dramatic: domestic coal production fell sharply and prices jumped sharply higher. So much so, the Chinese authorities took a series of steps to relax the 276-day production policy, culminating in the beginning of this year with a move to an explicit price band for domestic coal prices.

Despite this mid-year relaxation, these measures had a marked impact on the Chinese coal market: production fell by almost 8% (-140 Mtoe), by far the largest decline on record; and the price of steam coal increased by over 60% over the course of the year. Coal consumption also declined (-1.6%, -26 Mtoe) for the third consecutive year, although by less than production, with China resuming its position as the world's largest importer of coal.

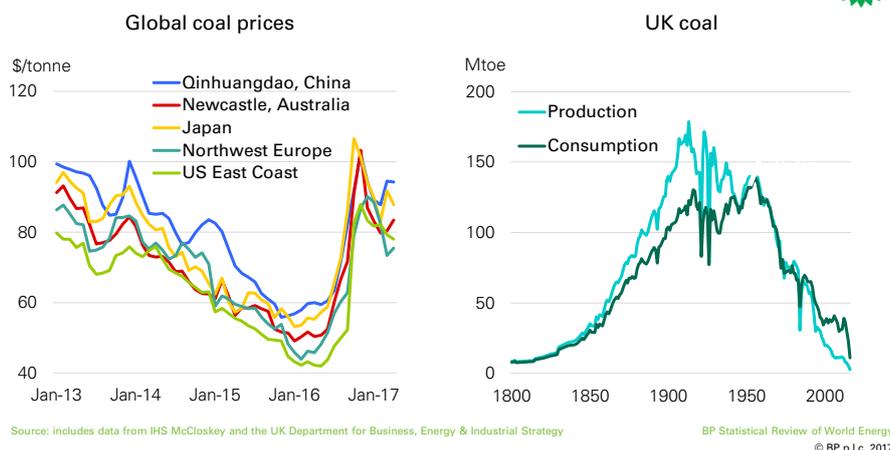
## Chinese coal production and prices



The events in China spilled over into global coal markets, with world prices taking their cue from China. This rise in world coal prices dampened coal demand, particularly in power sectors around the globe, with natural gas and renewable energy the

beneficiaries. Global coal consumption fell by 53 Mtoe (-1.7%) and global production by a whopping 231 Mtoe (-6.2%), with US coal production registering a second consecutive substantial fall (-19.0%, -85 Mtoe).

## Global coal prices and UK coal



A particularly extreme example of this long-run movement away from coal was seen here in the UK, where the rise in global coal prices added to the pressure from the recent increase in the UK's Carbon Price Floor. As a result, the UK's relationship with coal almost completed an entire cycle: with the UK's last three underground coal mines closing, consumption falling back to where it was almost 200 years ago around the time of Industrial Revolution, and the UK power sector recording its first-ever coal-free day in April of this year.

### Natural gas

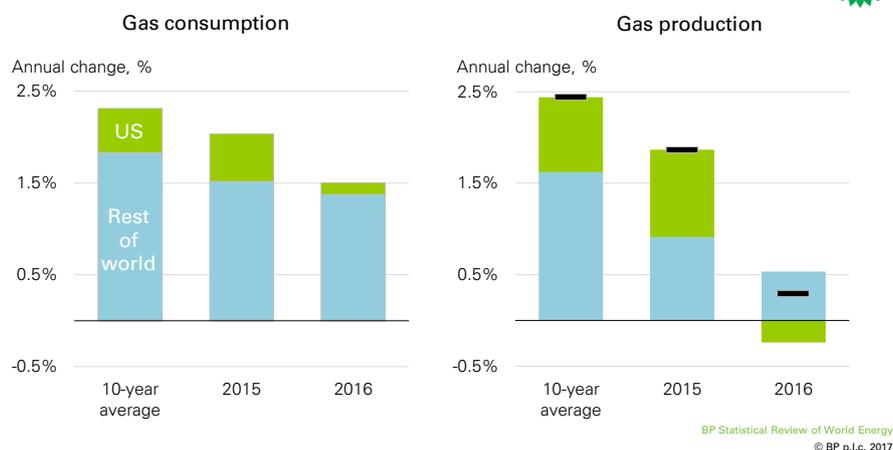
Turning next to natural gas which, despite the boost from rising coal prices, was relatively muted last year.

