Richard Howard | November 2016

NEXT STEPS FOR THE CARBON PRICE FLOOR

A Policy Exchange Research Note

Policy Exchange

About the Authors

Richard Howard joined Policy Exchange in 2014 as Head of the Environment and Energy Unit. He has since produced a number of influential reports on topics including energy policy and regulation, energy efficiency and fuel poverty, and air quality. Richard has more than 10 years' experience in energy and environmental policy, economics, and government affairs. He was previously the Chief Economist at The Crown Estate, and prior to that he worked as an economic consultant. He has a BSc in Economics from the University of Bristol and an MSc in Sustainability, Planning and Environmental Policy from Cardiff University, where he has been a visiting lecturer since 2009.

Acknowledgements

Policy Exchange would like to thank ESB for their generous support for this project, and Filippo Gaddo and Pete Thornton (Arup) for their analysis which informed this report.

Policy Exchange's Environment & Energy Unit

Policy Exchange's Environment & Energy Unit conducts innovative and independent policy research into a wide range of environmental, infrastructure and regulatory challenges. Our objectives are to influence policy making and to shape debate. We produce publications, organise events and use the media to promote our findings and policy proposals. A key focus of our work is to identify ways to tackle environmental challenges effectively, while minimising adverse impacts on living standards. We promote well-designed regulation to exploit the power of markets to achieve environmental outcomes innovatively and cost-effectively.

If you would like to find out more about our work, please contact:

Richard Howard, Head of Environment and Energy
Email: richard.howard@policyexchange.org.uk
Telephone: 0207 340 2650
www.policyexchange.org.uk

Introduction

This research note considers the future of carbon pricing in the UK. Specifically, it outlines the arguments for and against retaining the Carbon Price Support mechanism – a carbon tax levied on fossil fuel power generation in the UK. The report builds on analysis by Arup (a consultancy) which considers the impact of the Carbon Price Support mechanism on energy costs to consumers, carbon emissions, and security of supply (see Appendix 1).

The Government now faces some tough questions over the future of carbon pricing in the UK. Should it retain the UK Carbon Price Support mechanism, despite the cost burden it places on consumers and the distortions it creates? Or should Government abandon it and allow UK and EU carbon prices to converge? To what extent has the Carbon Price Support delivered its original objective to support low carbon investment? And with the planned phase-out of UK coal power stations by 2025, what is the Carbon Price Support actually supporting?

This report attempts to address the above questions. It provides a summary of a Policy Exchange roundtable on this topic, which was attended by a group of 25 energy businesses, policymakers, think tanks, and industry bodies.

Background

Power stations in the UK are subject to carbon taxes on the greenhouse gasses they emit. These come in the form of the European Emissions Trading Scheme (EU ETS) and the UK-specific Carbon Price Support (CPS) mechanism. Fossil fuel generators are required to pay these carbon taxes, the cost of which is ultimately passed on to consumers. Cornwall Energy estimates that the CPS alone adds around £36 per year to the average household electricity bill,[1] whilst the EU ETS adds a further £10 per year - together making up 9% of the average household electricity bill.[2]

The UK joined the EU ETS when it was first established in 2005. In theory, the scheme should be an efficient way to encourage cost-effective decarbonisation. Under the scheme, a number of carbon permits are auctioned each year, and companies can choose whether to purchase allowances or reduce their emissions. The number of permits declines each year in line with a pre-determined emissions cap. It was thought that the scheme would encourage market participants to

identify the cheapest decarbonisation opportunities available, and that it would provide certainty for investment.

However, in practice the EU ETS has turned out to be largely ineffective as a carbon pricing mechanism. The price of allowances has been persistently low since around 2009, due to a systematic over-supply of permits. This was caused by a number of factors including the expansion of renewable energy, and the recession from 2008 onwards which reduced total power demand. Traded emissions have fallen over time in line with the EU ETS cap, but this is largely due to other factors such as renewable subsidies and energy efficiency improvements, rather than due to the EU ETS mechanism itself.

