Department for
Business, Energy
& Industrial Strategy

BEIS 2019 FOSSIL FUEL PRICE ASSUMPTIONS

February 2020

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Introduction

This report presents an update to BEIS's long-term price assumptions for oil, gas and coal. These are assumptions for the wholesale fossil fuel prices that are relevant for the UK economy and which are set in international markets. For the oil price, which is set in a global market, this is the 1-month Brent price, which is quoted in US $/barrel. For the gas price, which reflects European gas market conditions, with the European market linked to other regional markets (especially North America and Asia), this is the GB National Balancing Point (NBP) spot price, which is quoted in pence/therm. For the coal price, this is the Amsterdam/Rotterdam/Antwerp (ARA) price[1], quoted in US $/tonne, which reflects European coal market conditions, again with regional links.

Making assumptions about fossil fuel prices far into the future is – needless to say – very challenging, as they depend on many unknowns (e.g. future economic growth rates across the world, development of new technologies, global climate change policies, technological developments and strategies of resource holders). BEIS produces a set of price assumptions based on available evidence around these fundamentals and their potential development over time to yield a plausible range for future prices. These assumptions are required for long-term modelling of the UK energy system and economic appraisal. They are not forecasts of future energy prices. To capture these uncertainties, analysts should use the High and Low assumptions for sensitivity analysis rather than just using the Central assumptions.

While the BEIS assumptions feed into policy appraisal and modelling work across Whitehall, estimates of public finances are made independently by the Office for Budget Responsibility (OBR) using their own fuel price assumptions. The OBR produces these assumptions for the short and medium-term, but not long-term. Where the BEIS and OBR assumptions overlap, similar methodologies are used.

The price assumptions have been subjected to peer review by a panel of external experts who have impartially scrutinised the analysis used for the fossil fuel price assumptions. The panel's report is published alongside this document.

[1] Cost, Insurance and Freight (CIF) price.

Overall Methodology and Approach

The overall approach for each fuel is:

- a market-based view over the short-term using futures and options[2] prices to aggregate price and volatility expectations from market participants; and
- a long-term fundamentals-based view that anchors the long-term price at the expected future full economic cost of supply.

Over the short-term the use of futures/forwards curves is a market-based approach for aggregating the information of market participants. The OBR and Bank of England follow the same approach for their short-term price assumptions. We recognise that at any point in time futures/forward curves may have embedded risk premia, so they are not perfect representations of market expectations. Limited market liquidity may also curb the quality of the price discovery.[3]

The long-term anchors were finalised in April. The short-term analysis was finalised in October. For all three fuels futures/forward curves were calculated averaging market data across the 30-day trading period to 30 August 2019.

Anchoring the long-term price at the expected future full economic cost of production is a transparent and economically sound approach that is consistent with HM Treasury (Green Book) principles for policy appraisal.[4] Long-term fossil fuel price assumptions are intended to reflect average price levels over a decade or more.

This year, following advice from the Panel and greater visibility on fossil fuel supply conditions post 2030, we have shifted our long-run anchor year from 2030 to 2035.

Part of this year's process included assessing whether the supply curves used for last year's exercise and their underlying assumptions were still appropriate to use in computing this year's long-run price assumptions. Underlying assumptions were analysed and discussed with our expert panel members. A conclusion was reached that there have been substantial changes, such as the continued growth in US shale production that have significantly changed the long-term outlook for supply. This year we commissioned Rystad Energy to produce long run supply curves for each fuel including a plausible range of uncertainty (a low, high and base case view). Rystad Energy's report is published alongside this document.[5]

For each fuel we have combined the three updated long-term supply outlooks (from Rystad Energy) with three demand assumptions (based on the three long-term scenarios from the International Energy Agency's (IEA) World Energy Outlook 2018, adjusted as required). The IEA model three core scenarios for global energy demand, which differ in their assumptions about the evolution of energy-related government policies: The New Policies Scenario; the Current Policies Scenario; and the Sustainable Development Scenario. The New Policies Scenario considers policies and interventions that have been adopted as of mid-2018 in

[2] For coal, data on options prices was not available and historical forecast errors used instead.
[3] For this reason, we like the OBR and as advised by the Expert Panel have only used forward prices for the first two years of the assumptions.
[4] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent
[5] https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2019

addition to other relevant declared policy interventions. The Current Policies Scenario simply takes into account policies already enacted (as of mid-2018). The Sustainable Development Scenario depicts a pathway to international climate and clean energy goals that can be achieved by fostering technologies close to being available on a commercial scale. We use the New Policies Scenario for central demand assumptions, Current Policies for high and Sustainable Development Scenario for low demand assumptions.

We have combined the high supply and low demand assumptions to construct the long-term low price assumptions for each fuel. Similarly, we have combined the low supply and high demand assumptions to construct the long-term high price assumptions. This creates a set of assumptions that span a wide range of possible outcomes. While the long-term demand and supply assumptions are from different sources, we consider these combinations to be plausible for each fuel.

With the global energy transition to a low carbon economy, the very long-term outlook for fossil fuels demand is to peak and then decline,[6] although the timing is very uncertain.[7] This suggests downward pressure on fossil fuel prices in the very long-term, although absent technological improvement this might be countered by supply curves moving up over time as the easiest to extract resources are exhausted. Moreover, if supply curves are relatively elastic in the very long-term, the impact of lower demand on very long-term prices could be limited. Complicating factors include: the possibility of technological breakthroughs; or a change in the strategic behaviour of major resource holders faced with the prospect of leaving reserves in the ground;[8] but modelling either of these considerations is highly speculative. Another possibility is a "disruptive transition"[9] where a more rapid shift away from fossil fuels unanticipated by investors leaves some upstream assets "stranded". This could result in a possibly prolonged period where oil prices fall below long run costs, the oil "stress test" could be indicatively used to reflect such a scenario.

The price assumptions for intermediate years (between the short-term and long-term) are simple linear interpolations. We do not attempt to model detailed dynamics or price cycles. Our primary focus is on a range of long-term price levels for fossil fuels.

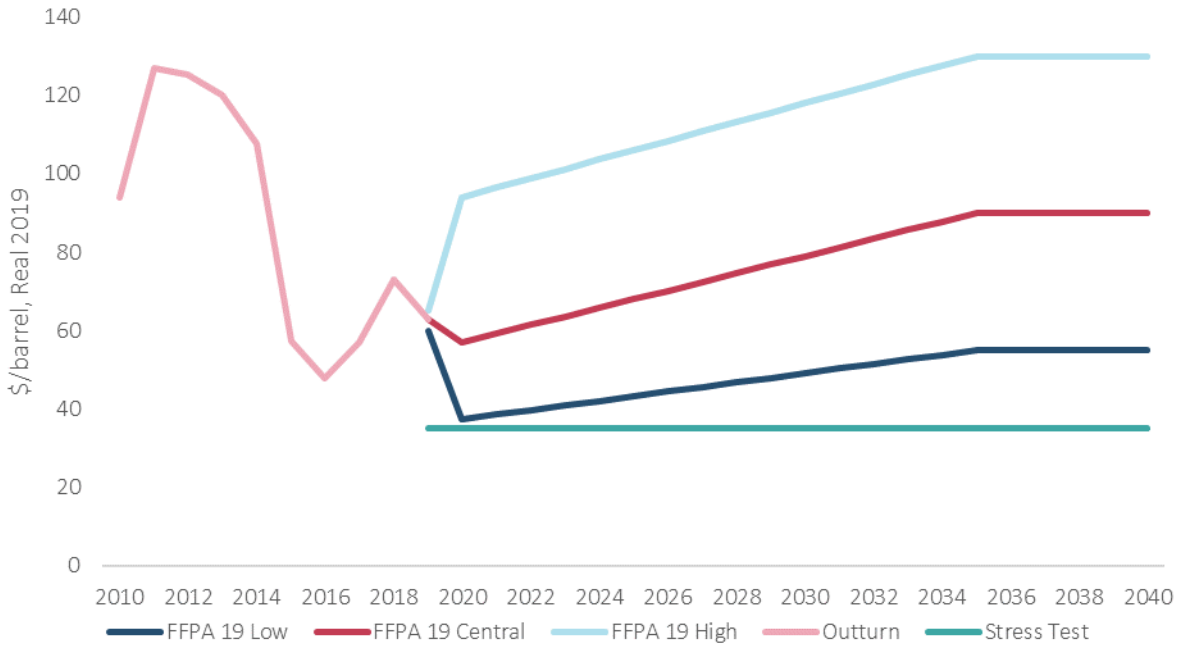
[6] For example see the joint IEA IRENA 2017 study https://www.iea.org/publications/insights/insightpublications/PerspectivesfortheEnergyTransition.pdf
[7] For example, global coal demand may already have peaked.
[8] Discussed in "Peak Oil Demand and Long-Run Oil Prices", Dale and Fattouh, 2018 https://www.oxfordenergy.org/publications/peak-oil-demand-long-run-oil-prices/ although they argue any change in strategic behaviour will be delayed
[9] For example, see the joint IEA IRENA 2017 study. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Mar/Perspectives_for_the_Energy_Transition_2017.pdf

Oil Price Assumptions

Table 1: 2019 BEIS Oil Price Assumptions

$/bbl	2019 BEIS Oil Price Assumptions			
Real 2019 prices	**Low**	**Central**	**High**	**Stress Test**
2019	60	63	65	35
2020	37	57	94	35
2021	39	59	96	35
2022	40	61	99	35
2023	41	64	101	35
2024	42	66	104	35
2025	43	68	106	35
2026	44	70	108	35
2027	46	72	111	35
2028	47	75	113	35
2029	48	77	116	35
2030	49	79	118	35
2031	50	81	120	35
2032	51	83	123	35
2033	53	86	125	35
2034	54	88	128	35
2035	55	90	130	35

Figure 1: 2019 BEIS Oil Price Assumptions



Modelling Approach

The approach used to create the oil price assumptions combines; (a) futures prices and options data for the short-term (2019-2020); and (b) evidence on the long-run (2035) costs of oil production and estimates of long-run oil demand to arrive at a long-run equilibrium price. For the purposes of creating the oil price assumptions, BEIS considers demand and supply of total oil liquids (for simplicity, hereafter: "oil") which includes crude oil, Natural Gas Liquids (NGLs), and biofuels.