Global consumption increased by 1.5% (63 Bcm), weaker than its 10-year average (2.3%); whilst global gas production was essentially flat (0.3%, 21 Bcm), the weakest growth in gas output for almost 35 years, other than in the immediate aftermath of the financial crisis. This sub-par growth went hand-in-hand with falling gas prices – Henry Hub prices were 5% lower than in 2015, European and Asian spot prices were down between 20-30% as prices continued to adjust to increased LNG supplies.

Much of the lacklustre performance can be traced back to the US, particularly on the supply side where falls in gas (and oil) prices caused US gas production (-2.5%, -17 Bcm)

to fall for the first time since the US shale gas revolution started in earnest in the mid-2000s.

## Growth in natural gas demand and supply



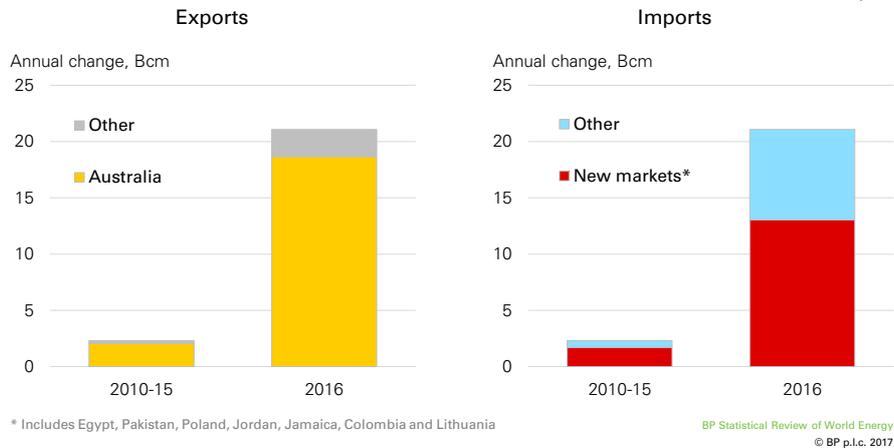
Outside of the US, on the demand side, gas consumption in Europe rose strongly (5.9%, 28 Bcm) helped by both the increasing competitiveness of gas relative to coal, and weakness in European nuclear and renewable energy. The Middle East (3.5%, 19 Bcm) and China (7.7%, 16 Bcm) both also recorded strong increases aided by improving infrastructure and availability of gas. The largest falls were in Russia (-3.3%, -12 Bcm), and Brazil (-12.5%, -5 Bcm) which both benefited from strong increases in hydropower.

On the supply side, Australian production (25.2%, 19 Bcm) was the standout performer as several new LNG facilities came on stream.

Looking at the growing market for LNG, although China continued to provide the main source of growth, it's striking that the increasing availability of supplies has prompted a number of new countries, including Egypt, Pakistan and Poland, to enter the market in the past year or two. These new entrants were helped by the increased flexibility afforded by plentiful supplies of FSRUs (Floating Storage and Regasification Units).

