

Energy in 2015 - A Year of Plenty

By Spencer Dale and Kai Dunker

INTRODUCTION

This article highlights developments in the energy market in 2015, and also looks ahead to what 2015 can tell us about future trends. It is based on the *BP Statistical Review of World Energy 2016*, which is the 65th edition of this annual publication.

In 2015, the global energy markets were in a state of flux as both energy demand and supplies were changing in profound ways.

On the demand side, the strong growth in energy consumption associated with the rapid industrialization of China, especially energy-hungry industrial production, and its integration into the global economy, was waning. This transition in energy demand was reinforced by global efforts to improve energy efficiency and reduce energy intensity as exemplified by the pledges and determination demonstrated at the COP21 meeting in Paris. The pledges are likely to lead to further policies aimed at shifting the fuel mix towards cleaner, lower-carbon fuels, with renewable power, along with natural gas, as the main beneficiaries. However, these efforts will need to be intensified if the world is to have any hope of achieving the goals set in Paris.

While energy demand was in a process of transition, rapid technological and productivity gains increased the abundance of global energy supplies. In the case of fossil fuels, this is exemplified by the U.S. shale revolution. However, the technological advances within non-fossil fuels are even more striking, as sharp cost reductions have gone hand-in-hand with rapid growth in supplies. For example, solar power production has increased more than sixty-fold in the space of 10 years, doubling capacity every 20 months.

KEY FEATURE OF 2015

The gradual transition towards slower growth in energy demand was again compounded by cyclical weakness in 2015. Global economic growth remained lacklustre at 3%, with much of this weakness concentrated in the more energy-intensive industrial sectors. One manifestation of this weakness in industrial production was that power generation grew less rapidly than total energy for only the second time in 30 years.

As a consequence of the combined impact of gradual transition in energy demand and cyclical weakness, global energy demand grew by just 1.0% in 2015. Though this was similar to the 1.1% growth seen in 2014, it was almost half the average rate seen over the past 10 years (1.9%).

The sluggish growth in energy demand meant that energy intensity – the average amount of energy needed to produce a unit of GDP – declined by 2%. Although broadly similar to the rate of decline seen for much of the past 10 years, it is striking that in a year when energy prices fell sharply, energy intensity still declined as much as it did.

The weakness in energy demand was driven by Non-OECD countries where consumption increased by just 1.6% in 2015, less than half of their average growth over the past 10 years. The main driver was China, where growth in energy consumption slowed to just 1.5% -- its weakest rate of growth since the late 1990s in the period prior to rapid industrialization. Even so, China remained the world's largest growth market for energy.

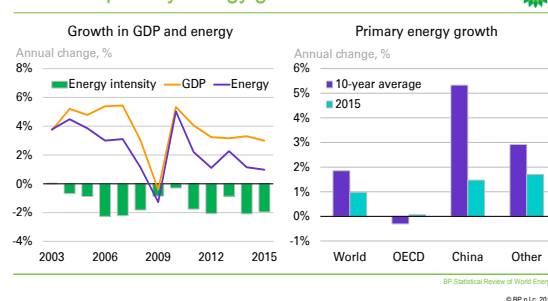
In terms of individual fuels, 2015 was mixed. Despite the weakness in overall energy demand, 2015 saw solid growth in several areas. Oil (growth of 80 Mtoe, 1.9%), was lifted by the sharp fall in oil prices and saw its share in primary energy increase for the first time since 1999. Natural gas (54 Mtoe, 1.7%) bounced back from the weather-induced weakness of 2014, and renewable energy in power (48 Mtoe, 15.2%) also grew. However, coal saw its largest decline on record (-71 Mtoe, -1.8%), due to large falls in the U.S. and to a lesser extent in China, with its share in primary energy falling to its lowest level for a decade.

Despite these differences across fuels, one can identify common features of how these twin forces

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GDP and primary energy growth

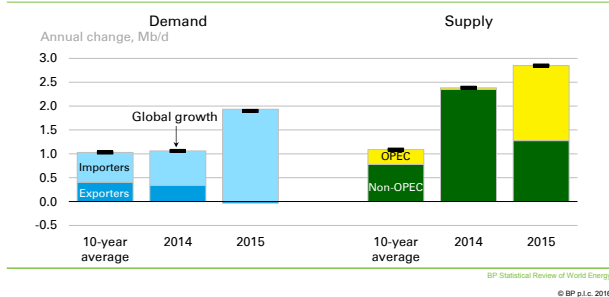


of slower demand growth and abundant supply impacted energy markets in 2015.