We use futures prices over the short term because frequently traded contracts contain all the current information available to the market and provide a measure of market expectations of future prices. Beyond this horizon, market liquidity is lower and the price discovery could be less reliable. On this basis, we linearly interpolate between 2020 and our long-run (2035) anchor to generate price assumptions for the intermediate years.

BEIS assumptions are intended to capture a range of plausible oil market dynamics through periods of relative looseness and tightness, but we do not attempt to model price cycles. Table 2 summarises the approach, which is explained in more detail in the following paragraphs. All data are in real 2019 US Dollars. Long-run values are rounded to multiples of US$5.[10]

Table 2: Summary of BEIS approach for 2019 Oil Price Assumptions

	Short-term (2019-2020)	**Medium-term (2020-2035)**	**Long-term (2035 onwards)**
Low Prices	Derive value from options pricing implied probability distribution	Linear interpolation to long-run low price assumption	IEA Sustainable Development Scenario demand for 2035 intersected with BEIS high supply curve
Central Prices	Average of futures curves prices	Linear interpolation to long-run central price assumption	Adjusted IEA New Policies Scenario demand for 2035 intersected with BEIS central supply curve
High Prices	2020 high price unchanged from last year's exercise	Linear interpolation to long-run high price assumption	Adjusted IEA Current Policies Scenario for 2035 intersected with BEIS low supply curve
Stress Test	The average real oil price from 1986 to 2003.		

Short-Term Assumptions

The Central oil price assumption for 2019 is calculated as an average of the closing prices for; (a) the outturn price for January to August monthly contracts ($65/bbl); and (b) monthly futures contracts for September to December 2019. For 2020, we averaged the daily closing prices for

[10] We aggregate the long run oil supply curves provided by Rystad to $5 tranches (rounding up).

monthly futures contracts from January to December 2020. All averages were calculated on the daily closing prices of each future contract over the period 22 July 2019 to 31 August 2019 (30 trading days).

The High and Low price assumptions for 2019 and the 2020 Low are based on a weighted average of; (a) the outturn price for January to August monthly contracts; and (b) the Bank of England's data on the pricing of oil options and on the implied volatility available at the end of August 2019.[11] The High-Low range is aims to capture 75% of short-term uncertainty i.e. a 75% likelihood that the oil price will fall within the High-Low price range for each of 2019 and 2020. The Low oil price assumptions are therefore set at the 12.5% point of the options derived distribution and the 2019 High set at the 87.5% point of the distribution.

For the 2020 High oil price assumption we and the Expert Panel judged that applying this methodology would fail to capture the range of uncertainty in the oil market. We judged it was unclear that uncertainty on the upside had diminished over the last year and therefore decided to keep the 2020 High value calculated in the 2018 fossil fuel price assumptions.

BEIS 2019 short-term Central oil price assumptions are lower than the ones published in 2018. This reflects lower outturn prices and lower market expectations for future prices (at the end of August 2019). This market performance is driven by weaker prospects for global economic growth, which is offsetting continued concerns about the impact of US sanctions on Iran and decreasing supplies from Venezuela.

The Low oil price assumptions could reflect a case where US Light Tight Oil (LTO) production keeps increasing beyond expectations, while OPEC and non-OPEC countries are unable to replicate the supply cuts agreed over 2017 and 2018 and global oil demand growth weakens. The High price assumptions could reflect an outcome where OPEC's strategic management produces substantial market tightness over 2019 and 2020, as US LTO growth slows and global oil demand growth increases.

Medium and Long-Term Assumptions

To obtain the Low, Central and High oil price assumptions for the 2021-2034 period we linearly interpolated between the 2020 and 2035 price assumptions. Beyond 2035 we maintain the price levels unchanged, given the long-term uncertainties. This trajectory deliberately simplifies the complex market dynamics, as the focus is to generate assumptions for long-run oil prices, and not on generating market scenarios or modelling cycles. To derive the 2035 price assumptions, we intersected different supply and demand curves to arrive at implied long-run equilibrium prices, as described below.

Oil Supply Curves

The new set of supply curves commissioned from Rystad Energy in 2019 provide estimates of long-run oil supply, including sensitivities around the base case supply curve to establish a 'high supply' case (i.e. a supply curve with higher volumes of oil produced at any given price level), and a 'low supply' case (i.e. a supply curve with lower volumes provided at any given

[11] More detail can be found in the technical appendix of Bank of England working paper: Recent developments in extracting information from options markets (2000).
http://www.bankofengland.co.uk/archive/documents/historicpubs/qb/2000/qb000101.pdf

price level) to capture the uncertainty over the long-term and a plausible range of alternative supply cases.

On the advice of the expert panel, in the central and high cost supply curves we have set the 2035 production capacity outlook for Iran at around 5 million barrels of oil per day (mb/d), reflecting the uncertainties over the capacity of the country. In addition, the volume of biofuels supply has been reduced by about 0.9 mb/d to express them in energy-equivalent volumes of supply.

Oil Demand Curves

The 2035 oil demand assumptions have been derived from the three scenarios in the IEA's World Energy Outlook 2018 (WEO 2018); The Current Policies Scenario (CPS), the New Policies Scenario (NPS) and the Sustainable Development Scenario (SDS). On the advice of the Expert Panel, the 2035 levels of oil demand for the Current Policies Scenario and the New Policies Scenario have been uplifted by 0.6 mb/d, to reconcile the outturn oil liquids demand volume reported in the IEA WEO 2018 for 2017 with the outturn demand reported in the latest IEA oil market updates. The volume difference arises from the timing of publication of the WEO, which includes only preliminary demand data for the most recent year. No adjustment has been made to the Sustainable Development Scenario demand level as it is aligned with meeting emission reduction targets. The resulting 2035 demand volumes are:

- High (adjusted Current Policies Scenario): 118.8 mb/d
- Central (adjusted New Policies Scenario): 109.5 mb/d
- Low (Sustainable Development Scenario): 83.9 mb/d

On the advice of the expert panel, we have compared the IEA demand scenarios (inclusive of adjustments) to those of other organisations that are in the public domain (see Annex B). Overall, we conclude that the range of views for future oil demand is broadly unchanged from 2018, and that the IEA oil demand scenarios adequately reflect the range of views on key uncertainties in oil demand: the increase in demand from the petrochemicals sector; energy efficiency improvements in transportation; and the uptake of electric vehicles.

Medium and Long-Term Price Assumptions

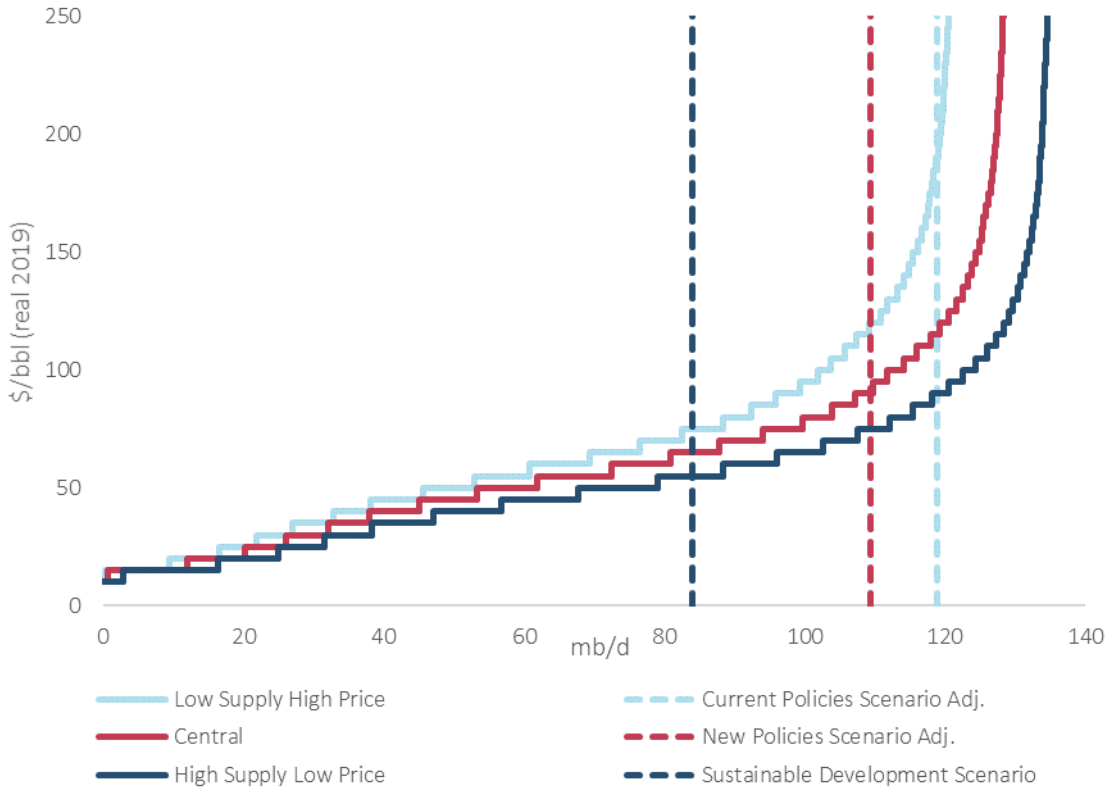
The medium and long-term BEIS oil price assumptions capture a plausible range of oil prices until 2035. Overall, the variation captured in the High and Low oil price assumptions reflects uncertainty around future OPEC policies, the strength of US oil production, key geopolitical uncertainties and the prospects for demand (closely linked to global economic growth and global action on emissions reductions).