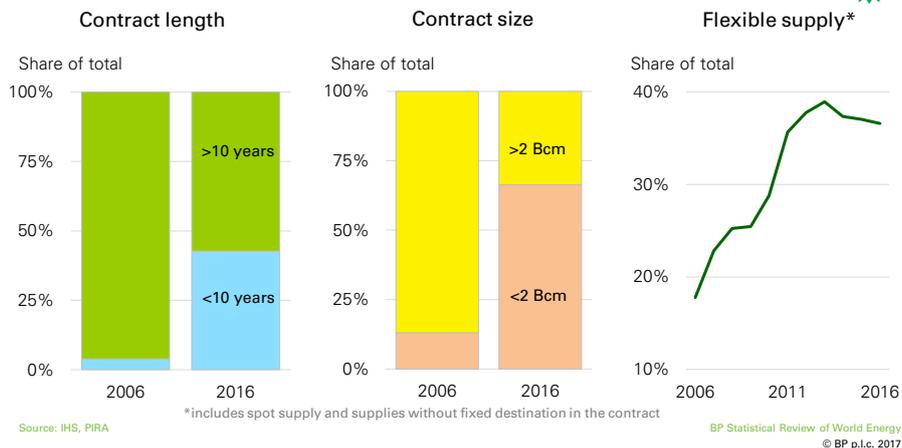
2016 was the first year of the growth spurt we expect to see in LNG, with global supplies set to increase by around a further 30% by 2020. That is equivalent to a new LNG train coming on stream every two months until the end of this decade – quite astonishing growth.

## LNG trade



As the importance of LNG trade grows, global gas markets are likely to evolve quite materially. Alongside increasing market integration, we are likely to see a shift towards a more flexible style of trading, supported by a deeper, more competitive market structure. Indeed, this shift is already apparent, with a move towards smaller and shorter contracts, and an increase in the proportion of LNG trade which is not contracted and is freely traded.

## LNG market characteristics



A particularly interesting market in the context of growing LNG supplies is Europe.

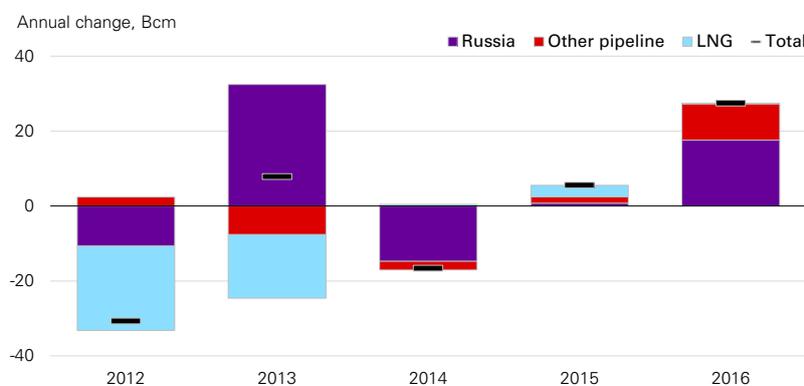
On the one hand, Europe's large and increasing need for imported gas, combined with its central location amongst several major LNG suppliers, means it's often highlighted as a natural growth market for LNG.

On the other hand, Europe’s access to plentiful supplies of pipeline gas, particularly from Russia, means LNG imports are likely to face stiff competition.

In terms of this battle of competing supplies: 2016 went to pipeline gas.

Europe’s gas imports increased markedly last year, on the back of the strong increase in demand and weak domestic production. But virtually the entire rise in European imports was met by pipeline gas, from a combination of Russian and Algerian supplies, with imports of LNG barely increasing.

### European gas imports



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The economic incentives in this battle of competing supplies are clear: just as with OPEC’s response to the emergence of US tight oil, Russia has a strong incentive to compete to maintain its market share in the face of growing structural competition from LNG supplies.

But this competitive process is complicated by possible concerns about Europe being overly dependent on a single source of supply and the energy security issues this might raise. A key question in this regard, is whether the growth of global LNG trade, by fostering a more globally-integrated gas market, with the optionality of being able to turn to LNG should the need arise, might mitigate those concerns.

The point here is that Europe doesn’t need to consume large amounts of LNG imports in “normal” times, if it has the option of doing so if and when the need arises.