One such feature is that energy prices reacted to the imbalance between demand and supply: prices of oil, natural gas, and coal fell sharply in 2015. The extent of the price falls was amplified by the fact that, unlike in the past, key suppliers did not adjust their production to stabilise prices. OPEC did not respond to the rapid gains in U.S. tight oil by reducing production, nor did the Russian gas exporter respond to increasing competition from liquefied natural gas (LNG) in Europe. The response of suppliers reflects that ceding market share in order to support prices is less attractive when the underlying cause of the imbalance is structural, rather than a temporal shock.

Another feature is that price signals in the energy market worked. That is, in response to lower prices in 2015, demand for some fuels was boosted, while supplies in the form of current activity and future investment were severely curtailed in others. However, in some markets, notably oil, the adjustment process was offset by non-price led developments. Even so, an adjustment process does appear to be underway, and the underlying effect was that the fuel mix of primary energy shifted in 2015.

Oil market in 2014 and 2015



FUEL BY FUEL

Oil

In 2014, developments in the oil market were driven by exceptional growth in non-OPEC supplies, led by U.S. tight oil, which triggered a sizeable supply imbalance and a consequent fall in oil prices. Oil demand and supply responded to this sharp fall in prices in 2015, although this adjustment was offset by non-price led developments.

Global oil demand expanded strongly in 2015, growing by 1.9 Mb/d, nearly twice its 10-year average of 1.0 Mb/d. This expansion was driven by net oil importers with the U.S. (0.3 Mb/d), EU (0.2 Mb/d), China (0.8 Mb/d), and India (0.3

Mb/d) all recording unusually strong growth, while, in contrast, demand growth within oil exporters was weaker than usual.

The strength in oil demand was most pronounced in the consumer-focused fuels, particularly gasoline and jet fuel. Demand for these fuels was supported by a rise in consumers' purchasing power due to low oil prices. In contrast, growth in diesel consumption was more subdued, as it is more reliant upon industrial activity.

On the supply side, the impact of low oil prices was most immediately felt within U.S. tight oil. U.S. oil rigs peaked in October 2014 at a little above 1600, falling by around two-thirds by the end 2015. The strong gains in rig productivity meant that the slowing in output growth was less pronounced. Total U.S. production still increased by 1.0 Mb/d in 2015, reinforcing the U.S.'s position as the world's largest oil producer. Even so, the increase in U.S. production was considerably smaller than in 2014 (1.7 Mb/d), largely due to U.S. tight oil which peaked in March 2015.

Longer lead times and higher levels of sunk capital meant other Non-OPEC production was less affected than U.S. tight oil. Total non-OPEC supply increased by 1.3 Mb/d, with Brazil, Russia, the UK and Canada all registering production increases in 2015.

The apparent comparative resilience of non-tight oil producers in relation to price is partly a matter of timing. Investment in oil and gas-related projects is estimated to have fallen by about \$160bn in 2015 – around a quarter off its 2014 level, which is the largest proportionate fall since the late 1970s; and capital spending has continued to fall sharply in 2016. Although some of the reduction in nominal spending was offset by cost deflation, the lower levels of investment will inevitably detract from future supply growth. A key uncertainty for the near term is whether this fall in capex will cause the oil market to tighten excessively over the next few years.

However, oil markets in 2015 were not just characterized by price-sensitive demand and supply reacting to lower prices. OPEC production increased by 1.6 Mb/d to a new record of 38.2 Mb/d. The two main drivers were Iraq (0.7 Mb/d) and Saudi Arabia (0.5 Mb/d), which together accounted for the majority of the increase. Despite adjustments in the price-sensitive components of oil demand and supply, the net result was that the increase in aggregate global oil production of 2.8 Mb/d again outstripped that of demand, further adding to the supply imbalance.