The Central oil price assumption result from intersecting the adjusted IEA NPS demand with the central supply curve. The 2035 Central oil price assumption is set at $90/bbl (per barrel) in real 2019 prices, $5 higher than the corresponding price in the 2018 assumptions. This mainly reflects the stronger NPS long-run demand outlook.

The Low oil price assumption combines the IEA SDS demand and the 'high supply' case which produces a price of $55/bbl in 2035 – this is $5/bbl lower than the 2018 assumption. This lower price reflects the shift of the demand anchor from 2030 to 2035, where strong action to reduce carbon emissions displaces larger volumes of global oil demand over time.

The High oil price assumption combines the adjusted IEA CPS demand with the 'low supply' case. The adjusted IEA Current Policies Scenario demand intersects a portion of the low supply curve with limited responsiveness to higher prices (see Figure 2). The resulting price is sensitive to minimal changes in the assumptions, generating a higher risk of inaccurate modelling. On the advice of the expert panel, we have replaced the result of the modelling with a high price of $130/bbl in real terms. This reflects a judgement that beyond $130/bbl it is plausible to assume that the oil industry can significantly increase productive capacity to meet sustained demand increases, and that there would be structural adjustments to demand towards alternative sources of energy.

Figure 2: Supply curves and IEA Demand Scenarios



The Low "Stress Test"

The Low "Stress Test" price assumption is designed to assess policies in a world of sustained very low oil prices. The stress test reflects the historical experience that the oil price can deviate from the evidence on long-run equilibrium values for long periods, as it did from the mid-1980s to early 2000s. To derive the 2019 Low "Stress Test" price we have used the same methodology developed in 2016,[12] which results in a price of $35/bbl. The value is unchanged from 2018.

[12] Oil prices flat in real terms at their average value from 1986 to 2003. See para 28 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/576542/BEIS_2016_Fossil_Fuel_Price_Assumptions.pdf

Gas Price Assumptions

Table 3: 2019 BEIS Gas Price Assumptions

p/therm	2019 BEIS Gas Price Assumptions		
Real 2019 prices	**Low**	**Central**	**High**
2019	34	38	43
2020	32	47	73
2021	33	49	74
2022	33	50	75
2023	34	51	76
2024	35	52	77
2025	36	53	78
2026	37	54	79
2027	37	56	80
2028	38	57	81
2029	39	58	82
2030	40	59	83
2031	41	60	84
2032	41	61	85
2033	42	62	86
2034	43	63	87
2035	43	64	88

Figure 3: 2019 BEIS Gas Price Assumptions

Modelling Approach

The approach used to create BEIS's gas price assumptions combines; (a) forward prices and options data for the short-term; and (b) evidence on the long-run costs of gas production and estimates of long-run gas demand to arrive at long-run implied equilibrium prices.

The reason for using forward prices over the short-term (2019-2020) is that they reflect market expectations about gas supply and demand over this time horizon. In the long-run the price assumptions are anchored at the expected cost of marginal gas supplies to European markets at projected levels of European gas demand. This is a long-run market equilibrium condition. We recognise that the gas market is an increasingly global one and that the approach of modelling a European gas market is a modelling abstraction. The table below summarises the approach which is explained in more detail in subsequent sections.

Table 4: Summary of BEIS approach for 2019 Gas Price Assumptions

	Short-term (2019-2020)	**Medium-term (2021-2034)**	**Long-term (2035 onwards)**
Low Prices	Using options volatility to derive low range	Linear interpolation to long-run low price assumption	IEA Sustainable Development Scenario demand intersected with BEIS high supply curve
Central Prices	Forward curve	Linear interpolation to long-run central price assumption	IEA New Policies Scenario demand intersected with BEIS central supply curve
High Prices	Using options volatility to derive high range	Linear interpolation to long-run high price assumption	IEA Current Policy Scenario demand intersected with BEIS low supply curve

The assumptions based on this evidence have been compared with the demand scenarios and price assumptions[13] of other organisations (see Annexes B and C) which BEIS uses to inform its judgement. Whilst it is beyond the scope of this report to analyse the assumptions of other institutions in detail, it is clear that there are a wide range of views and BEIS's Central assumption lies within that range. All data are in real 2019 prices (pence/therm).

Short-Term Assumptions

The Central gas price assumptions for 2019 are calculated as a weighted average of outturn NBP day-ahead prices for January 2019 to August 2019 (37 p/therm), the monthly forward contract for September 2019 and the quarterly forward contract for Q4 2019, averaging the market data over the 30 trading days to 30 August 2019. The 2020 Central gas price

[13] The organisations may describe them as price forecasts, projections or scenarios.

assumptions are based on the average of the corresponding four quarterly forward contracts in 2020, using the same market data period.

Across the Central, High and Low cases this year's 2019 price assumptions are lower than in the 2018 set of assumptions. This is mainly driven by the low prices that have been experienced since the beginning of 2019, due in part to increasing global supplies of liquefied natural gas (LNG). There is a wider range of uncertainty in our 2020 assumptions compared to in 2018. Our High gas price assumptions are higher than in 2018 which likely reflects uncertainty over the future of Russian gas transit through Ukraine. Whereas the Low gas price assumptions are lower than the 2018 price assumptions reflecting market expectations of further strong LNG supply growth in 2020. The 2020 Central gas price assumptions are broadly in line with our price assumption.

For our 2019 gas price assumptions we have opted to use the forward curve only for the first two years. Beyond this time horizon, liquidity (the volume of traded contracts) begins to fall and therefore may not offer the same opportunity of price discovery. The expert panel supports this view, citing increased certainty over the short-term LNG supply outlook.

High and Low gas price assumptions are derived as a range around the 2019 and 2020 Central price assumptions using data on NBP options volatility.[14] Using implied volatility, we have selected a confidence level of 75% i.e. suggesting that the market in August 2019 attached a 75% likelihood that the gas price will fall within High-Low price range for each of 2019 and 2020. The choice of the 75% confidence interval is designed to reflect plausible alternative outcomes for the gas price rather than focusing on more extreme outcomes (which would result for example from using a 95% confidence level).

Medium-Term Assumptions

To obtain the Low, Central and High gas price assumptions for the 2021-2034 period, we linearly interpolated from the 2020 values to the long run 2035 anchor price levels. This trajectory deliberately simplifies the complex market dynamics, as BEIS focuses on assumptions for gas prices that can be used for policy appraisal and not on generating market scenarios or modelling price cycles.

Long-Term Assumptions

There is uncertainty about how European and UK gas prices could develop over the medium and long-term as they are influenced by several factors. Global LNG capacity is expected to grow rapidly to 2020 and therefore even with global gas demand growth, the market is likely to be well supplied into the early 2020s. However, there are major uncertainties around Russia's pricing strategies, developments in US and Asian demand, which in turn could affect the amount of LNG available to the European market.

[14]Replicating an Energy Information Administration (EIA) approach, we derived confidence intervals around expected futures prices using the "implied volatilities" of options. Further information can be found in Annex D of the BEIS 2016 Fossil Fuel Assumptions report.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/576542/BEIS_2016_Fossil_Fuel_Price_Assumptions.pdf

Following the recommendations made by the expert panel in their 2018 report,[15] we have reviewed the long-run supply curves. On the advice of the panel, we agreed that there have been enough changes in the long-run supply outlook to commission new supply curves. We appointed Rystad Energy to produce scenarios for the evolution of long-run supply curves for gas to European markets.[16] The supply curves were built up from breakeven costs for investment/long-run marginal costs for the key categories of supply and are expressed in real 2019 $/mmbtu (million British Thermal Units). These cost of supply curves represent volumes that are available to Europe.