The UK Government has, on several occasions, encouraged the European Commission to reform the EU ETS in order to overcome its design flaws. However, recognising the defects with the mechanism, the Government decided to create a UK-specific "Carbon Price Floor" to prop up the carbon price faced by fossil-fuel power generators and encourage low carbon alternatives. The Carbon Price Floor was first mooted in 2010 as part of the Coalition agreement,[3] and the Government subsequently ran a consultation on specific proposals in late 2010.[4] The stated objective of the Carbon Price Floor was *"to support and provide certainty for low carbon investment".*[5] It did this by setting out a trajectory for the UK carbon price to increase to £30/tonne in 2020 and £70/tonne in 2030 (in 2009 prices). This was to be achieved by creating a UK-specific "Carbon Price Support" tax on top of the price in the EU ETS market.

The UK Carbon Price Support was eventually introduced in April 2013 at a rate of £16/tonne. Given the fall in the EU ETS price over the intervening period (to just €5/tonne), this made the overall carbon price in the UK around five times higher than in the rest of the EU. The widening gap in carbon prices led to concerns about the cost of the policy to households and businesses. In particular there was a concern that this could lead to competitiveness issues in energy-intensive industries. Government responded by establishing a scheme to compensate energy-intensive industries for *part* of the cost of the EU ETS and CPS (European State Aid rules restrict the Government from exempting companies from these costs altogether). A previous Policy Exchange report estimated that these compensation schemes amount to around £100 million per year, with the cost picked up by UK tax-payers.[6]

With the gap between UK and EU carbon prices widening, HM Treasury intervened in 2014 to 'cap' the Carbon Price Support rate at £18/tonne until 2019/20. In effect, this meant that Government had abandoned the Carbon Price Floor trajectory just 12 months after its introduction. Further to this, in the 2016 Budget, HM Treasury confirmed that the cap on the CPS rate would be extended for one additional year to 2020/21.

Despite these changes, the CPS has already had a significant impact on the generation mix by increasing the cost of coal generation relative to gas. Analysis by Cornwall Energy suggests that the CPS increases the marginal cost of coal generation by over 50% (from £30.3/MWh to £45.8/MWh) which at current market prices is sufficient to make coal slightly more expensive than gas generation.[7] As a result of this, the share of coal generation fell from 46% in 2012, to just 3% in the third quarter of 2016 (falling below that of solar photovoltaics for the first time).[8] Moreover, as documented in our recent report, *Power 2.0*, this has led to 13.7 Gigawatts (GWs) of coal capacity closing since 2010 (equivalent to more than one fifth of peak power demand).[9]

Since the introduction of the Carbon Price Floor, the Government has set out plans to phase out unabated coal generation altogether by 2025.[10] It is expected that a further 4GW of coal capacity will close by 2017, leaving a further 13.6 GWs of coal capacity which would need to close between 2017 and 2025. A recent Government consultation proposed to implement the coal phase out either by extending an Emissions Performance Standard to existing coal power stations, or requiring them to be fitted with Carbon Capture and Storage technology. [11] The consultation also proposes to place restrictions on coal generation ahead of the 2025 closure date, for example by placing a cap on running hours or emissions.

As well as shifting power generation from coal to gas, the CPS has also encouraged a growth in electricity imports from continental Europe, where carbon and electricity prices are lower. There is currently 4GW of interconnector capacity physically linking the power market in Britain to other markets such as France, Ireland and the Netherlands. Electricity imports now stand at 6% of total power supplied to the UK (in 2015). As highlighted in our previous report, *Getting Interconnected*[12], a number of new interconnector projects are being planned to link Britain with Norway, Denmark, Iceland, and Belgium, and increase the connection capacity to France. The growth in interconnection is in part being driven by the difference in carbon taxes between the UK and the rest of Europe,

which creates an arbitrage opportunity. Perversely, the rollout of additional interconnectors may actually increase emissions across Europe as a whole. Analysis by Aurora Energy Research has shown that as long as the carbon price differential is maintained, then building additional interconnectors would *increase* European-wide emissions, as it would cause gas and coal power stations in continental Europe to run more often.[13]

Where next for the Carbon Price Floor?