The adjustment to lower prices has continued so far in 2016, with indicators pointing to solid demand growth and a decline in non-OPEC supply. Based on current trends, it seems likely that the oil market

will move broadly into balance in the second half of 2016. Although this means that oil stocks will stop accumulating, it will still leave a significant overhang of inventories, reflecting the increase in crude and product stocks in recent years. OECD commercial inventories, for example, rose by 280 Mbbls in 2015, ending some 350 Mbbls above their 5-year average. Although comparable data for the non-OECD are not available, it is likely that non-OECD inventories also rose further. The market will only truly return to normal when the sizeable stock overhang has been worked off.

The persistent supply imbalance and growing inventory levels weighed on oil prices, which fell sharply towards the end of 2014 and into 2015. Dated Brent averaged \$52 in 2015, its lowest nominal annual average since 2004, and almost 50% below its 2014 level.

Comparing the recent fall in prices with previous episodes of sharp price declines shows a pattern closer to that seen in the mid-1980s, than in either 2008-9 or 1997-8.

The latter two shocks were driven by sharp contractions in demand growth that reversed relatively quickly. In contrast, the mid-1980s price fall was driven in large part by new sources of supply, as new production from the North Sea and Alaska came on stream. This led to a more protracted period of weak prices as the market had to absorb gradually the additional supply.

Although different in many respects to the mid-1980s, the underlying cause of the current price weakness was also supply driven, in this case an increase in supply from U.S. tight oil. As a consequence, prices have been lower for longer than in either 2008-9 or 1997-8.

Refining

Meanwhile, the sharp increase in crude supplies and a fall in prices led to a buoyant year for refining. Refinery throughput rose by 1.8 Mb/d in 2015, more than triple its 10-year average growth, with margins increasing to near-record highs. Reflecting the diverging trends in product demand, gasoline cracks reached their highest levels on record, whereas diesel cracks fell back. The strength of margins encouraged refiners to increase product stocks, easing pressure on crude storage capacity and taking OECD product stocks to more than 100 Mbbls above recent averages.

The increase in refining runs dwarfed the expansion in refining capacity (0.5 Mb/d), such that refining utilization increased by 1 percentage point to 82.1%, its fastest increase since 2010. Indeed, capacity grew at its slowest rate for over 20 years, as past decisions to delay several projects in China were felt. More recently, restrictions on China's so-called teapot refineries were relaxed, also helping utilization to increase.

Improvements to U.S. infrastructure meant that, despite the abundance of supplies, North American crude differentials narrowed further last year, with Brent-WTI averaging around \$3.7/bbl and the spread between WTI and Western Canadian Select (WCS) averaging just \$11.9/bbl.

2015 also saw the repeal of the ban on U.S. crude exports outside of North America which dated back to the aftermath of the Arab Oil Embargo in the mid-70s. Given the easing in U.S. production growth in 2015 and declines so far in 2016, relatively little U.S. crude has been exported so far. But the lifting of the ban means there is now more of a natural ceiling to the Brent-WTI differential as and when U.S. production begins to pick up again.

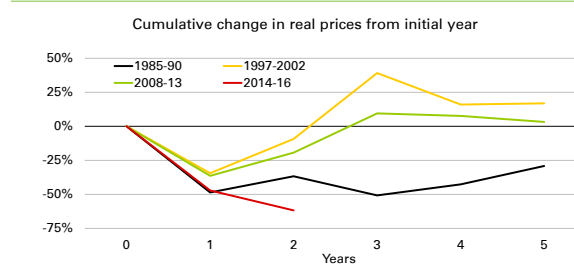
Natural gas

The global natural gas market, much like oil, revolved around lower prices as continued strong growth in global production was combined with subdued demand outside of the power sector.

Henry Hub fell 40% relative to its 2014 average, while the Japan/Korea Marker fell 46%, and NBP 21%. These price falls, which were exacerbated in Asia and Europe by the decline in oil prices, helped to balance the market by allowing gas to gain share in the power sector, which is the most price-sensitive component of gas demand. Overall, aggregate gas consumption increased by 1.7%. Although significantly stronger than the weather-induced weakness in 2014 (0.6%), this was still below its historical average of 2.3%.