Rystad Energy captured some of the uncertainty of the composition of the gas supply curves by varying four key variables:

1) *US LNG prices:* US shale gas production and LNG liquefaction capacity has grown rapidly since 2016 and has the potential to produce a substantial amount of LNG over the coming decades.

   The cost of US LNG is assumed to be the Henry Hub price plus the price of delivery to Europe – this includes liquefaction, shipping and regasification. Rystad Energy have assumed Henry Hub prices to be around $3.6/mmbtu in 2035 for the central case and have flexed long run US LNG prices by assuming the 2035 Henry Hub price could be $1/mmbtu higher or lower than the central assumption.

2) *Extra LNG available to enter the European market:* The LNG market continues to grow globally. The amount of LNG available to Europe is affected by the demand for LNG in other markets, particularly in the Asian market. Rystad Energy have modelled this uncertainty by assuming 15% greater demand for LNG in Asia in their low supply scenario which results in lower volumes available for Europe. Conversely, they have modelled 15% lower Asian demand in their high supply case.

3) *Volumes available from Qatar:* Qatar is currently a key supplier of LNG into Europe and new investment could further increase their domestic and overseas production. In their central scenario, Rystad Energy have assumed that Europe will take 20% of Qatari production. This assumption has been flexed in the high and low supply cases. In the low supply case, Rystad Energy have assumed that Europe only imports contracted volumes. In the high supply case they have assumed that 40% of Qatari volumes are available to Europe.

4) *Operating and capital costs:* Historically the oil and gas industry has observed large fluctuations in the development costs of the upstream industry. To reflect these modelling uncertainties, Rystad Energy have flexed capital costs by plus/minus 15% and operating costs by plus/minus 10% in the high and low cases.

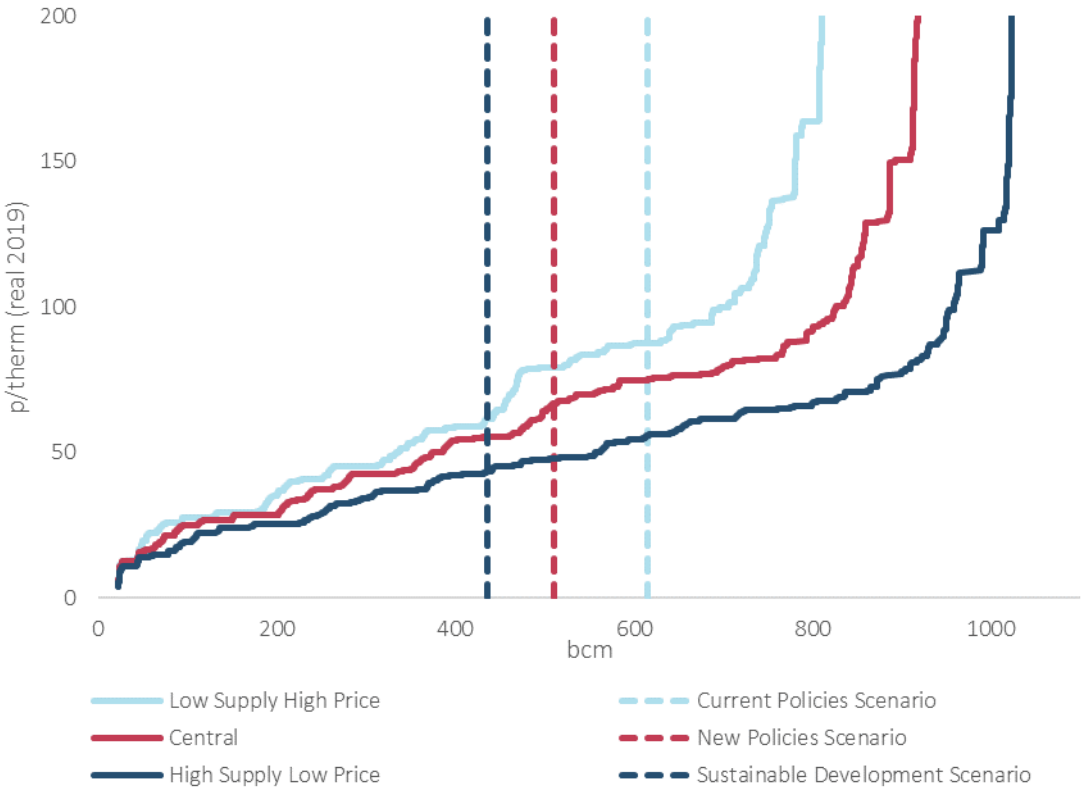
Russia has traditionally held a high share of the European gas market and its dominant position allows it some flexibility in terms of the price it charges for its gas. However, as the volumes of LNG available to Europe increase, there is uncertainty over Russia's European gas pricing strategy. Given this uncertainty, Rystad Energy have assumed that Russia will make production decisions based on the breakeven price of their different assets rather than adopting a specific pricing strategy.

[15] See conclusions in section 5.1
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/764344/Fossil_Fuel_Price_Assumptions_Expert_Panel_Report_2018.pdf
[16] https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2019

The long-term gas price assumptions combine the three updated long-term supply outlooks with the three long-term demand scenarios for European gas demand from the IEA World Energy Outlook 2018. The geographical coverage of "Europe" used for the Rystad Energy gas supply curves provided to BEIS differs from the IEA's and we have therefore adjusted the IEA's demand scenarios to allow for the difference in coverage.[17]

Figure 5 presents the implied gas price assumptions by combining our supply curves and adjusted IEA gas demand scenarios. All data are in real 2019 p/therm. The supply curves provided by Rystad Energy were in real 2019 $/mmbtu. To convert from $/mmbtu to p/therm, in the short-term (2019 to 2023), BEIS uses the exchange rate published in the OBR's Economic and Fiscal Outlook (March 2019). In the medium and long-term, BEIS have linearly interpolated between the OBR's 2023 exchange rate and Oxford Economics' long-term exchange rate forecast of £1=$1.50 for 2035. We have then flatlined after 2035.

Figure 5: Long run gas supply curves combined with IEA demand scenarios



Central Gas Price Assumption

For the 2035 Central gas price assumptions we have combined the IEA New Policies Scenario demand with the central 2035 supply curve. We have therefore assumed for the Central assumption that in the long-run the supply side, specifically US LNG supply, is relatively flexible and responsive to price.

Low Gas Price Assumption

The Low gas price assumption is illustrative of a world where there is substantial demand reduction for fossil fuels including gas due to, for example, increased policy action to mitigate

[17] Further information on the methodology can be found in Annex D

climate change. For the 2035 Low price gas assumption we combine low demand with high supply i.e. the IEA Sustainable Development Scenario demand (the lowest level of gas demand of the three IEA scenarios) and the 'high supply' case provided by Rystad Energy. This results in a 2035 Low gas price assumption of 43p/therm – this is higher than the 2018 assumption but remains consistent with a price weakness caused by a low carbon world with a smaller role for gas.

This demand and supply combination is plausible because if gas demand is low, it is plausible that US wholesale gas prices and US LNG costs would be lower.

The energy transition remains an enormous challenge, and it is uncertain which combination of existing and future technologies will provide our energy services in the long-term. The prospects for gas demand could be affected by either weaker or stronger environmental policies.

Many organisations publish long-run energy scenarios and outlooks. Comparison of these outlooks helps to highlight differences of view and areas of uncertainty with some organisations projecting lower long-term gas demand than the IEA's Sustainable Development Scenario (Annex B).

For example, some studies conclude that for the EU, fossil fuels, including natural gas, can have no substantial role in an EU energy system consistent with climate targets beyond 2035[18] implying dramatic drops in gas demand. However, other studies find that gas demand can be sustained around current levels out to at least 2040 in scenarios consistent with climate targets.[19] This demonstrates the level of long-term uncertainty.

Another possible driver of lower prices is technological breakthroughs but modelling these would be speculative.

High Gas Price Assumption

For the 2035 High gas price assumption we combine the IEA Current Policies Scenario demand level with the 'low supply' 2035 supply curve. We have therefore assumed higher US wholesale gas prices limit the competitiveness of US LNG which in turn enables Russia to maintain a higher market share in Europe. This results in a 2035 High gas price assumption of 88p/therm – this is higher than the 2018 assumption reflecting a world where future investments in new supply capacity are not made.

For the Low, Central and High gas price assumptions, a flat line for gas prices in the period after 2035 has been assumed. This trajectory is clearly a simplification, with the possibility that very long-term prices could trend up reflecting the need to access more expensive sources of supply, or trend down reflecting technological improvement or declining demand. However, given there is less visibility on potential gas supply conditions post 2035, we have chosen to anchor our long-term assumptions based on evidence for 2035.