### Renewables, hydro and nuclear energy

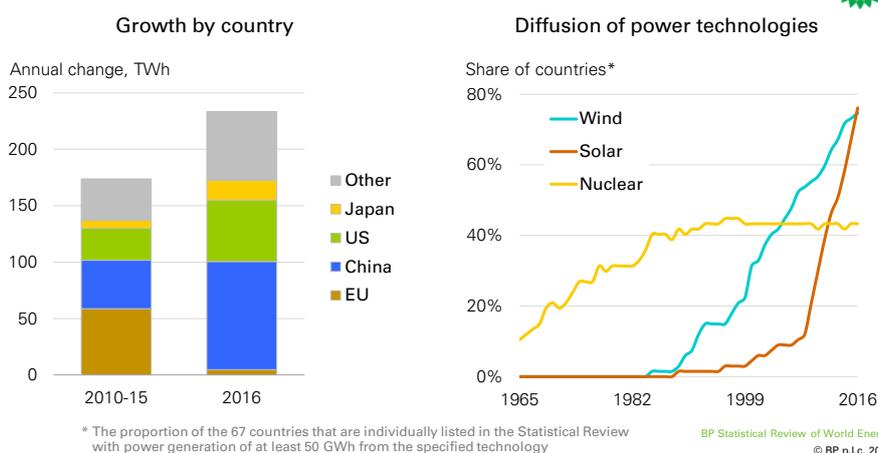
The leading light of the energy transition is, of course, renewable energy which continued to grow rapidly last year, led by wind (15.6%, 131 TWh) and solar (29.6%, 77

TWh). Although the share of renewable power within primary energy edged up only slightly to just above 3%, its strong growth meant it accounted for over 30% of the increase in primary energy.

China continued to dominate renewables growth, contributing over 40% of global growth – more than the entire OECD – and surpassing the US to become the largest producer of renewable power.

One noticeable weak spot last year was the EU, where renewable energy barely grew as load factors in both wind and solar fell back from unusually high levels in 2015. The experience of the EU last year is a reminder of the variability that weather conditions can inject into renewable energy generation from year to year. To take one example, the decline in wind power alone in Denmark last year represented a loss of almost 5% of its total power generation.

## Growth and diffusion of renewables



Although wind continued to provide the lion's share of the increase in renewable power, solar is catching up fast.

The right-hand chart (above) considers the 67 countries that are separately tracked in the Stats Review and records the share of those countries that, in any given year, produced a material amount of each energy. It took around 20 years for the share of countries producing a sizeable amount of wind power to increase from 15% to 75%; solar achieved the same degree of diffusion in less than half that time.

These different rates of diffusion reflect the different characteristics of the technologies: the more modular nature of solar power, together with its steeper learning curve has allowed it to spread more quickly than wind.



In addition to these characteristics, the fact that the transfer of wind and solar technology is not subject to onerous security restrictions has also greatly helped their rapid diffusion relative to nuclear power, which plateaued at less than half the number of countries.

In terms of other non-fossil fuels: China provided the main source of world growth in both hydro (2.8%, 120 TWh) and nuclear (1.3%, 41 TWh) power. Growth in China's hydro power has slowed sharply in recent years from the rapid rates of expansion that characterized the latter part of the 2000s. In contrast, China's nuclear programme is just beginning to ramp up: it brought on five new reactors last year – the largest ever annual increase in China's nuclear history – and has more than 20 reactors currently under construction.

That provides an overview of the different fuels. I want to conclude by considering how these various developments came together in two key aspects of the global energy system: the power sector and carbon emissions.