The Government now faces a tough decision on the way forward for UK carbon prices, with an announcement expected imminently as part of the Autumn Statement. Industry participants and other stakeholders are divided on the issue. On the one hand, a group of large energy companies has written to the Chancellor urging the Government to retain the Carbon Price Support until at least 2025, on the grounds that it is "central to the UK's decarbonisation efforts."[14] This view has been echoed by industry bodies such as Energy UK and the CBI.[15] On the other hand, the EEF (the manufacturers' organisation) has repeatedly suggested that the Carbon Price Support should be abandoned in order to reduce costs to manufacturing businesses, and improve the UK's competitiveness – a view echoed by the Centre for Policy Studies.[16]

To consider this further, Policy Exchange recently held a roundtable on the future of carbon prices, which was attended by a group of 25 energy businesses, policymakers, think tanks, and industry bodies. As part of the discussion, analysts from Arup presented new analysis on the impact of possible changes to the Carbon Price Support (their presentation is provided in Appendix 1).

Arup modelled three alternative scenarios for the future of the carbon price (see Figure 1 in Appendix 1). In all scenarios, it is assumed that the EU ETS price increases from 2020/21 onwards due to ongoing structural reforms. Arup modelled one scenario in which the CPS remains in its current form, as a £18/tonne carbon tax on top of the EU ETS ("CPS Remains" scenario). They also modelled two alternative scenarios in which the CPS is gradually removed from 2021 onwards, such that the carbon prices in UK and EU eventually converge ("Flat" and "Rollercoaster" scenarios).

"CPS Remains" Scenario

Under this scenario, the CPS is retained, and the overall carbon price increases from 2021 onwards to around reach £35/tonne in 2025. The increasing carbon price would make coal generation uneconomic relative to gas, causing a rapid closure of the UK's remaining coal power stations during the early 2020s. Under this scenario, 9GW of coal capacity is expected to close between 2020 and 2023, plus a further 2GW between 2023 and 2025 (Figure 3). New generation capacity would need to be built in order to maintain security of supply. The modelling suggests that an additional 11GWs of gas generation capacity would be built in the period 2020-25, 7GWs of which would be additional, and 4GWs of which would replace existing, less efficient gas power stations (Figure 2). This is likely to include a mix of large-scale Combined Cycle Gas Turbines and smaller gas engines.

European coal and gas generators would continue to have a significant cost advantage over generators in the UK, as they would continue to face lower carbon prices. This would result in an increasing amount of electricity imports from the continent (it is assumed that 10GW of additional interconnector capacity would be built by 2030). In total, it is expected that electricity imports would increase from 21TWhs today to 50TWhs in 2030, representing around 14% of total power consumption (Figure 4). In other words, the UK would become far more reliant on European power producers. The modelling suggests that wholesale electricity prices would increase from around £40/MWh today to nearly £60/MWh in 2030, in part due to the increase in UK carbon prices (Figure 8).

"Rollercoaster" Scenario

This scenario assumes that the CPS is retained in its current form until 2022, but is then gradually removed, with UK and EU carbon prices converging in 2026. Similar to the "CPS Remains" scenario, the relatively high carbon price during the early 2020s would cause the remaining coal power stations to close, and a new fleet of gas power stations to be built in their place (Figures 2 and 3) .

Since UK and EU carbon prices are allowed to converge in this scenario, this would make UK generators more competitive relative to those in other European countries. Consequently, the modelling suggests that the volume of electricity imports would halve, from 50TWh in 2030 in the "CPS Remains" scenario, to

24TWh in the "Rollercoaster" scenario (Figure 5). Effectively, by removing the additional carbon tax, generation would be shifted from Europe to the UK. Arup suggest that this would result in additional investment in power generation in the UK, creating additional jobs and boosting GDP (Figures 19 and 20).