However, this broad global narrative disguises considerable variation across regions. On the demand side, the key source of weakness was Asia, where growth in gas consumption slowed to just 0.5% (3

Past episodes of large oil price falls



Note: Oil prices have been converted into 2015 dollars to show changes in prices adjusted for inflation

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Bcm). The main reason for Asia's slow growth was China, where growth fell to below 5%, down from double-digit growth seen over much of the past 10 years. This fall reflects both the general slowdown in China's energy demand, as well as increasing competition from alternative fuels. In the U.S., a mild winter and weak industrial production meant gas demand outside of the power sector fell in 2015. In contrast, gas consumption in the EU (16 Bcm, 4.6%) bounced back from the depressing effects of an exceptionally mild winter in 2014. The Middle East also recorded strong growth (26 Bcm, 6.2%), as new sources of production came on stream.

On the supply side, the U.S. remained the global powerhouse, with output growing by over 5% (39 Bcm), accounting for more than half of the increase in world production. All of this increase was driven by U.S. shale gas, since conventional U.S. gas production fell. In addition to the U.S. and the Middle East, there were also notable supply increases in Norway (7.7%, 8 Bcm), China (4.8%, 6 Bcm) and Australia (9.4%, 6 Bcm).

Standing back from the differences across countries, three general features of the gas market in 2015 can be identified. First, natural gas gained significant share from coal within several major power markets around the world. These gains were most striking in the U.S., where the increasing price competitiveness of gas relative to coal allowed gas to overtake coal as the dominant source of energy in the U.S. power sector by the middle of 2015.

Second was the changing trade pattern of global LNG. LNG supplies rose by around 6 Bcm in 2015, with increases in Australia, Papua New Guinea, and Qatar more than offsetting the disruptions to Yemeni supplies. At the same time, the deceleration in China's gas consumption, combined with falls in South Korea and Japan, meant that after being the primary growth market for LNG over the past 5 years or so, Asian LNG demand fell in 2015. As a result, LNG flows were diverted west, with increased imports to the Middle East, North Africa, and Europe. This shift in the pattern of trade flows went hand-in-hand with a sharp narrowing in price differentials, as the Asian premium over European gas prices virtually disappeared.

This convergence in prices is consistent with the global gas markets becoming increasingly integrated. As global LNG supplies grow in importance and, as a consequence, global gas trade becomes increasingly price sensitive; the impact of shocks in one part of the world, (in this case weak Asian demand), will increasingly be transmitted to other parts of the globe.

The final feature to highlight about the natural gas market in 2015, concerns the greater abundance of LNG flowing into Europe, and the corresponding fall in European gas prices. In particular, how the Russian exporter responded to this increased competition.

Given that much of Russia's gas exports to Europe are indexed to oil, one option would have been to maintain that link, although the flexibility built into those contracts might have resulted in some loss of demand. The alternative would have been for Russia to compete on price in order to maintain their

market share. Unfortunately, since rebates and discounts are granted on a contract specific basis, it is not possible to observe Russian gas prices directly.

However, it is possible to approximate Russian export prices to Germany by using data on Average German Import Prices (AGIP) and the composition of those imports. Although the resulting proxy is crude, it does suggest that Russian export prices to Europe fell more quickly in 2015 than a simple link to oil prices would have implied and have remained close to European spot prices.

This suggests that Russia has competed on price in order to maintain its market share. Much like OPEC's response in the oil market, the option of giving up market share in

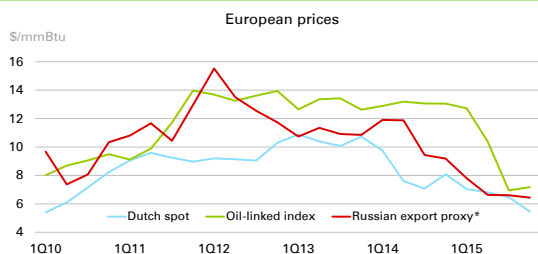
order to support prices is less attractive if the source of the price weakness, (in this case increased supplies of LNG), is expected to persist.

Coal

2015 proved to be a year of large falls in the coal market: global consumption (-71 Mtoe, -1.8%) and production (-159 Mtoe, -4.0%) recorded their largest falls on record, and coal prices fell by around 20%.

To a large extent, coal was a casualty of the larger, secular, forces driving global supply for, and demand of energy.

Natural gas prices



Source: includes data from BAFIA and Platts
*Estimate derived from reported Average German Import Price and trade volumes

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The main manifestation of the technological wave driving energy supplies was the shift in the fuel mix in the U.S. power sector. There the strong growth in U.S. shale gas forced down U.S. gas prices, causing gas to displace coal in the power sector. That switch, which was reinforced by tightening environmental policies, caused U.S. coal consumption to fall sharply (-57 Mtoe, -12.7%).

