Department of Energy & Climate Change

DECC 2015 Fossil Fuel Price Assumptions

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Introduction

1. This note updates DECC's long-term price projections for oil, gas and coal.

2. These projections are required for long-term economic appraisal and therefore reflect a range of potential long-term trends. They were finalised in April 2015 and are being published now together with updated UK Energy and Emissions Projections, which have just been completed.

3. These are not forecasts of future energy prices. Forecasting fossil fuel prices far into the future is extremely challenging, as it depends on a large number of unknowns, including future economic growth rates across the world, development of new technologies, global climate change policies and strategies of major resource holders.

4. DECC generated a set of projections based on estimates of fundamentals and other available evidence that represents a plausible range for future prices. No probabilities are attached to the scenarios that underpin the price projections.

5. These updated projections feed into work across Government on appraising economic impacts of policies.

6. Estimates of public finances are made independently by the Office for Budget Responsibility (OBR) using their own fuel price assumptions. The OBR does not produce fossil fuel price assumptions for the long time periods required for economic appraisal of policy so DECC requires its own projections.

7. Each set of price projections (across oil, gas and coal) has been peer reviewed, in which an expert with expertise in the given fuel type provided scrutiny to the methodologies behind the projections. The peer review reports are published alongside this document.

DECC 2015 Oil Price Scenarios (2015 $)

	2015 (Real 2015$)			
	Stress Test	Low	Central	High
2015	30	44	64	83
2016	30	38	71	104
2017	30	31	74	117
2018	30	30	76	128
2019	30	30	78	138
2020	30	38	85	142
2021	30	45	92	146
2022	30	53	99	151
2023	30	60	106	155
2024	30	68	113	159
2025	30	75	120	164
2026	30	75	120	168
2027	30	75	120	172
2028	30	75	120	176
2029	30	75	120	181
2030	30	75	120	185
2031	30	75	120	185
2032	30	75	120	185
2033	30	75	120	185
2034	30	75	120	185
2035	30	75	120	185
2036	30	75	120	185
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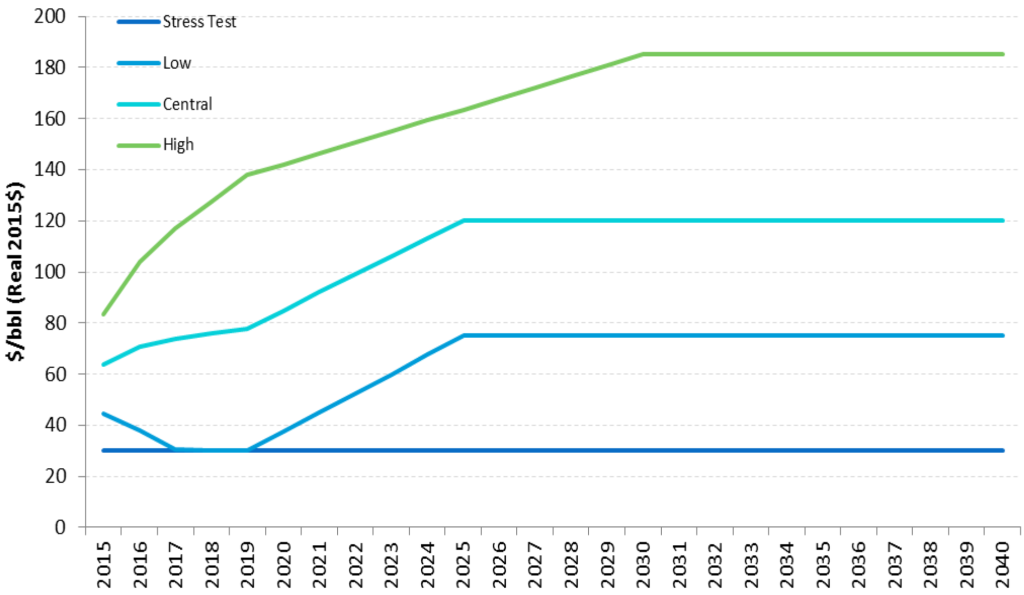
2039	30	75	120	185
2040	30	75	120	185



Context

1. By the end of 2014 the oil price collapsed by roughly 60% from its June 2014 high above USD 115/bbl for front-month ICE Brent to below USD 46/bbl in January 2015. The price drop was driven by a combination of stronger than anticipated non-OPEC supply, in particular US unconventional oil[1], such as shale oil, and some softening in global oil demand. In late November 2014 prices dropped further as OPEC signalled to the market that it would not to restrain output indicating market expectations adjusted to this confirmation that there would be no immediate balancing of the market to dampen the excess supply.

Uncertainty and drivers of short/medium term volatility

Supply

2. Whilst OPEC (or Saudi) action at a strategic level cannot be ruled out, our view is that the medium term dynamics will be governed by demand and supply responses to lower prices seen in 2015. In particular, focus has been drawn to implications for US shale oil production as the nature of production techniques mean that it is likely to be the most price responsive non-OPEC supply. Uncertainty over shale oil responsiveness to prices and the other sources of non-OPEC supply such as Canadian oil sands that have high extraction costs are a key uncertainty on the supply side over the medium term.

3. Significantly lower prices in the near term relative to the last few years could result in a tight market in the medium term as investments are postponed. However, shale oil in particular has proven resilient thus far to lower prices and the industry may find ways to cut cost and innovate making those barrels more competitive and counter the investment reduction. In addition, the impact and/or changes to international sanctions could bring additional barrels onto the market that are not currently anticipated. Finally another key supply side uncertainty is the on-going security concerns in Middle Eastern and North African oil producers that lend the potential for unplanned supply disruptions or added geopolitical 'risk premiums' to prices.