Interestingly, the modelling suggests that the removal of the CPS could result in an overall *reduction* in carbon emissions across Europe of 3.3 million tonnes (Mt) per year by 2030 (Figure 7). Carbon emissions would increase by 8.7 Mt in the UK, but reduce by 11.9 Mt across the rest of Europe. This may seem counter-intuitive, but is caused by new highly-efficient gas power stations in Britain displacing older gas and coal power stations in the rest of Europe. This is desirable from the perspective of reducing total greenhouse gas emissions, but perversely may be undesirable from the perspective of UK Carbon Budgets, which only consider UK territorial emissions. This raises questions about the logic of the carbon accounting framework which underpins Carbon Budgets.

The removal of the CPS in the 2020s would also result in a reduction in power prices and savings for consumers. The modelling suggests that removing the CPS would reduce wholesale electricity prices by around £4/MWh over the period 2019-30 relative to the "CPS Remains" scenario (Figure 9). This would feed through to lower retail electricity prices, saving consumers a total of £12.5 billion in energy bills over the period 2019-30 (Figure 17). On the flipside, it would reduce revenues to existing low carbon generators such as nuclear and renewables, making them less profitable. Removing the CPS would result in a loss of taxation receipts (-£0.7 billion over the period 2019-30) but the scale of this would be far outweighed by the saving to consumers (Figure 18).

Alternative Scenarios

The scenarios presented above are just some of the many possible options. Arup modelled an alternative scenario in which the CPS is removed more gradually from 2021 onwards (**"Flat" scenario**). The overall carbon price would be lower in the early 2020s than in the other scenarios, causing coal to remain on the system for longer. This would result in a smaller amount of new gas capacity being built, and later than in the other scenarios. This scenario would also result in a reduction in electricity imports, a reduction in wholesale electricity prices, and savings to UK consumers (although less than in the "Rollercoaster" scenario).

There have also been suggestions (e.g. by EEF) that the Carbon Price Support should be removed now rather than waiting until the 2020s. This would represent a very significant change in policy direction by the Government - effectively reneging on the CPS rates that have already been set to 2021. This has not been included in Arup's modelling, but would likely result in a significant increase in coal generation and UK carbon emissions. This would undermine the UK's commitment to remove coal from the power system by 2025, and make it more difficult to achieve UK Carbon Budgets. On the flipside, it would result in an immediate saving to consumers of circa £36 per household. [17]

Discussion and Conclusions

It is clear that the Government faces a tough decision as to the future direction of carbon pricing in the UK – and that the answer varies depending on how the Government prioritises affordability, carbon, security of supply, and fiscal considerations. There are no scenarios that tick all of these boxes, so inevitably policymakers will need to choose.

- From an **affordability** perspective, the removal of the CPS in the 2020s would result in a significant saving to consumers. The analysis by Arup suggests that removing the CPS would result in a total saving to consumers of £9.6 billion to £12.5 billion over the period 2019 to 2030.
- The impact on **emissions** depends on how this is measured: removing the CPS would increase UK territorial emissions, but reduce European emissions overall by up to 3.3 Mt per year by 2030.
- The scenarios are all similar from a **security of supply** perspective, provided it is assumed that the gap left by the closure of coal can be filled by other forms of capacity such as gas, storage, interconnection and demand response.
- From a **fiscal** point of view, the removal of the CPS will result in a loss of tax receipts (of £0.6-0.7 billion over the period 2019-2030) although this is comparatively small compared to the financial saving to consumers.

One of the key questions considered at the Policy Exchange roundtable concerned the rationale for retaining the Carbon Price Support going forward. Roundtable participants generally felt that the CPS had *not* met its original objective of encouraging investment in low carbon power generation such as renewables, since it was not sufficiently certain or 'bankable'. Renewables have

been deployed because of the subsidies available, not because of the taxes on fossil fuel generation.

However, the CPS has performed an important role in encouraging a shift from coal to gas generation since its introduction in 2013. There is a strong rationale to retain the CPS in order to achieve the Government's ambition to phase out coal generation by 2025. Removing the CPS early would conflict with the commitment to phase out coal, since it would result in coal staying on the system for longer, and undermine the case for investment into alternatives.