[18] For example, Anderson, K. and Broderick, J. (2017) Natural gas and climate change. Manchester: Tyndall Manchester Climate Change Research

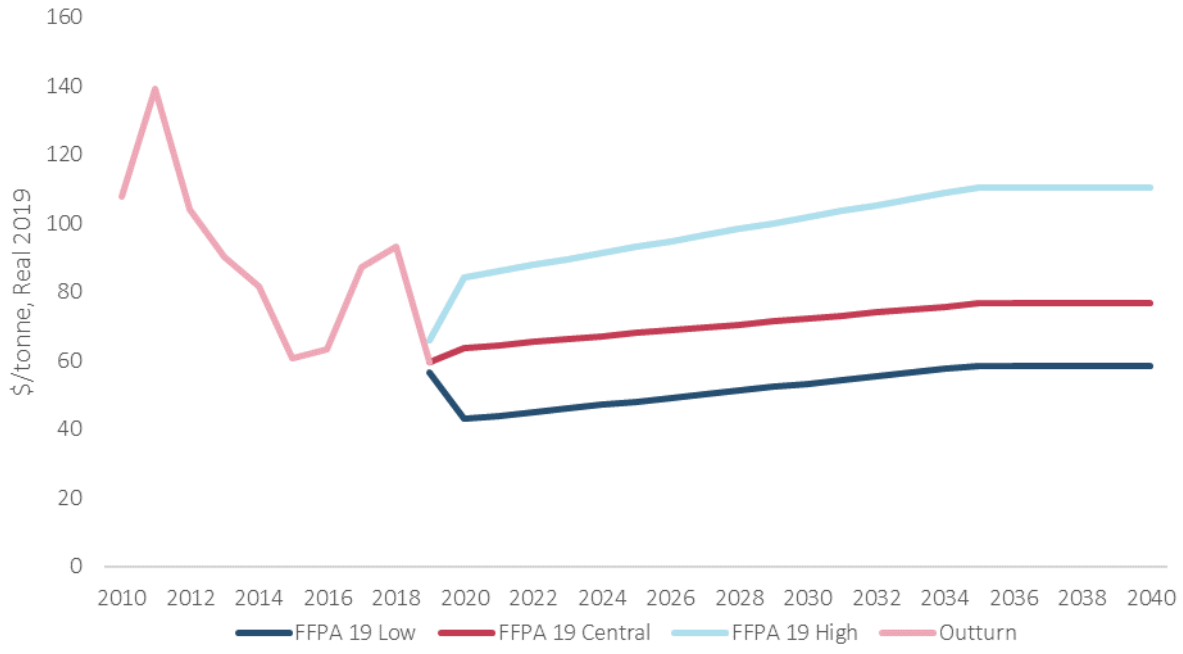
[19] For example, BP's Energy Outlook 2018 shows gas demand growing between 2016-2040 in most of their scenarios. Their "Even Faster Transition Scenario" shows gas demand growth of -0.1% per annum, which is a scenario that follows the same broad decline in carbon emissions as the IEA's 'Sustainable Development Scenario', with emissions falling by almost 50% by 2040.

Coal Price Assumptions

Table 5: 2019 BEIS Coal Price Assumptions

$/tonne	2019 BEIS Coal Price Assumptions		
Real 2019 prices	**Low**	**Central**	**High**
2019	56	59	66
2020	43	64	84
2021	44	64	86
2022	45	65	88
2023	46	66	90
2024	47	67	91
2025	48	68	93
2026	49	69	95
2027	50	70	97
2028	51	71	98
2029	52	71	100
2030	53	72	102
2031	54	73	104
2032	55	74	105
2033	56	75	107
2034	57	76	109
2035	59	77	110

Figure 6: 2019 BEIS Coal Price Assumptions



Modelling approach

The approach used to derive BEIS's coal price assumptions combines; (a) forward prices and historic forecasting errors from using forward prices to forecast short-term coal prices; and (b) evidence on the long-run costs of coal production and long-run coal demand to arrive at a long-run implied equilibrium price. The table below summarises the approach taken for the Low, Central and High coal price assumptions. The methodology is explained in more detail in subsequent sections.[20]

Table 6: Summary of BEIS approach for 2019 Coal Price Assumptions

	Short-Term (2019 – 2020)	**Medium-Term (2021 – 2035)**	**Long-Term (2035 – 2040)**	**Key Assumptions (long-term price anchor 2035)**
Low Prices	Forward prices adjusted downwards	Linear interpolation to long-run low price assumption	IEA Sustainable Development Scenario demand (2035) intersected. with BEIS high coal supply curve. Flatlining until 2040	90% of Columbian and Russian supply and 80% of South African supply available to Europe
Central Prices	Based on forward price curve	Linear interpolation to long-run central price assumption	IEA New Policies Scenario demand (2035) intersected with BEIS central coal supply curve. Flatlining until 2040.	80% of Columbian exports, 80% of Russian production and 30% of South African production available to Europe
High Prices	Forward prices adjusted upwards	Linear interpolation to long-run high price assumption	IEA Current Policies Scenario demand (2035) intersected with BEIS low coal supply curve. Flatlining until 2040.	70% of Columbian and Russian supply and 15% of South African supply available to Europe

Short-Term Assumptions

The Central coal price assumption for 2019 ($59/tonne) is derived from an average of CIF ARA outturn prices for January 2019 to August 2019, the monthly forward contract for September 2019 and the quarterly forward curve for Q4 2019, averaging over the data resulting from the 30 days trading period to 30 August 2019. The 2020 central coal price assumption is derived from the average of year ahead forward prices for 2020 traded over the same period. Forward

[20] In all coal price scenarios, the quality of coal has been standardised to the benchmark ARA specification of 6322 kcal/kg gross as received (gar) / 6000 kcal/kg net as received (nar).

prices aggregate the future price expectations and insights of market participants; as such, they are taken to be the best indicator for short-term coal price movements.

Coal prices for 2019 are lower than in the 2018 assumptions. Coal consumption in the largest consumer countries such as China and India dwarfs European import demand and due to the arbitrage opportunities stemming from the ease of coal transport, changes in demand in these countries can cause large price movements in the European coal market.

Coal prices have fallen since October 2018 as the result of China halting coal imports for the rest of the 2018 year and weak demand from India that led to an oversupply of cargoes to Europe leading to high stocks at European (ARA) coal terminals. Additionally, across the European continent, unusually warm temperatures over the winter (e.g. temperatures in Britain reached 21 degrees Celsius in the second part of February 2019) lowered the demand for coal. This is a strong contrast from 2018, when a short period of cold weather known as the “Beast from the East" sent European coal prices to their highest levels in recent years. As a consequence of low European demand and low prices, the spreads between European and Asian/Pacific coal prices widened making the European market less appealing for coal producers.

Since the beginning of 2019 coal prices have continued declining hitting multi-year record lows ($48/t in June) due to high stocks and low demand. Following three years of supply-side reforms, supply and demand in China’s coal market reached a balance in 2018. At the beginning of 2018, the government set an annual target to remove 150 Mtpa (million tonnes per annum) of outdated coal capacity, which was halfway met by the end of July, putting the country on track to beat its long-term targets as part of an effort to achieve “blue skies”. While the number of old mines had fallen, new more efficient mines began operating. In parallel to modernising their capacity the Chinese government’s intervention aims at limiting imports and encouraging domestic supply. This is expected to drive Australian and European prices downwards.

Higher European carbon prices and low gas prices both made coal unattractive in 2019. Forward markets show coal prices falling in 2020 with fewer trades taking place, reflecting the relatively high levels of coal stocks in the major centres of demand.

For many countries in Europe, coal is falling down the rankings as part of the energy mix as a growing number of countries have closed or made closure plans for coal-fired power generation. The EU-28 has been increasing its renewable sources of energy,[21] with production increasing by two thirds over the period 2007-2017 and consumption more than doubling between 2004 and 2017. In addition to the UK’s commitment to phase out unabated coal, France, Italy and Finland have made a policy commitment to phasing out coal use. In Germany - the European Union’s largest coal consumer - the German ‘Coal Commission’ has proposed an exit from coal-powered electricity generation by the end of 2038. A number of other countries are also approaching the end of coal use and Belgium ceased coal power generation in 2016. Even with higher natural gas prices, the combination of carbon dioxide (CO2) emission prices and efficient gas plants can make gas-fired generation competitive with coal.[22]

[21] https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics#Renewable_energy_produced_in_the_EU_increased_by_two_thirds_in_2007-2017

[22] https://webstore.iea.org/market-report-series-coal-2017

The future of coal-fired generation in Europe is therefore more dependent on policies and ambitious decarbonisation targets than on fuel costs. The decrease in coal demand forecast in Europe will be tied to further policy decisions in future.

High and Low coal price assumptions are estimated from the historic deviation ("error") between the quarterly and year ahead forward curves and respective outturn prices between 2009 and 2018. Both High and Low coal price assumptions are calculated on the basis of one standard deviation of historic forward price errors. The Low and High coal price assumptions are designed to reflect plausible alternative outcomes for the coal price rather than focusing on the extremes.

Medium-Term Assumptions

We consider there is too little liquidity in the coal forward price curve beyond 2020 to act as a reasonable guide to future prices. We have used the forward curve only for the first two years. Beyond this time horizon, liquidity (the volume of traded contracts) begins to fall and therefore may not offer the same opportunity of price discovery.

From 2021 the Low, Central and High coal price assumptions are linearly interpolated to their long-run equilibrium values in 2035.

An implication of this methodology is that the lower prices observed in the first eight months of 2019 reduce the medium-term profiles for our price assumptions. This is more an effect of the methodology used than necessarily reflecting fundamental price drivers.