Demand

4. On the demand side the main uncertainties stem from economic growth and associated oil demand with the main upside potential in emerging economies such as China, India, Brazil and south eastern Asian countries. For example, China is likely to remain the major source of incremental demand; hence their economic prospects and associated oil demand will play a key role in oil demand growth. However as the Chinese economy matures, Chinese demand for oil may be set to grow more slowly.

5. In addition the overall global response to lower oil prices following the collapse in prices in 2014/15 is uncertain. Whilst the drop was largely driven by increased supply, sustained low prices may induce a stronger demand response than is expected and put more upward pressure on prices than is expected.

Cycles and volatility

6. In general price cycles and volatility over the medium term can be fed by feedback loops both on the demand and on the supply side. Persistently 'high' oil prices can dampen oil demand through income and price effects and slow economic growth for oil importers which in turn puts downward pressure on oil demand. High prices can induce more investment in the sector albeit with a lag. Conversely, persistently 'low' prices can induce feedback mechanism that can act to put a floor on prices as demand responds and investment in future supply is discouraged. The set of DECC projections captures a range

[1] Broadly, unconventional oil is defined as oil that is derived through the use of different production technologies from those used today in mainstream production - thus unconventional in the sense of production technique.

of these plausible oil market dynamics through periods of relative looseness/tightness though intentionally does not attempt to model price cycles.

Methodology

7. The approach used to create DECC's oil price projections combines: (a) futures prices and historical errors associated with using them to predict future spot prices and (b) evidence on the long run costs of oil production and estimates of long run oil demand to arrive at an implied equilibrium price. The reason for using futures prices over the medium term is that they reflect expectations of market participants about oil supply and demand over this time horizon. In the long run the price projections are anchored at the expected cost of marginal oil supplies around projected levels of global oil demand. This is a long run market balancing condition in that the market price that consumers are willing to pay must cover the cost of the marginal supply if investment in that capacity is to be made. The table below summarises the approach which is explained in more detail subsequently.

	Starting price	**Medium term (2015-2019)**	**Long term 2040**
Stress Test	Remains flat at $30		
Low	Range from central (2 standard dev)	Fans out from central	IEA 450 scenario demand intersected with DECC central supply curve
Central	Futures curve	Futures curve	IEA New Policies scenario demand intersected with DECC central supply curve
High	Range from central (2 standard dev)	Fans out from central	IEA New Policies scenario demand intersected with DECC 'high' supply curve

8. The projections based on this evidence are compared with the forecasts and projections of other organisations (see Annex C) which DECC uses to shape its judgement. Whilst it is beyond the scope of this report to analyse the projections of other institutions in detail it is clear that there is a wide range of views and DECC projections lie within that range. All data are in real 2015 US Dollars. Long run values are rounded to the nearest multiple of US$5.

9. For the central projection, the oil price in 2015 is based on the Brent futures curve for 2015 (the weighted average of the first ten monthly contracts as at end of February 2015 and the average outturn price for one month Brent from 1st January to 28th February). The average year-to-date oil price is $54/bbl versus the projected price of $64/bbl when these projections were produced. This is within the range implied by historical forecast errors based on the futures curve.

10. High and Low projection starting prices are derived as a range around this central starting price based on two standard deviations of the prediction error defined as real natural logarithm of the rolling 12 month average Brent price minus the real natural logarithm of the average of 12 months futures contracts for any given day, scaled to reflect the existence of 3months outturn data for the calendar year. The sample used to construct this prediction error consisted of 3640 observations from the 19th January 2000 to 31st

December 2013. This results in a range of plus or minus $23 on a year-ahead basis (and $20 on a remainder of the year basis).

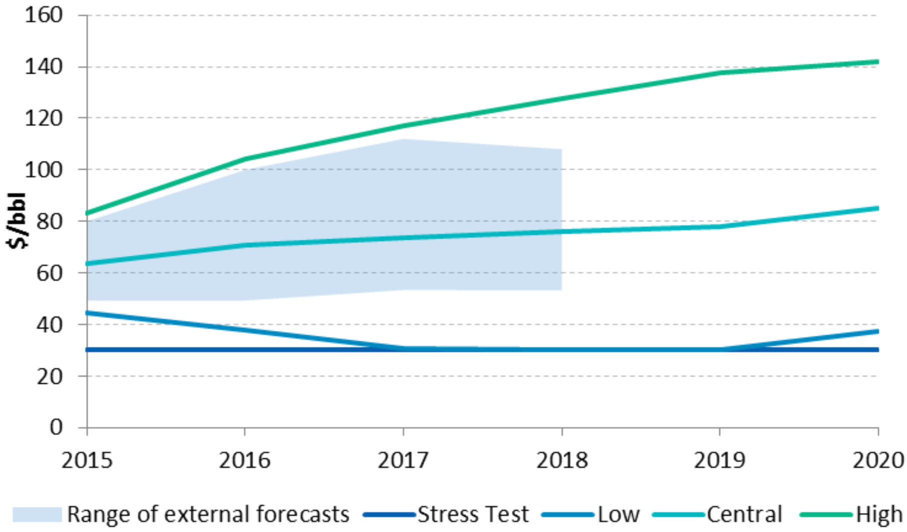
11. Over a four year forecast horizon we assume that this prediction error increases to $60/bbl. However, in the low projection, we assume that the price is bounded at $30/bbl because at this price a substantial proportion of global production has higher short-run marginal costs of production and becomes at risk of being shut in.

Central Scenario

Medium term projection

12. Between 2016 and 2019 the central projection is based on the futures contracts at the end of February 2015 corresponding to the respective year of the projection. Whilst the futures curves are known to provide very imprecise forecast performance they are likely to reflect expectations of market participants of the path of future spot prices. Part of their poor forecasting performance is that often 'exogenous' or unexpected developments in the market result in outturn prices being far off from a priori expectations. We use the futures curve on the premise, as frequently traded contracts, that they contain all current information available to the market and so provide a measure of market expectations of the path of prices. Despite their historic forecasting performance, the alternatives such as using an average of external forecasts are unlikely to be better and can be subject to sample size and composition bias. The IEA also use the futures curve as their working assumption (not forecasts) for modelling inputs.