In contrast to 2012 (the last time U.S. coal consumption fell sharply), the general abundance of global coal supplies in 2015 meant that the surplus of domestic U.S. coal could not easily be exported to other parts of the world. Instead, U.S. coal production also fell markedly (-53 Mtoe, -10.4%).

The transition underway in energy demand was seen most starkly in China. As China's period of rapid industrialization has come to an end, its demand for coal has slowed sharply. In 2015, China's coal consumption fell for the second consecutive year (-29 Mtoe, -1.5%), as Chinese industrial production decelerated more sharply than the rest of the economy, and as coal lost out to increasing competition in the power sector.

Chinese coal production fell by a similar amount (-37 Mtoe, -2.0%). Indonesian production also fell sharply (-41 Mtoe, -14.4%) as its key export market, China, contracted.

Following two consecutive years of falling Chinese coal demand, a key question for the global coal market going forward is whether Chinese coal consumption has peaked? There are powerful structural factors pushing in this direction: most notably, the shifting pattern of Chinese growth towards slower, more service-orientated growth; and the determination of the Chinese authorities' to switch to cleaner, lower-carbon fuels. However, the falls in coal consumption last year were compounded by a sharp slowing in some of China's most energy-intensive – and coal-intensive – sectors: output in iron, steel, and cement all fell in absolute terms last year. The sharp slowing in these energy-intensive sectors was in part driven by cyclical elements which are unlikely to be repeated. Overall, the net impact of these opposing structural and cyclical forces on future Chinese coal demand is unclear.

NON-FOSSIL FUELS

While coal markets experienced the largest contraction on record in 2015, non-fossil fuels grew by 3.6%, slightly higher than its 10-year average.

Renewable energy in the power sector grew by over 15%, supported by improving technology and falling costs. Although the share of renewable energy in the global energy mix remains small at 2.8%, its strong growth accounted for all of the increase in global power generation in 2015, and 38% of the entire increase in global energy consumption.

While the growth of renewable energy continued to be led by wind power (17.4%, 125 TWh), solar power is catching up fast. It expanded by nearly 33% (62 TWh) in 2015, with China overtaking Germany and the U.S. as the largest generator of solar power.

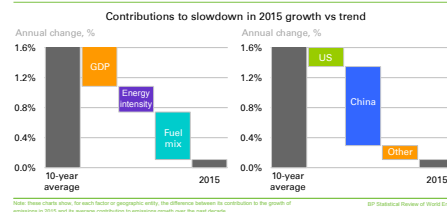
Meanwhile, hydro and nuclear energy grew more modestly. Global hydro power increased by just 1.0% (38 TWh) as it was held back by drought conditions in parts of the Americas and Central Europe. Nuclear energy increased by 1.3% (34 TWh), as rapid expansion in China offset secular declines within mainland Europe. This gradual shift of nuclear energy away from the traditional centres of North America and Europe towards Asia, particularly China, looks set to continue over the next 10-20 years.

CARBON EMISSIONS

The most striking development in 2015 was for carbon emissions. The slower growth of energy demand, together with a shift in the fuel mix away from coal towards lower carbon fuels meant that carbon emissions from energy use were essentially flat last year (0.1%). This was the slowest growth in nearly a quarter of a century (other than in the immediate aftermath of the financial crisis), and stands in sharp contrast to the average 1.5% a year growth in carbon emissions over the past 10 years. Some of the slowdown in 2015 is a natural consequence of weaker economic growth relative to the average of the past, but the majority reflects a faster rate of improvement in both energy efficiency and the fuel mix.

The vast majority of the turnaround in carbon emissions can be attributed to China. Its carbon emissions fell slightly in 2015 (-0.1%) for the first time in almost 20 years. This raises the important question as to whether this slowing in the growth of Chinese carbon emissions will continue. As with the decline in Chinese coal consumption, there are good reasons for thinking that some of this slowdown reflects structural forces that are likely to persist and grow in importance. However, the decline likely

Factors driving slower growth of carbon emissions



also reflects some cyclical factors particularly the contraction in some of China's most energy-intensive sectors, which are unlikely to keep repeating and may well unwind in future years.