Long-Term Assumptions

The long-run market balancing condition requires that the market price that consumers are willing to pay must cover the full cost (i.e. including capital costs) of the marginal supply if investment in that capacity is to be made. We have therefore anchored price assumptions around the estimated long-run marginal cost of seaborne steam coal imports to Europe in 2035 given an estimated level of demand for coal imports, with a delivery point of ARA (see Figure 7).

On the supply side, BEIS appointed Rystad Energy to produce scenarios for future seaborne thermal coal supplies to Europe. The supply curves were built up from breakeven costs for investment/long-run marginal costs for the key categories of supply. They reflect variation in the technical/ geological/country characteristics and were based on a mine by mine analysis. Breakeven costs were also categorised by country and type of resource and exclude sunk and committed investment costs. Further detail on the construction of the long run coal supply curves is provided in the Rystad Energy report published alongside these assumptions.

Figure 7: Long run European thermal coal import supply curves combined with IEA demand scenarios[23]

The key driver of long-run European supply variation between the three assumptions is the proportion of coal that 'swing suppliers' such as South Africa and Russia export to Asia rather than Europe. This in turn is affected by the level of Asian coal demand, driven by factors such as environmental regulation, the level of non-coal power generation capacity and electricity demand.

Consistent with oil and gas, Rystad Energy have flexed capital costs by 15% and operating expenditure by 10% in the low supply and high supply cases. Estimates of coal demand are derived from the 'New Policies', 'Current Policies' and ''Sustainable Development' Scenarios in the IEA's World Energy Outlook 2018. The IEA provides scenarios of coal demand for Europe. This region matches the region that would consume the seaborne supplies of coal to Europe estimated by Rystad Energy. However, two adjustments to the IEA demand estimates are required to match coal supply and demand to derive price estimates for European steam coal imports. First, European coal production must be netted off coal demand in order to obtain demand for coal imports. We have used scenarios for coal production in Europe from the IEA's World Energy Outlook to do this. Second, the demand for steam coal must be separated from demand for other types of coal such as lignite and metallurgical coal in order to be consistent with supply estimates.[24]

[23] The steep increase at the far right of the supply curves is a result of the modelling approach. In reality, global arbitrage opportunities would respond to price signals and create a smother curve – i.e. a gradual increase due to arbitrage opportunities from the Asian market.

[24] Metallurgical coal is netted off using the estimate of the proportion of European coal demand accounted for by metallurgical coal in 2023 from the IEA Coal 2018 publication (BEIS apply a linear extrapolation in order to predict a trend beyond this year). Lignite coal demand has been removed by netting off European coal production, as trading of lignite is very limited due to its low energy content relative to its weight. This approach towards

Central Price Assumption

In the central case, Columbia and Russia are expected to be the key suppliers of low cost coal into Europe. Lower levels of coal at higher cost are expected from the US, Russia and South Africa.

This level of coal supply is consistent with Asian coal demand in the IEA's 'New Policies Scenario', where demand grows primarily in India and southeast Asia. This in turn means that only 30% of South African coal is expected to be available to Europe, with the remainder being exported to the Pacific basin.

European coal demand for the long run Central coal price assumption is estimated from the IEA's 'New Policies Scenario'. In this scenario, the EU ETS develops in accordance with the 2030 Climate and Energy framework, with emissions reductions targets in this framework leading to strengthened support for renewable electricity generation. This demand scenario is consistent with the proportion of coal that swing suppliers sell to Europe falling from their current levels, as the decrease in European demand makes the Asian market more attractive for these suppliers.

Low Price Assumption

The high supply curve is constructed on the same basis as in the central case, with the difference that 80% (rather than 30%) of South African coal is available to the European market. This assumption is based on lower Asian demand which would be consistent with, for example, a prolonged economic slowdown in China and tighter environmental regulation in Asia.

Demand is estimated using the IEA 'Sustainable Development Scenario' for Europe, which is lower than demand in the New Policies Scenario. This scenario assumes that the EU ETS is strengthened in line with the 2050 roadmap for Europe, as well as greater support for renewables than in the 'New Policies Scenario'.[25] Combining this low demand scenario with a high supply curve is plausible, but, as noted above, would likely require a significant increase in environmental action from governments in Asia.

High Price Assumption

Long-run supply for the low supply case is constructed assuming that 30% of western Russian coal is exported to Asia; in the central case 80% of western Russian coal is exported to Europe. This would be consistent with potential transport infrastructure developments going ahead in Russia to increase its capacity to export coal eastwards and increased economic growth in Asia.

Demand in the high case is estimated using the IEA 'Current Policies Scenario'. Policies such as the EU ETS and renewables subsidies are assumed to remain in line with the 2020 Climate and Energy Package, and other policy commitments such as the Industrial Emissions Directive are continued.

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estimating seaborne coal import demand implicitly assumes that there are no net imports/exports to/from Europe by rail, which is reasonable as Russia is unlikely to supply significant quantities of coal to European countries via rail.

[25] Recent reforms of the Market Stability Reserve (MSR) have contributed to reinforce the ETS, with prices rising from €5/t CO2 in August 2017 to almost €21/t CO2 in September 2018.

This higher demand scenario could materialise simultaneously with lower supply to Europe if, for example, lower European environmental regulation is combined with increased rates of Asian economic growth, which attract greater proportions of coal supply to Asia.

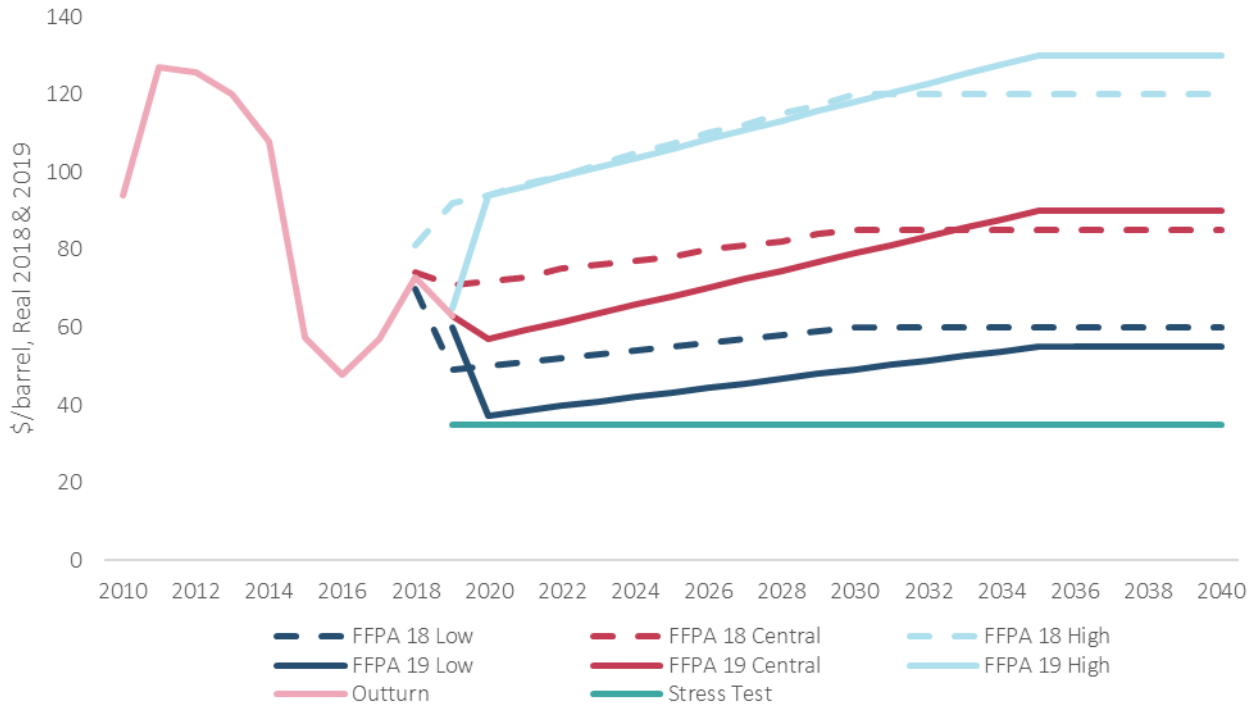
Beyond 2035 we maintain the coal price assumption levels unchanged, given the long-term uncertainties.

Annex A – Comparison with 2018 BEIS Fossil Fuel Price Assumptions (FFPA)

Oil Price Assumptions

The short-term 2019 oil price assumptions are lower than in 2018 (see Figure 8) as weaker forecasts of economic growth are in part compensating the market perceptions of increased geopolitical risk, particularly as a result of new US sanctions against Iran and Venezuela. Additional supplies from US LTO also continue to counterbalance this tightening trend. The long-term demand outlook to 2035 appears slightly stronger than in the 2018 assumptions in the central outlook but does not radically change the overall view. The demand outlook for the Low oil price assumption is lower than in 2018. The supply outlook for the United States is stronger than in 2018 across all supply curves and compensates the worsening supply outlooks for Venezuela and Iran.