13. The chart below plots the DECC projections from 2015 to 2020 alongside the range of short term external forecasts[2] which illustrates the range of uncertainty in the market even between participants' central views.



[2] Bloomberg survey of analyst forecasts as of 11/2/2015 (sample size used here is 40).

Longer term central projection

14. To extend the central projection beyond 2019 we assume that long term oil supply is responsive to price and that any large rents in the market could incentivise increased exploration activity and production. Rents in the market can arise because the global oil supply curve tends to become increasingly price inelastic at high levels of total supply (beyond future expected levels of demand).

15. To help inform where on the supply curve the market might be in the future, we use the IEA World Energy Outlook 2014 to judge levels of demand for liquids fuels from their New Policies Scenario[3]. This level of demand is 102mb/d in 2025 and 108.5mb/d in 2040.[4]

16. At these levels of future demand there are alternative possible long run (2040) market outcomes which will depend on a host of factors like development of new oil production technologies, characteristics of the resource base, strategies of resource holders, as well as on unknown unknowns. We use data from Rystad Energy to derive a supply curve[5] with which we intersect the IEA 2040 demand to arrive at an implied equilibrium price. Clearly this is a simple framework and is designed to capture the condition that in the long run the price will equal marginal cost of extraction for a given supply curve (noting characteristics of the oil market detailed below).

17. An important structural characteristic of the oil market is that the majority of the low cost producers are in the Middle East (and members of OPEC) and face production costs well below the most expensive supplies at the moment – namely unconventional oil from North America. While it is widely assumed that non-OPEC suppliers act competitively, OPEC suppliers governed largely by National Oil Companies, may choose alternative production and investment strategies to meet strategic domestic priorities and take advantage of their relatively low production costs. As a result of this the assumed production and investment profile of low cost producers is an important consideration when analysing the implied supply curve as it ultimately determines the shape.

18. The table below illustrates the implied production from OPEC members for the supply curve used in DECC central projection in 2025 and 2040. Clearly material differences in supply from low cost producers will change the shape of the supply curve and for a given level of demand imply an alternative equilibrium price as the marginal barrel becomes a cheaper/more expensive barrel to extract. Our view on composition of the supply curve is informed using Rystad Energy estimates of breakeven prices.

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[3] Comparison of projected demand from different institutions is presented in Annex B.

[4] Note these projected levels of global oil demand will reflect the IEA's oil price projections which are different from DECC's. However whilst the long run price elasticity of demand is significantly higher than in the short run studies have shown that it often remains relatively low. As such the uncertainty around how much demand responds to oil prices is therefore likely to be less than from underlying economic growth and government policies.

[5] Schematic of the analytical process Rystad employs to estimate break even prices is detailed in Annex A.

Implied OPEC supply (mb/d)		
Country	2025	2040
Saudi Arabia	11.2	14.2
Iraq	6.3	6.3
Iran	4.1	6.5
Venezuela	2.7	4.2
UAE	3.6	2.5
Kuwait	2.3	2.1
Qatar	1.6	2.0
Angola	1.7	2.1
Nigeria	3.0	1.6
Libya	1.0	1.6
Algeria	1.0	0.9
Ecuador	0.3	0.4

19. Rystad capture some of the uncertainty of the composition of the supply curve in 2040 by considering alternative development rates of the resource base. We use two of their implied supply curves, one based on supply for their central assumption for exploration[6] (50% of licensed areas drilled) and one based on a higher level of exploration activity (65% of licensed areas drilled).

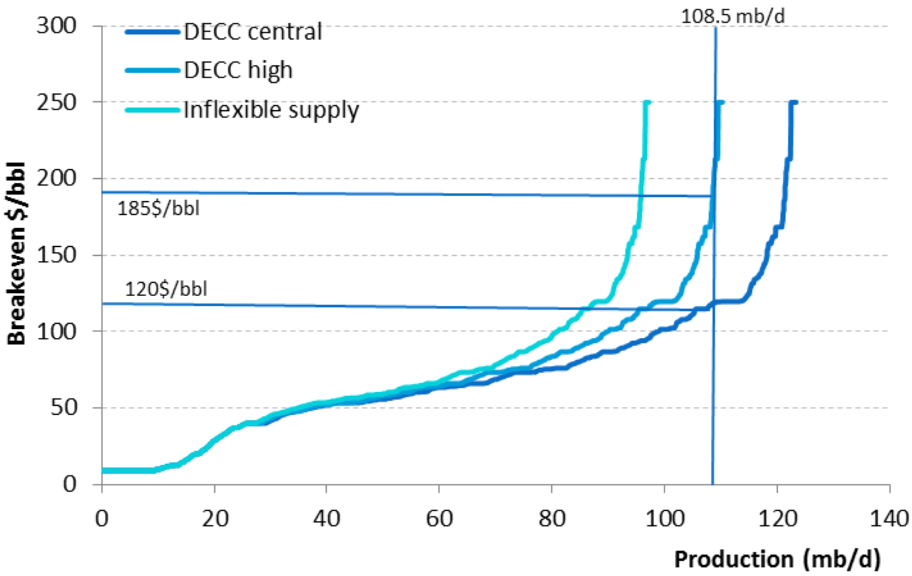
20. At the level of global demand under the IEA New Policies Scenario 2040 and the Rystad central exploration assumption the global market would be on the highly inelastic part of the global supply curve and create an additional incentive to explore for potentially less costly resources.

21. We have therefore used a central 2040 supply curve based on the Rystad high level of exploration activity assumption that shifts the supply curve to the right and reduces large rents that would otherwise accrue in the market. This combination of global supply and demand scenarios would be consistent with an oil price of $120/bbl in 2040 (see figure below). In 2025, with the level of global demand under the IEA New Policies Scenario and the 2025 global supply curve, the market clearing oil price would also be $120/bbl.