PAST CLUES TO FUTURE TRENDS

Before concluding, it is interesting to look at the profound changes in global energy markets which took place in 2015 and what clues they hold about future trends. There are three key issues of interest for the future that can be drawn out of energy market developments in 2015: China, renewable energy, and carbon emissions.

Regarding the first issue, developments in China have to a large extent, driven the recent slowing in global energy demand. This is not so much due to the slowdown in economic growth but rather to rapid declines in energy intensity as China's pattern of growth has adjusted from energy-intensive industrial growth to service-sector growth.

Put differently, if China's energy intensity had not declined over the past 5 years, global energy demand would have been almost 5% higher – roughly

equivalent to the entire energy consumption of France, Germany, and Belgium combined – even with the slowdown in Chinese GDP growth. Future trends in China's energy intensity matter as much, if not more so, for energy demand as its economic growth.

However, the level at which China's energy intensity will start to stabilize is uncertain, and will depend on the success of its twin policy objectives of improving its level of energy efficiency, and of shifting towards a more service-based (and hence less energy-intensive) pattern of growth.

The second issue is how quickly the share of renewable energy within global demand is likely to expand under the impact of the technological wave. The key lesson from history is that it takes considerable time for new types of energy to penetrate the global market. Starting the clock at the point at which new fuels reached 1% share of primary energy, it took more than 40 years for oil to expand to 10% of primary energy; and even after 50 years, natural gas had reached a share of only 8%. Some of that slow rate of penetration reflects the time it takes for resources and funding to be devoted in scale to new energy sources. But equally important is the highly capital-intensive nature of the energy eco-system, which has many long-lived assets, and provides a natural brake on the pace at which new energies can gain ground.

The growth rates achieved by renewable energy over the past 8 or 9 years have been broadly comparable to those recorded by other energies at the same early stage of development. Indeed, thus far, renewable energy has followed a similar path to nuclear energy. The penetration of nuclear energy plateaued relatively quickly as the pace of learning slowed and unit costs stopped falling. In contrast, BP's Energy Outlook assumes that the costs of both wind and solar power will continue to fall as they move down their learning curve, underpinning continued robust growth in renewable energy. Consequently, the path of renewable energy in the Energy Outlook implies a quicker pace of penetration than any other fuel source in modern history. Yet even then, renewables share of primary energy will barely reach 8% in the next 20 years. Thus, the simple message from history is that it takes a long time for new energies to gain a substantial foothold within global energy mix.

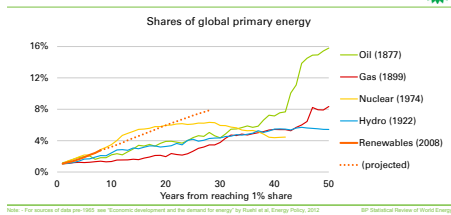
The third issue relates to the stalling growth of carbon emissions in 2015. This equated to a fall in the carbon intensity of GDP—the average amount of carbon emissions per unit of GDP—of 2.8%. In the past 50 years, there have been only two other occasions in which carbon intensity of GDP has fallen by as much, and they both coincided with sharp upward movements in oil prices.

However, the IEA 450 scenario – a commonly used benchmark for the progress the world needs to make to achieve the goals agreed at Paris – suggests that the carbon intensity of GDP has to fall at an average rate of close to 5.5% p.a. on a sustained basis for the next 20 years. So while 2015 was a step in the right direction, it was only a small step in meeting the Paris goals.

CONCLUSIONS

To summarize, 2015 was a year of transition towards a new energy world as recent developments in both demand and supply came to a head. On the demand side, waning energy-intensive industrial demand growth in China, coupled with global efforts to improve energy efficiency and reduce energy intensity, is fundamentally changing global energy demand going forward. And on the supply side, a wave of technological and productivity gains, exemplified by the U.S. shale revolution and rapid expansion of renewables, have led to an abundance of global energy supplies. These factors have collided in 2015 resulting in weak global energy demand growth and the slowest growth of carbon emissions in nearly a quarter of a century, despite a continued fall in energy prices.

Speed of transition



Notes: For sources of data pre 1985, see "Economic development and the demand for energy" by Raiffa et al. Energy Policy, 2012. BP Statistical Review of World Energy © BP plc 2016