Figure 8: Comparison of 2019 oil price assumptions with the 2018 oil price assumptions



Gas Price Assumptions

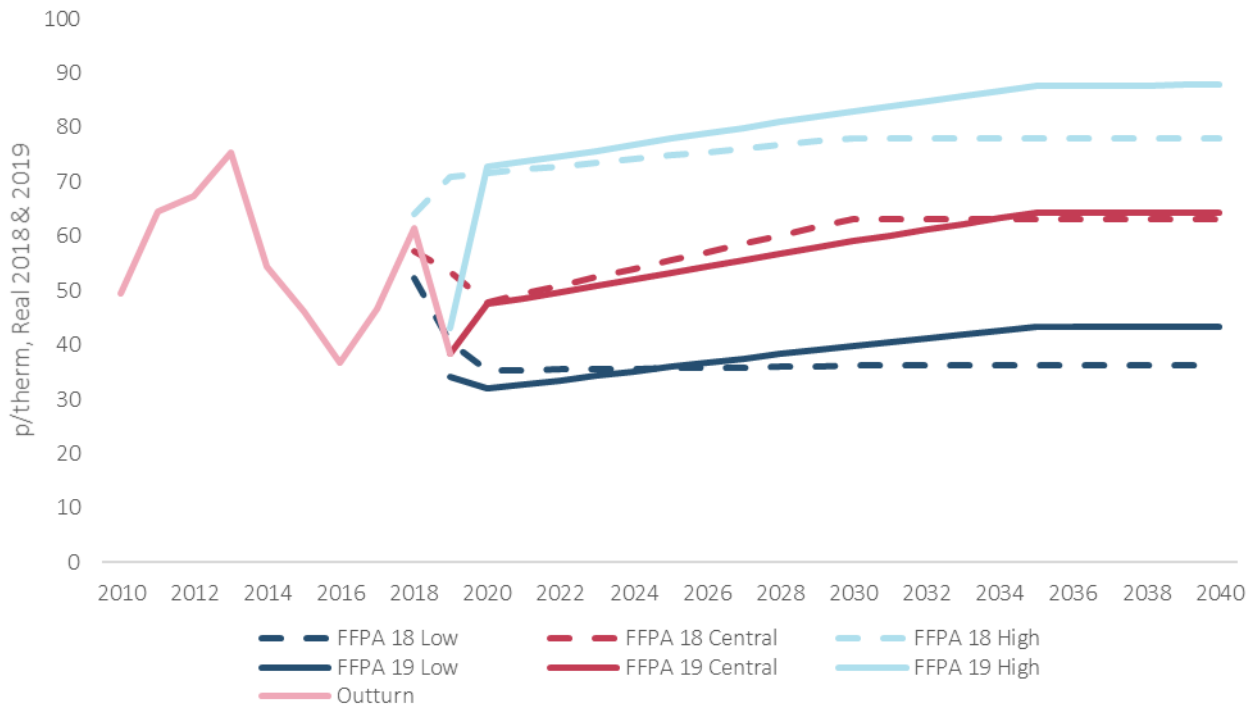
In the short-term, the Central, High and Low gas price assumptions in 2019 are lower than the 2018 set of assumptions (see Figure 9). NBP day ahead prices in 2019 have weakened, partly reflecting milder temperatures in North West Europe in comparison to last year. Moreover, there's also been an increase in LNG imports, due to increased supply across the globe, specifically from the US and Russia. These factors have

contributed to a fall in gas price prices across Europe. There is a wider range of uncertainty in our 2020 assumptions compared to last year. Our High gas price assumption is higher than in 2018 which likely reflects uncertainty over the future of Russian gas transit through Ukraine. Whereas the Low gas price assumption is lower than the 2018 price assumptions reflecting market expectations of further strong LNG supply growth in 2020. Our 2020 Central gas price assumption is broadly in line with our 2018 set of price assumptions.

Long-term price assumptions have increased across each price case with the largest increases in the High and Low gas price cases. There are two main reasons for these differences:

- We have shifted our long-term price anchor from 2030 to 2035. The 2035 supply curve is higher than in 2030 which reflects easier to extract resources being replaced by more costly reserves.
- We commissioned Rystad Energy to update our long-term supply curves for each price case. Their supply curves take into account an updated view of the European gas market and global LNG developments. Rystad Energy's 2019 assessment of the breakeven prices of some assets supplying the European market varies from Wood Mackenzie's 2016 assessment (used prior to the Rystad Energy supply curves). There are also some methodological differences between the two reports, for example the approach to pricing Russian gas supply.

Figure 9: Comparison of 2019 gas price assumptions with the 2018 gas price assumptions



Coal Price Assumptions

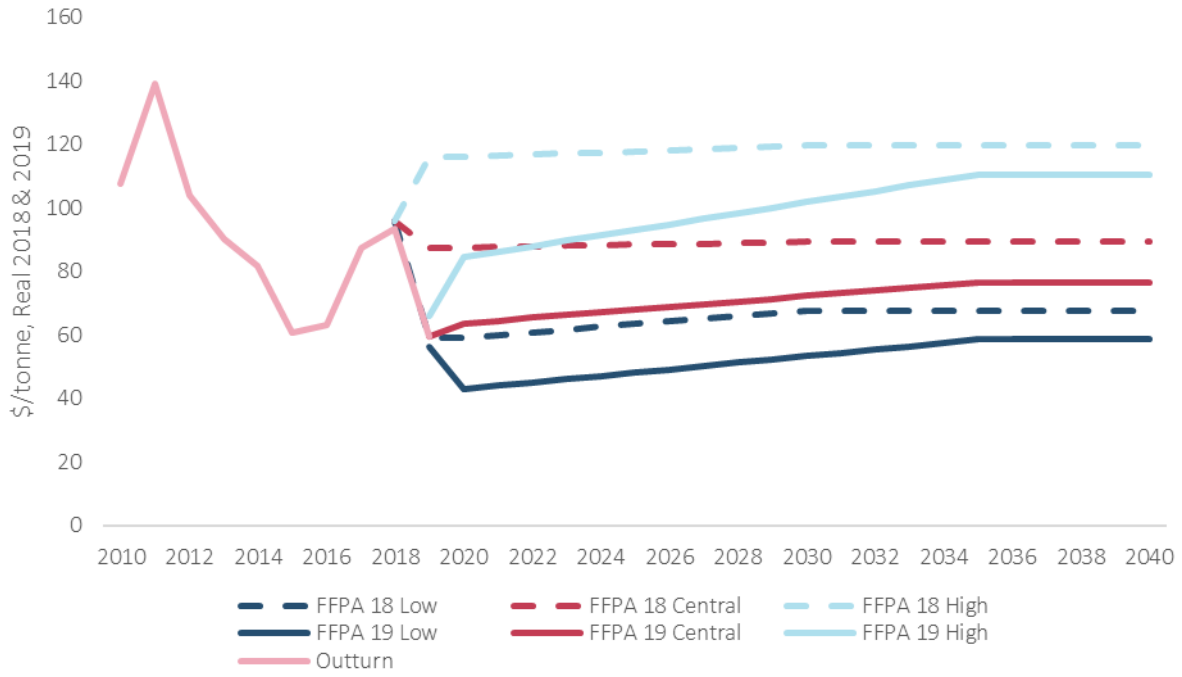
The 2019 Coal Price assumptions are lower than the 2018 assumptions in the short-term (see Figure 10) due to a decrease in coal spot and forward prices in the second half of 2018, which was sustained in the first eight months of 2019. This market movement resulted from weaker demand and stockpiling in both Asian and European markets.

The medium-term price assumptions are lower than in our 2018 assumptions. This is a result of the medium-term methodology - i.e. prices are linearly interpolated from 2021 to their long-run equilibrium values in 2035 – and therefore driven down by the low 2019 and 2020 forward coal prices. Prices in 2019 – average just above the 2018 low prices assumptions – are at a particularly atypical low level driven by mild temperatures, higher carbon prices and low gas prices, all resulting in higher coal stocks. If the underlying drivers of coal prices (temperatures, carbon prices and gas prices) change significantly in 2020, the short and medium-term assumptions could be revised significantly in the next publication.

The long-run Central and Low coal price assumptions in 2019 are lower than those in the previous year as a result of lower import scenarios for Europe from the IEA.

For the High price assumption, even though our long-term 2035 demand assumption is slightly higher than in the 2018 assumptions, the lower price is the result of a change in the supply curves used. The 2019 High coal price curve has more coal available to Europe at prices around $110/t due to a more precise modelling of arbitrage situations with the Asian market in the new supply curves.

Figure 10: Comparison of 2019 coal price assumptions with the 2018 coal price assumptions



Annex B – Demand Scenarios

The tables below compare demand scenarios from key energy institutions and companies where information is publicly available.[26] Whilst we acknowledge that there are significant uncertainties with demand scenarios we have chosen to use IEA demand scenarios as they are internationally recognised as a leading institution in energy market analysis. In addition, the IEA WEO 2018 demand range broadly captures most external demand scenarios across the fuels.