[6] Rystad use historical averages of licence award to production ratios by region to translate alternative exploration scenarios into production capacity

Implied long run supply curve

(2040 DECC central, high and Rystad inflexible supply scenarios)



Source: Rystad Energy, IEA and DECC inference

22. The projection for years 2020 to 2025 is linearly interpolated to $120 and remains flat thereafter. This trajectory is clearly a simplification, and the market is likely to see much more complex dynamics. However, a key focus of the DECC projections is on the long run level of real oil price rather than shorter term market dynamics.

High Scenario

23. The high oil price projection is based on a state of the world in which global oil supply does not respond as strongly to persistently large rents in the market. We use an alternative long run supply curve (Rystad's central view) which assumes a lower proportion of 2040 liquids production comes from undiscovered fields and that there is a 50% likelihood of the licensed areas being drilled. Altering this assumption shifts the supply curve inwards and there are less infra-marginal barrels produced.

24. Using this alternative supply curve and intersecting with the IEA New Policies Scenario demand is consistent with a real oil price of $185/bbl in 2040. The 2015-2019 trajectory fans out from the central as explained at para 19 above and between 2020 and 2030 is interpolated to $185/bbl, reflecting a market that is steadily tightening over a prolonged period, and remains flat thereafter.

Low Scenario

25. The low price projection is illustrative of a world where there is substantial demand reduction due to for example aggressive policy action to mitigate climate change. We have used the level of global oil demand in 2040 under the IEA 450 scenario of 80.7 mb/d to capture the impact of these policies and demand changes. This is combined with the central scenario supply curve to derive an implied price of $75/bbl in 2040[7]. The 2015-2019 trajectory fans out from the central as explained at para 19 above and 2020-2025 is interpolated to $75/bbl and remains flat thereafter.

[7] Note that the IEA 450 scenario has a price of $100/bbl and therefore if the price elasticity of demand were taken into account the low scenario would have somewhat higher oil output and prices.

“Low Stress Test”

26. The “low stress test” price scenario is designed to assess policies in a world of sustained low oil prices. To do so, we assume that oil prices stay flat in real terms at around $30. This is the level of the real oil price during the period 1986 to 2003, the most recent period in which the oil price was ‘low’ and relatively stable. However, estimates suggest the cost structure of the industry is now higher than it was in this period, although costs could adapt over time to a low oil price.

27. While current market fundamentals point to some tightening of the market over the medium and long term it is possible that market fundamentals could develop in a way that leads to permanently lower oil prices. These factors could include a combination of major technological breakthroughs in oil production technology, a change in strategic approach of major resource holders and substantial reduction in demand through use of other energy carriers for transport.

Comparison with external projections

28. The IEA 2014 World Energy Outlook’s New Policies Scenario projects an average Oil Price from 2020 to 2040 of $117/bbl (real 2015)[8] and a price of $138/bbl in 2040.

29. The EIA 2015 Annual Energy Outlook the Central Scenario projects an average Oil Price from 2020 to 2040 of $82/bbl (real 2015) and a price of $146/bbl in 2040.

30. A key factor underlying these projections of the oil price is economic growth in the emerging economies increasing the demand for oil. The IEA also identify the scale of the investment required to meet future demand and the constraints, including the availability of skilled personnel, on the industry’s ability to bring forward that production. In the longer run both the EIA and IEA projections assume that over time global oil supply increasingly struggles to keep pace with demand and that the market increasingly clears on the more inelastic part of the global supply curve.

31. Whilst we acknowledge that characteristics of the global oil market are such that this scenario is plausible, we have assumed for the central projection that in the long run the supply side is more flexible and responsive to any periods of relatively high real oil prices. Annex C presents the DECC projections alongside projections from other institutions for comparison.

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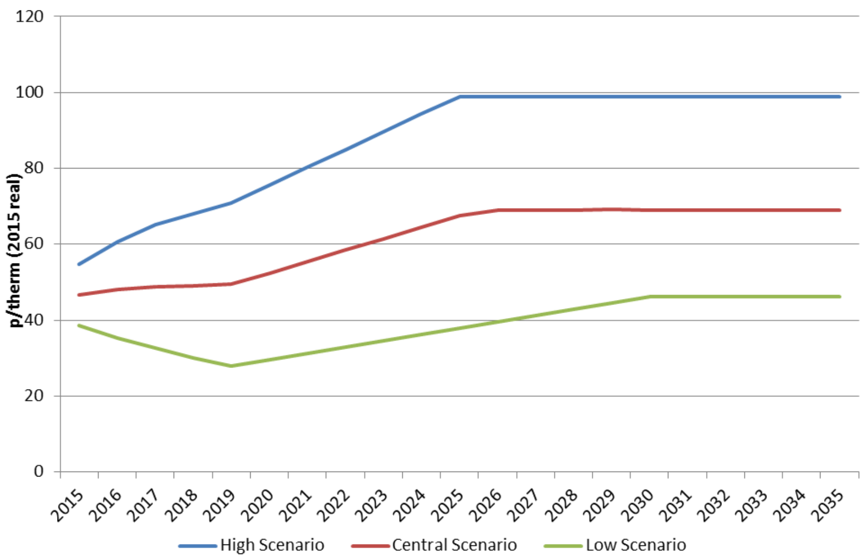
[8] Converted into 2015 prices using 2.3% assumed inflation as per the WEO 2014. The EIA projection in the next paragraph is converted to 2015 prices using the deflator in the EIA AEO 2015.