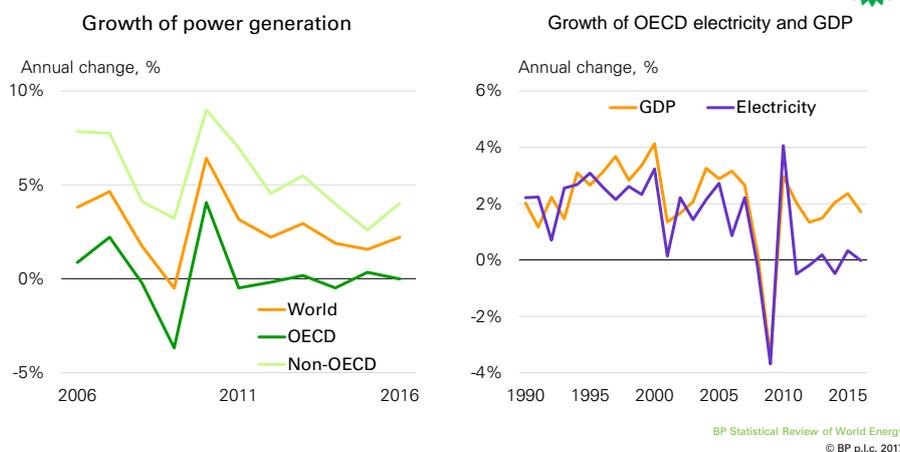
#### 4. Power sector

The power sector plays a central role in the development of global energy markets. It's by far the single biggest market for energy: over 40% of primary energy went into the power sector last year. Moreover, the power sector is at the leading edge of the energy transition, in terms of both improvements in energy efficiency and the shift towards a lower-carbon fuel mix.

Power generation increased by 2.2% (601 TWh) in 2016, stronger than the previous year (1.6%) but quite a bit below its historical average. Almost all of this growth came from developing countries; power generation within the OECD was essentially flat. Indeed, this continues a trend seen since around 2010, since when power generation in the OECD has essentially flat-lined.

Some of this weakness in OECD power demand reflects slower rates of economic growth, but the majority stems from an increasing gap between the growth of GDP and power.

## Electricity generation



This decoupling is pretty consistent across the OECD which, given the variations in income levels across these economies, suggests that the prime driver is not some form of saturation effect as countries become more prosperous.

The timing of the decoupling implies that it might be related to the nature of the economic recovery post the financial crisis: a counterpart to the weak levels of investment and low productivity growth as labour has been substituted for machines. This may be part of the story, but given the size of the gap it seems unlikely to account for the entire breakdown.

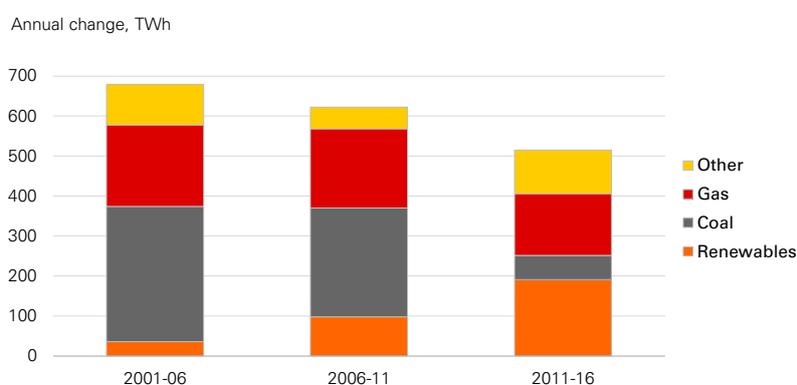
A key part of the explanation is likely to stem from a step change in efficiency gains due partly to the rapidly increasing deployment of energy-efficient appliances. One example of this is the recent rapid take-up of LED lightbulbs which, on plausible assumptions, could account for a significant proportion of the saving in electricity consumption seen over the past couple of years.

As a slight aside, these increasing efficiency gains highlight an important issue associated with the measurement of power and electricity. Although 42% of primary energy is absorbed by the power sector, when measured in terms of energy consumed at the final point of use, electricity accounts for only a little over 20%.

The point here is that these final consumption measures typically don't take any account of the greater efficiency of electricity at the point of use relative to other fuels: consider, for example, the efficiency of an electric car versus a conventional internal-combustion engine. What we ideally need is a measure of "energy services" supplied by different forms of energy at their point of use. We would be very happy to publish such a measure in future editions of the Stats Review if anyone is able to produce one.