Once coal has been phased out, the rationale for keeping the CPS becomes much weaker. As shown in the analysis above, a high UK carbon price in the late 2020s would simply push power generation from the UK to the rest of Europe, and may actually *increase* total emissions. A possible solution would be for Government to commit to keeping the CPS only until the mid 2020s, and then allow UK and European carbon prices to converge, as in Arup's scenarios.

Another key theme of discussion was policy stability and the impact of policy changes on investor confidence. One of the issues with the Carbon Price Support has been its credibility as a long term policy. The original carbon price trajectory was not seen as believable or 'bankable' by investors, and in fact it lasted just 12 months before the Government changed course. That said, some of the roundtable participants were nervous about the possibility of further changes to the CPS, as they felt this could undermine investor confidence. The removal of the CPS would affect both fossil fuel generators and low carbon generators (due to the likely reduction in wholesale electricity prices). Many of the roundtable participants felt that the CPS should be retained in its current form until at least the mid-2020s.

The future direction of carbon prices is just one of a number of uncertainties hanging over the forthcoming Capacity Market auction, through which the Government will procures capacity to ensure security of supply. The next auction will take place in December 2016, and relates to capacity delivered in winter 2020/21. As it stands, potential bidders do not have visibility of carbon prices beyond March 2021, making it very difficult for them to make an informed bid into the Capacity Market auction. There is also some uncertainty regarding the Government's proposal to phase out coal generation by 2025. Whilst Government has recently reaffirmed its commitment to phase out coal by 2025, the details of how this will be achieved are yet to be finalised. There are also a

number of other uncertainties affecting the Capacity Market auction, as discussed in our recent report, *Power 2.0*.[18] For example, Ofgem is currently undertaking a review of the "embedded benefits" available to generators connecting to distribution networks, whilst Defra is considering new regulations concerning emissions from diesel generators. Overall, these uncertainties will make it much more difficult for generators to bid into the next Capacity Market in December 2016. All else being equal, this uncertainty is likely to drive up the price of new capacity.

Recommendations

We recommend that the Government uses the Autumn Statement 2016 as an opportunity to provide clarity about the future of the Carbon Price Support mechanism beyond 2021. We think that there is a strong rationale to retain the CPS until the early 2020s, to support the Government's ambition to phase out coal generation. However, once coal generation has been phased out, the rationale for retaining the CPS becomes considerably weaker. We recommend that the CPS is phased out by the mid 2020s, to bring carbon prices in the UK in line with the rest of Europe. This will reduce electricity prices and bills for UK consumers, and support investment into new, flexible power generation in the UK, creating jobs and boosting GDP.

We do not think that the Government should remove the CPS now, as has been suggested by some stakeholders such as the EEF. Whilst this would result in an immediate saving to consumers, it would significantly undermine investor confidence as well as the credibility of the Government's decarbonisation plans.

Following Brexit, the Government needs to consider the UK's involvement in the EU ETS. The scenarios presented in this report assume that the UK continues to participate in the EU ETS, and that the European Commission reforms the scheme to address the systematic oversupply of permits. However, these assumptions are by no means certain, and the future of the Carbon Price Support is to some extent conditional on the nature of the UK's involvement in the EU ETS.

Endnotes

[1] Source: Cornwall Energy. http://www.cornwallenergy.com/cms/data/files/Downloads/160930_Chaart-of-the-week.pdf

[2] BEIS (2016) *Domestic Energy Price Statistics*

[3] HM Government (2010) *The Coalition: our programme for government*

[4] HM Treasury (2010) *Carbon price floor: support and certainty for low-carbon investment*

[5] HM Treasury (2010) *Carbon price floor: support and certainty for low-carbon investment*

[6] Howard, R. (2015) *The Customer is Always Right*. Policy Exchange

[7] Source: Cornwall Energy. http://www.cornwallenergy.com/cms/data/files/Downloads/160930_Chaart-of-the-week.pdf