DECC 2015 Gas Price Scenarios

p/therm (2015 prices)	Low	Central	High
2015	38	47	55
2016	35	48	61
2017	33	49	65
2018	30	49	68
2019	28	49	71
2020	30	52	76
2021	31	55	80
2022	33	58	85
2023	34	61	90
2024	36	64	94
2025	38	67	99
2026	39	68	99
2027	41	68	99
2028	43	68	99
2029	44	68	99
2030	46	68	99
2031	46	68	99
2032	46	68	99
2033	46	68	99
2034	46	68	99
2035	46	68	99
2036	46	68	99
2037	46	68	99
2038	46	68	99
2039	46	68	99
2040	46	68	99

Figure 1: DECC 2015 natural gas price projections



32. The European natural gas market, of which the UK is a part, is currently supplied by domestic production (about 60%), piped gas primarily from Russia (30%) and LNG (10%). Of these three sources, LNG tends to be the most expensive because of the costs of liquefaction, transportation and regasification. Over time, as domestic production declines, LNG can be expected to increasingly supply the EU and UK natural gas markets, continuing to be the main marginal supply source. Our gas price scenarios reflect this structure of the European natural gas market.

Central Scenario

- **2015-2019:** An average of the past three months of forward curve prices. For 2015 this is a weighted average of the NBP spot price from 1st January to 31st March 2015, the monthly forward curve from April to June, and quarterly forward curves for Q3 and Q4. 2016 and 2017 are an average of the quarterly forward curves. 2018 and 2019 are a weighted average of the winter and summer forward curves.
- **2020-2024:** Linear interpolation between the 2019 and 2025 projections.
- **2025-2030:** Assumes that US LNG is the marginal source of supply to the UK. Pricing based on Energy Information Administration (EIA) Henry Hub (HH) reference case price projection plus the cost of delivery to Europe (basket of external estimates).
- **2031 onwards:** Flat line at 2030 price.

33. By 2025 we assume that US LNG will be the marginal source of supply. Currently 63.8bcma of US LNG export capacity is under construction, with the potential for a further 44.7bcma[9] – all of which has the potential to be operational by the end of 2020. The potential size of US exports, the proximity to Europe (compared to Asia) and the relatively low North American gas price means that the US is considered a plausible long run price anchor for the UK. The EIA HH reference case assumes that in 2025 the US exports 72bcm of LNG, this rises to 95bcm by 2030 and flat-lines thereafter.

34. 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 re-gas[10]. We have used a basket of external commentators' views to estimate the cost of delivery. This is the same approach as was used last year. However the average of the cost of delivery estimates is $0.46 lower than last year driven by a reduction in estimates for liquefaction costs.

High Scenario

- **2015-2019:** Calculation of the volatility over time based on one standard deviation from the mean multiplied by the square root of time. For 2015 time is assumed to be 0.75 of the year because the spot price is used for Q1, for 2016 time is 1.75, for 2017 2.75 etc.
- **2020-2024:** Linear interpolation between the 2019 and 2025 price projections.

[9] Assumes Corpus Christi, Sabine Pass T5, Freeport T3, and one or two other projects go ahead – based on market commentators' views.

[10] When considering LNG delivery costs the industry normally considers the DES (Delivered Ex-Ship) price. This does not include re-gas cost. For completeness, and comparability to the NBP we have included re-gas costs in our projections.

- **2025 onwards:** Assume Australian LNG is the marginal source of supply. Pricing based on IEA estimates of Australian LNG delivered to Europe.

35. Australia is projected to have the largest LNG export capacity[11] in the world by 2020. In a tight LNG market (e.g., with robust Asian demand and limited US exports), it is assumed that Australia becomes the global price setter by 2025. This does not necessarily mean that Australian LNG would be shipped to Europe. Rather, the assumption is that in an environment of strong demand and weak supply, the European price could be determined by the cost of Australian LNG, with the Europe having to attract LNG away from the Asian market by offering a competitive price.

Low Scenario

- **2015-2019:** Calculation of the volatility over time – same principle as the high scenario outlined above.
- **2020-2029:** Linear interpolation to 2030 projected price.
- **2030 onwards:** Assume pipeline gas from Russia is the marginal source of supply to Europe. Pricing based on average of Russian cost estimates on new supplies.

36. Russia is the main provider of piped natural gas to Europe. In a scenario with relatively low European demand (e.g., due to energy and climate change policies) and abundant LNG, Russia could look to protect its European market share by pricing its gas more competitively. Although Russian gas would be piped to Europe, rather than the UK, we would expect the continental price and NBP to reach equilibrium at the Russian price. The lowest price that Russia would tolerate is that which cover the long run marginal cost of its new gas production, plus costs of transporting the gas to Europe.

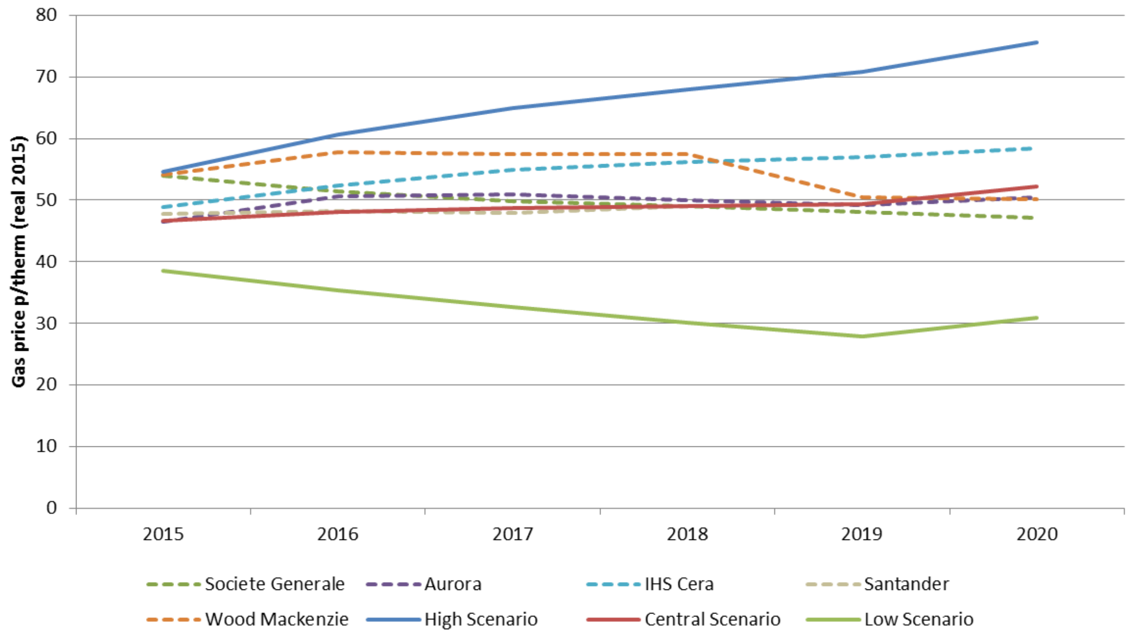
37. The long term marginal cost of new Russian gas supplies is an average of estimates from the IEA ($7), Aurora Energy Research ($6) and Oxford Institute for Energy Studies Yamal ($7.5) –converted to the same price base and current exchange rates. This gives a price of $7/mmbtu, which is equivalent to 44p/therm in UK price terms.