In terms of the other key aspect of the energy transition – the shift to a lower-carbon fuel mix – the ability of fuels to compete side-by-side in the power sector means it’s also leading the way. In particular, renewable energy has accounted for a progressively larger share of the increase in power over the past 15 years or so. The combination of slower growth in power, together with the increasing contribution from renewable energy, has squeezed the growth of coal and gas. This squeeze has been most pronounced for coal, but over the past 5 years has also begun to impact natural gas.

## Growth of power generation by fuel



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The evolution of the power sector is likely to remain a key bellwether for the pace and nature of the energy transition in coming years – so watch this space.

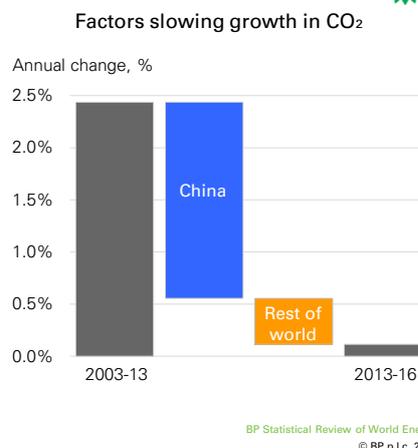
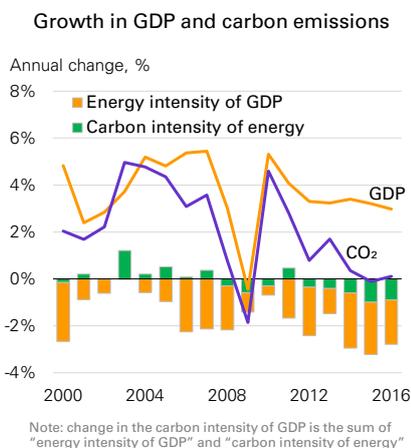
## 5. Carbon emissions

Turning finally to carbon emissions.

The good news is that carbon emissions were essentially flat in 2016. This is the third consecutive year in which we have seen little or no growth in carbon emissions – in sharp contrast to the 10 years before that, in which carbon emissions grew on average by almost 2.5% per year.

Some of this slowdown reflects weaker GDP growth, but the majority reflects faster declines in the carbon intensity of GDP – the average amount of carbon emitted per unit of GDP – driven by accelerating improvements in both energy efficiency and the fuel mix.

## Growth in carbon emissions



A key question this raises is whether the experience of the past three years signals a decisive break from the past or was it largely driven by cyclical factors which are likely to unwind over time?

Long-run transition or short-run adjustment?

Looking at the factors driving this improvement, the key difference is China. China's carbon emissions are estimated to have actually fallen over the past two years, after growing by almost 75% in the previous 10 years.

As I mentioned earlier in the context of the slowdown in China's energy consumption, there are good reasons for thinking that some of this break with the past reflects structural factors that are likely to persist: slower economic growth; a shift in the composition of growth towards less energy-intensive sectors, and a movement away from coal. But some probably reflects cyclical factors, particularly the declines in China's most energy-intensive sectors, which are unlikely to keep being repeated and may well unwind in future years.

We still have a very long road in front of us to get to Paris. We must retain our focus and efforts on reducing carbon emissions.

## 6. Conclusion

Energy markets in 2016 were affected by both the continuing need for short-run adjustments and the growing pull from the long-run transition.

2016 saw the third consecutive year of weak growth in global energy consumption and little or no growth in carbon emissions.



Much of this slowing can be traced to the developments in China which – as we saw – probably reflected a combination of a long-run transition to a more sustainable pattern of growth as well as a near-term cyclical slowdown in key industries.

Some of the strength we saw in the demand for individual fuels, most notably oil, largely reflected the adjustment to a period of excess supplies.

But the trends in some of the other fuels – most notably the contrasting fortunes of renewables and coal – had much to do with the longer-run energy transition that is underway.

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