[8] BEIS (2016) *Energy Trends, Table 5.1, Electricity Generated by source;* Imperial College London / Drax (2016) *Drax Electric Insights Quarterly – Q3 2016*

[9] Howard, R. and Bengherbi, Z. (2016) *Power 2.0: building a smarter, greener, cheaper electricity system.* Policy Exchange

[10] Source: https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy

[11] BEIS (2016) *Coal Generation in Great Britain*

[12] Moore, S. and Newey, G. (2014) *Getting Interconnected*

[13] Aurora Energy Research (2016) *Dash for Interconnection*

[14] Twidale, S. (2016) *"Four British power firms call for carbon tax extension"*, Reuters, 26th September 2016; Clark, P. (2016) "*UK climate pledge faces stiff test amid carbon tax drive"*, Financial Times, 25th September 2016

[15] Sources: http://www.cbi.org.uk/news/invest-for-the-future-business-priorities-for-autumn-statement-2016/ http://www.energy-uk.org.uk/publication.html?task=file.download&id=5899

[16] Sources: http://www.cps.org.uk/files/factsheets/original/160929100405-84AreWeHeadedforBlackoutBritain.pdf http://www.edie.net/news/11/Scrapping-Carbon-Price-Floor-would--level-the-playing-field---says-EEF/

[17] Source: Cornwall Energy. http://www.cornwallenergy.com/cms/data/files/Downloads/160930_Chaart-of-the-week.pdf

[18] Howard, R. and Bengherbi, Z. (2016) *Power 2.0: building a smarter, greener, cheaper electricity system.* Policy Exchange

Appendix 1

A bumpy ride ahead?

Analysis of changes to the Carbon Price Support and the impact on the electricity sector

16/09/2016

Business & Investor Advisory

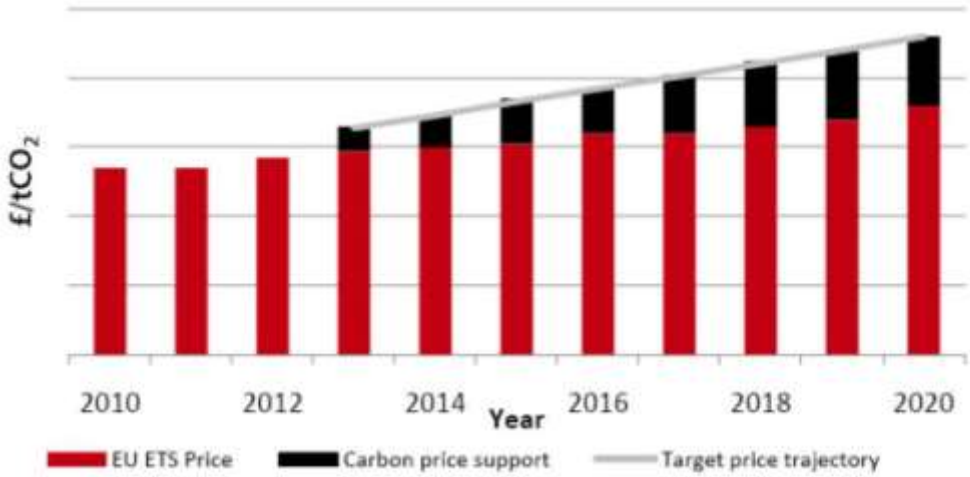
ARUP

Background

This paper looks at the impact of different potential trajectories for the Carbon Price Support after the current phase ends in 2020/2021.