Comparison with external projections

38. Figure 2 shows the medium term price projections of independent forecasters, which range between 48p/therm and 58p/therm. These forecasts are well within the range implied by our low and high scenarios.

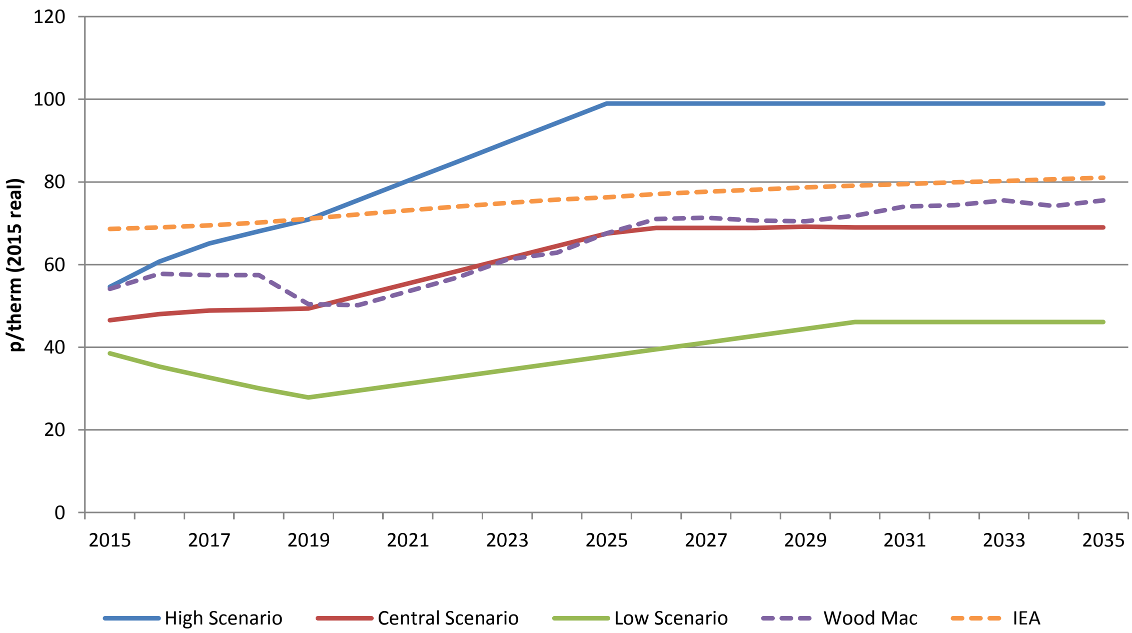
[11] Based on projects which are operational or under construction.

Figure 2: DECC natural gas price scenarios 2015 compared to external medium term price forecasts



39. Figure 3 shows that from 2020 to 2030 the Wood Mackenzie price projection maps closely to our central scenario. The most recent IEA (2014) price forecast falls within our three scenarios from 2019 onwards.

Figure 3: DECC natural gas price scenarios 2015 compared to external long term price projections



DECC 2015 Coal Price Scenarios

(in 2015 $/tonne)	Low	Central	High	Notes
2015	53.0	59.9	66.8	**Central Scenario** 2015-2018: based on forward curve 2019-2024: linear interpolation 2025: long run marginal cost of coal imports 2026-2030: 1% real growth rate year on year 2031-2035: flat-lined **Low Scenario** 2015-2018: downward adjustment on forward prices 2019-2024: linear interpolation 2025: long run marginal cost of coal imports 2026-2035: flat-lined **High Scenario** 2015-2018: upward adjustment on forward prices 2019-2024: linear interpolation 2025: long run marginal cost of coal imports 2026-2030: 2% real growth rate year on year 2031-2035: flat-lined
2016	48.9	59.3	69.7	
2017	46.9	60.1	73.4	
2018	47.5	63.9	80.3	
2019	50.8	66.6	83.0	
2020	54.1	69.3	85.7	
2021	57.4	72.0	88.4	
2022	60.7	74.7	91.1	
2023	64.0	77.4	93.9	
2024	67.3	80.1	96.6	
2025	70.6	82.8	99.3	
2026	70.6	83.6	101.3	
2027	70.6	84.4	103.3	
2028	70.6	85.3	105.3	
2029	70.6	86.1	107.4	
2030	70.6	87.0	109.6	
2031	70.6	87.0	109.6	
2032	70.6	87.0	109.6	
2033	70.6	87.0	109.6	
2034	70.6	87.0	109.6	
2035	70.6	87.0	109.6	
2036	70.6	87.0	109.6	
2037	70.6	87.0	109.6	
2038	70.6	87.0	109.6	
2039	70.6	87.0	109.6	
2040	70.6	87.0	109.6	

Methodology

40. The methodology for DECC 2015 coal price scenarios is based on an assessment of forward prices in the medium term (2015-2024) and on an analysis of supply and demand fundamentals in the long run (2025-2035). The methodology is broadly similar to the one used last year, with some minor modifications to reflect the higher level of uncertainty in the market.