[26] As of 7th May 2019

Oil

Oil Demand Scenarios (mb/d)						
Source	**Published**	**2020**	**2025**	**2030**	**2035**	**2040**
Total liquids						
IEA WEO 2018 (New Policies)	Nov-18	-	105	108	109	111
IEA WEO 2018 (Sustainable Development)	Nov-18	-	98	93		77
IEA WEO 2018 (Current Policies)	Nov-18	-	108	113	-	124
OPEC WOO 2018 (Reference)	Sep-18	101	106	109	111	112
BP Outlook 2019 ET Scenario*	Feb-19	102	102	109	110	109
BP Outlook 2019 RT Scenario*	Feb-19	-	95	92	88	82
EIA Reference Scenario 2018	Jul-18	-	-	-	-	124
Equinor Energy Perspectives 2019 Renewal Scenario	Jun-19	-	-	92	-	-
Equinor Energy Perspectives 2019 Reform Scenario	Jun-19	-	-	108	-	-
Equinor Energy Perspectives 2019 Rivalry Scenario	Jun-19	-	-	114	-	-
IEEJ Reference Scenario*	Oct-18	-	-	111	-	119
IEEJ Advanced Technologies Scenario*	Oct-18	-	-	103	-	103
ExxonMobil Outlook for Energy**	Feb-18	102	108	112	115	117
Winning et. al (2018)[27] NDC Scenario***	May-18	99	106	111	115	116
Winning et. al (2018) B2D Scenario***	May-18	99	93	86	82	75
Winning et. al (2018) T15 Scenario***	May-18	99	88	81	78	72
Shell Sky Scenario****	Mar-18	105	110	106	103	101
Crude oil						
DNV GL Energy Transition Outlook 2018	Oct-18	83	90	86	80	69

** Data provided in MToe and converted using a MToe to mb/d of 0.02*
*** Data provided in QBTU and converted using a QBTU to mb/d conversion factor of 0.54*
**** Data provided in PJ and converted using a PJ to mtoe conversion factor of 0.024*
***** Data provided in EJ and converted using an EJ to mtoe conversion factor of 23.9*

[27] Winning M., Pye S., Glynn J., Scamman D., Welsby D. (2018) How Low Can We Go? The Implications of Delayed Ratcheting and Negative Emissions Technologies on Achieving Well Below 2 °C. In: Giannakidis G., Karlsson K., Labriet M., Gallachóir B. (eds) Limiting Global Warming to Well Below 2 °C: Energy System Modelling and Policy Development. Lecture Notes in Energy, vol 64. Springer, Cham

Gas

The different geographical coverage of “Europe” by other organisations make it difficult to compare demand scenarios on a like for like basis. The table below shows Global Gas Demand scenarios where comparisons can be made.

Global Gas Demand Scenarios (bcm)						
Source	**Published**	**2020**	**2025**	**2030**	**2035**	**2040**
IEA WEO 2018 (New Policies Scenario)	Nov-18	3635	4293	4641	5025	5399
IEA WEO 2018 (Current Policies)	Nov-18	3635	4386	4860	5366	5847
IEA WEO 2018 (Sustainable Development Scenario)	Nov-18	3635	4189	4318	4298	4184
BP Outlook 2019 - ET Scenario*	Feb-19	3927	4345	4609	-	5229
BP Outlook 2019 - RT Scenario*	Feb-19	-	4486	4088	-	4056
ExxonMobil Outlook for Energy 2018**	Feb-18	3824	4164	4473	4705	4908
Equinor Energy Perspectives 2019 Renewal Scenario	Jun-19	-	-	4246	-	-
Equinor Energy Perspectives 2019 Reform Scenario	Jun-19	-	-	4471	-	-
Equinor Energy Perspectives 2019 Rivalry Scenario	Jun-19	-	-	4422	-	-
DNV GL Energy Transition Outlook 2018	Oct-18	4116	4346	4742	4835	4650
Winning et. al (2018) NDC****	May-18	3747	4216	4642	4861	5034
Winning et. al (2018) B2D****	May-18	3747	3752	4106	3953	3789
Winning et. al (2018) T15****	May-18	3747	3418	3744	3514	3340
EIA Reference Scenario 2018	Jul-18	-	-	-	-	5096
Shell Sky Scenario*****	Mar-18	3967	3942	4115	4122	3920

* Mtoe converted to bcm using a conversion factor of 1.11
** QBTU converted to bcm using a conversion factor of 28
*** tcf converted to bcm using a conversion factor of 28.32
**** PJ converted to bcm using a conversion factor rate of 0.026
***** EJ converted to bcm using a conversion factor rate of 26

Coal

External projections of European import demand for thermal coal, 2025-2040 (Mt)				
Source	**Published**	**2025**	**2030**	**2040**
IEA WEO 2018 (New Policies)	Nov-18	150	128	119
IEA WEO 2018 (Sustainable Development)	Nov-18	110	86	69
IEA WEO 2018 (Current Policies)	Nov-18	181	187	182
BP Energy Outlook 2019 (ET Scenario)	Feb-19	179	152	112
External projections of World Coal Consumption, 2025-2040* (Mt)				
Source				
IEA WEO 2018 (New Policies)	Nov-18	6281	6306	6348
IEA WEO 2018 (Sustainable Development)	Nov-18	6663	7086	7949
IEA WEO 2018 (Current Policies)	Nov-18	5075	4027	2662
AER Global Energy Market Forecasts (Central)	Apr-19	6327	6338	6193
AER Global Energy Market Forecasts (High)	Apr-19	6376	6528	7006
AER Global Energy Market Forecasts (Burnout)	Apr19	5669	5193	3892
BP Energy Outlook 2019 (ET Scenario)	Feb-19	6298	6078	6042
BP Energy Outlook 2019 (RT Scenario)	Feb-19	3728	2875	1798
EIA Reference Scenario 2018	Jul-18	-	-	6762
Equinor Energy Perspectives 2019 Renewal Scenario	Jun-19	-	3833	-
Equinor Energy Perspectives 2019 Reform Scenario	Jun-19	-	5667	-
Equinor Energy Perspectives 2019 Rivalry Scenario	Jun-19	-	6667	-

** Figures converted into Mt from original units.*

Annex C – Comparison of prices with key external organisations

The tables below compare price assumptions of different institutions focusing on those that present a range of price assumptions and where information is publicly available. Clearly there are a wide range of views driven by alternative views on states of the world and underlying assumptions. What is clear, however, is that in general BEIS long-run price assumptions fall within the range of views presented by other institutions.

Oil

Prices in 2019 $/bbl					
	BEIS Low	**IEA Sustainable Development**	**EIA low oil price**	**External Assumptions***	
2020			45	57	
2025	44	98	45	55	
2030	50	93	46	53	
2035	55	84	48	44	
2040	55	77	48	34	
	BEIS Central	**IEA New Policies**	**EIA Reference**	**External Assumptions***	
2020			75	65	67
2025	68	106	84	72	79
2030	79	108	95	79	86
2035	90	109	102	78	99
2040	90	102	107	77	
	BEIS High	**IEA Current Policies**	**EIA high oil price**	**External Assumptions***	
2020			126	69	
2025	106	109	159	55	
2030	118	114	180	103	
2035	130	119	194	112	
2040	130	125	202	124	

Sources:
IEA World Energy Outlook 2018
EIA Annual Energy Outlook 2019
**Wood Mackenzie (Feb 2019) and Aurora Energy Research (Jan 2019)*

Gas

Prices in 2019 p/therm				
	BEIS Low	**IEA Sustainable Development**	**External Assumptions***	
2020	32	50	51	
2025	36	55	54	
2030	40	53	60	
2035	43	53	64	
2040	43	53	68	
	BEIS Central	**IEA New Policies**	**External Assumptions***	
2020	47	51	55	46
2025	53	58	63	53
2030	59	57	66	55
2035	64	60	70	65
2040	64	62	72	
	BEIS High	**IEA Current Policies**	**External Assumptions***	
2020	73	51	58	
2025	78	58	74	
2030	83	58	85	
2035	88	62	94	
2040	88	65	102	

Sources:
IEA World Energy Outlook 2018
**Wood Mackenzie (Feb 2019) and Aurora Energy Research (Jan 2019)*

Coal

Prices in 2019 $/tonne				
	BEIS Low	**IEA Sustainable Development**	**External Assumptions***	
2020	43	82	79	
2025	48	72	71	
2030	53	69	58	
2035	59	69	42	
2040	59	69	30	
	BEIS Central	**IEA New Policies**	**External Assumptions***	
2020	64	87	77	85
2025	68	84	70	79
2030	72	86	72	82
2035	77	88	73	82
2040	77	89	72	
	BEIS High	**IEA Current Policies**	**External Assumptions***	
2020	84	88	79	
2025	93	88	87	
2030	102	93	100	
2035	110	98	115	
2040	110	103	122	

Sources:
** Aurora Energy Research (January 2019) and Wood Mackenzie (February 2019)*

Annex D – Adjusting IEA European Union gas demand projections

An adjustment was applied to the IEA gas demand projections to allow us to combine gas demand with Rystad Energy's long-run supply curves.

This was to account for the difference in region coverage between the IEA's Europe definition and Rystad Energy's "Europe". Rystad Energy's definition of Europe excludes Gibraltar, Israel, Kosovo and Turkey but includes Andorra, Faroe Islands, Liechtenstein, Monaco, San Marino and Vatican City.

The adjustment was applied based on historical (2016) gas consumption for each country included in the region list. This means that we have made the assumption that gas demand for the additional countries will change over time by the same proportion as the IEA projects for Europe.

This publication is available from: www.gov.uk/government/publications/fossil-fuel-price-assumptions-2019

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