41. Forward prices aggregate the expectations and insights of market participants about the most probable coal price trajectory; as such, they are taken to be the best indicator for short-run movements in coal prices. High and low scenarios have been constructed to reflect past forecast errors in forward prices.

42. In the long run, coal prices are expected to reflect the full costs of the supply sources that are needed to meet the projected coal demand. The long term prices should be seen as average prices that could prevail over a decade or more. The scenarios do not model some of the market dynamics that have contributed to substantial volatility in coal prices (i.e. technological developments, duration of business cycles, weather or political events). The uncertainty coming from these additional factors is assumed to be reflected in the range of demand levels used in the long-term scenarios.

43. The scenarios refer to steam coal imports into North Western Europe (i.e. CIF ARA[12]) over a given year. Steam coal is mainly used in the power sector and it is the most traded type of coal in both the Atlantic and Pacific basins. Prices are reported in 2015 USD/tonne terms.

Central Scenario

44. The price in 2015 is calculated as an average of the spot price in the first quarter of 2015 and of the forward price indices over the remaining quarters of 2015. The prices in 2016-2018 are based on CIF ARA forward prices as observed in the first quarter of 2015. Prices were linearly interpolated in 2019-2024.

45. A long run marginal cost (LRMC) approach was used to calculate the central estimate in 2025. The LRMC of importing coal into Europe from different coal exporting mines is calculated by adding the business costs that each mine is expected to incur in 2025 to an assumed margin covering capital costs required by the companies to be profitable in the long term.

46. Miners' business costs represent the costs involved in realising the fair market value of the thermal coal product that has been produced by the mine and includes both site and realisation costs. That is, they cover raw material costs, royalties, overland transport costs, port handling costs and shipping freights. The projected mining costs were taken from CRU's thermal coal cost service[13].

47. The projected levels of European coal import demand are based on the scenarios constructed by the International Energy Agency in their 2014 World Energy Outlook[14]. In each scenario the figure for steam coal import demand is calculated as the difference between the million tonnes of coal demanded by the European power sector and the tonnes locally produced in OECD Europe. The implied level of import demand is then superimposed on the projected business cost curve in order to derive the price at which the European coal market clears.

48. In 2025, the projected demand for 118.30 mt of coal[15] is satisfied at a price of $82.8/tonne. A growth rate of 1% is applied in real terms on prices between 2025 and 2030.This reflects a likely increase in variable mining costs and an expected decrease in coal quality. Also, the non-zero growth rate assumption reflects external forecasters' expectations. All four sources considered

[12] The price includes the cost of insurance and freight for coal delivered to the major importing ports in northwest Europe – Antwerp/Rotterdam/Amsterdam.

[13] CRU is a private and independently owned company specialising in research and consulting services in the metals and mining industries.

[14] For more information on the assumptions and modelling behind each coal demand scenario, the reader is referred to the World Energy Outlook website.

[15] The coal demand level is normalised with respect to energy content (i.e. 6,000 kcal/kg).

here, i.e. Woodmac, EIA, AER, and IEA assume upward sloping trajectories for coal prices beyond 2025. Prices are then assumed to follow a flat profile in 2030-2035.

Low Scenario

49. The low estimates for 2015-2018 are calculated by applying a time-varying downward adjustment factor on forward prices to reflect uncertainty. The scaling factor is constructed by considering one standard deviation of the year-ahead forward contracts' prediction errors weighted by the square root of the forecast horizon. Prices are linearly interpolated to 2025.

50. The low estimate for the 2025 price of coal in the long term is also based on a LRMC approach, analogous to the one used for the central estimate. The price variation is given by a lower projected level of European coal import demand. In 2025, the projected demand for 12.74 mt of coal is satisfied at a price of $70.6/tonne. Prices are flat-lined from 2025 onwards to reflect a low pathway for coal prices.

High Scenario

51. The high estimates for 2015-2018 are calculated by applying an upward adjustment on forward prices. The methodology is analogous to the one used in the low scenario. Prices are again linearly interpolated from 2019 to 2024.

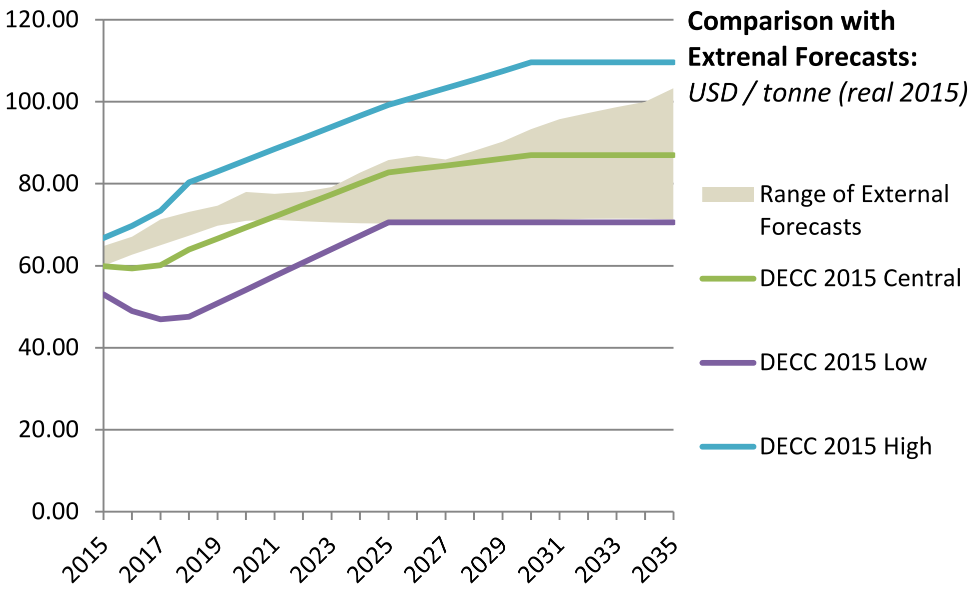
52. The high estimate for the price of coal in 2025 uses the same LRMC methodology based on an assessment of the projected level of European coal demand in the IEA current policies scenario[16]. In 2025, the projected demand for 154.83 mt of coal is satisfied at a price of $99.3/tonne.

53. Prices are assumed to increase at a real rate of 2% year on year between 2025 and 2030 (i.e. using a slightly higher growth rate than the rate used in the central scenario). Prices are then assumed to follow a flat profile beyond 2030.

Comparison with external projections

54. The long term central scenario falls within the range of prices projected by key external forecasters, which include international organisations, private research providers and other governments.

[16] The current policies scenarios is the high energy demand scenario in the IEA WEO.


120.00
100.00
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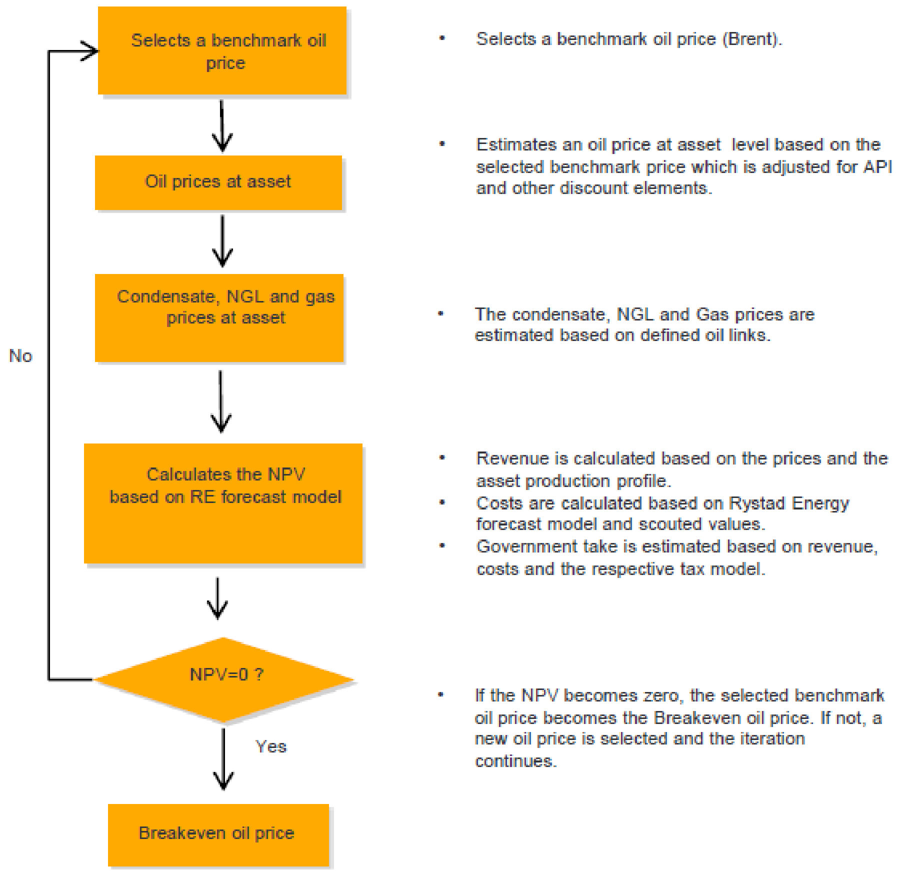
60.00
40.00
20.00
0.00
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
Comparison with Extrenal Forecasts:
USD / tonne (real 2015)
Range of External Forecasts
DECC 2015 Central
DECC 2015 Low
DECC 2015 High

Annex A

Rystad Energy approach to calculating break-even oil prices:

Rystad consider ultimate recoverable resources for each field and develop production forecasts by individual asset (taking a bottom up approach). The schematic below illustrates their iterative approach to calculating a break-even price for any one asset. In the breakeven calculation all future cash flows (including2015) are considered. This means that all costs, revenues and government take are reflected in the calculation. A 10% nominal discount rate is assumed for all assets.



Annex B

The table below compares oil demand projections from key energy institutions. Whilst we acknowledge that there are significant uncertainties with demand projections we have chosen to use unadjusted IEA demand numbers as they are internationally recognised as a leading institution in energy demand and supply projections.

2040 total liquid demand projections (mb/d)

IEA (WEO 2014)			EIA (AEO 2015)			OPEC (WOO 2014)
Current Policies	New Policies	450	Low	Ref	High	Ref
120.2	108.5	80.7	124.7	121.0	123.6	111.1

Annex C

The table below compares price projections of different institutions. Clearly there is a wide range of views driven by alternative views on states of the world and underlying assumptions. What is clear however is that DECC projections fall within the range of views presented by other institutions.

Prices in 2015$/bbl				
	DECC low	**EIA low**	**IEA 450 scenario**	
2020	38	60	110	
2030	75	71	107	
2040	75	79	105	
	DECC central	**EIA reference**	**IEA New Policies**	**OPEC reference**
2020	85	82	117	100
2030	120	110	129	103
2040	120	146	138	106
	DECC high	**EIA high**	**IEA Current Policies**	
2020	142	154	121	
2030	185	201	145	
2040	185	261	162	

IEA publication: WEO 2014

EIA publication: AEO 2015

OPEC publication: WOO 2014

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