- The Carbon Price Floor places a price on carbon dioxide emissions through the EU Emissions Trading Scheme (EU ETS) and the Carbon Price Support (CPS). The CPS is paid only by UK generators and does not impact the costs of foreign generation.
- Businesses using fossil fuels to generate electricity in Great Britain (GB) are required to pay a CPS rate on those fuels, on top of the EU ETS price. The fuels which are liable to pay the CPS include:
  - Natural Gas;
  - LPG;
  - Coal and other solid fossil fuels.
- Given the low price of the EU ETS, the CPS has been capped at £18 per tonne of carbon dioxide from 2016/17 to 2019/20. In effect, this freezes the Carbon Price Support rates for each of the taxable commodities at 2015/16 levels.
- The CPS supports the aim of reducing domestic emissions by creating a price signal for less electricity to be generated from carbon-intensive fuels. In the medium term, the effect of the policy is to accelerate the closure of coal generators by reducing their running hours.
- The following analysis investigates what happens to GB generation, net imports and prices under different CPS trajectories after 2019/2020.
- We have also assessed the impact on retail prices for final consumers and the potential wider economic impacts.

Illustration of the Carbon Price Support Mechanism, not to scale (source: Carbon Price Floor, Standard note SN/SC/5927)



Scenarios: carbon prices

We have investigated the future impacts of keeping the CPS against tapering it to provide a flat overall carbon price and a more mixed scenario.

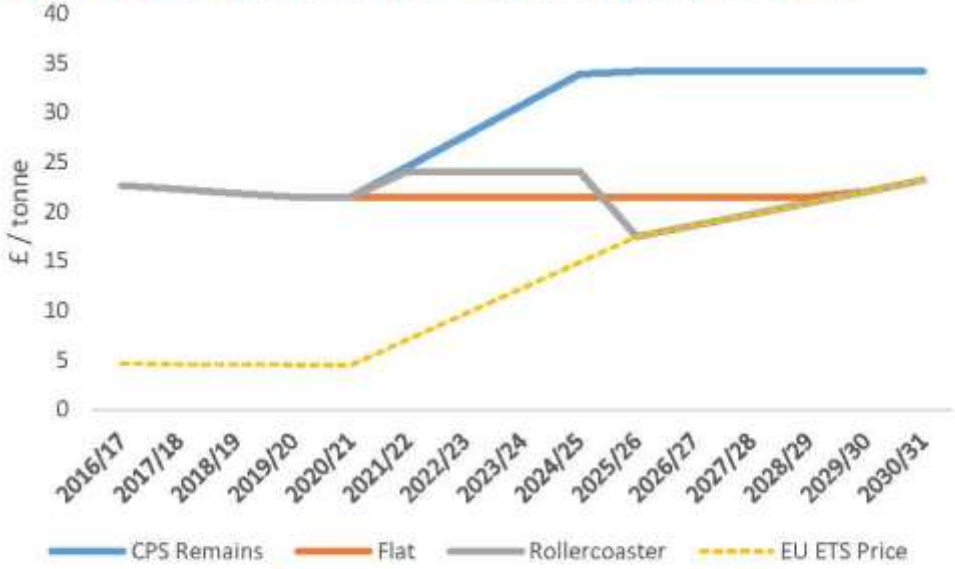
GB carbon price trajectories

- Three scenarios for GB carbon prices have been modelled. The scenarios make different assumptions about the future of the CPS, assuming the same forecast for the EU ETS price. Figure 1 provides a representation of the trajectories modelled.
  - **"CPS Remains"**: assumes that the current carbon price support remains in place at £18 until 2025. After 2025, we begin to taper the CPS slowly to keep the effective carbon price flat.
  - **"Flat"**: assumes a tapering of the carbon price support during the 2020s in order to allow the GB carbon price to tend back to the EU-ETS price by 2029/2030.
  - **"Rollercoaster"**: assumes that the CPS is held a the current level for an extra year before beginning to taper, until in 2025/2026 it falls to zero. It is assumed that all coal generators will be forced to close by this point.

French CPS

- In the following analysis we have not included a French Carbon Price Support. The addition of a French CPS appears likely, however, based on our preliminary modelling and analysis of the French CPS, the impact on the key messages coming out of this work is minor.

Figure 1: Carbon price assumptions (financial years) – *real £2016*



Executive summary

Keeping the Carbon Price Support indefinitely may not provide the optimal environment for new investment into new generating capacity.

- **Capacity mix:** Keeping or removing the CPS has an impact on the future capacity mix. The manner in which the CPS is removed will also have an impact on future capacity.
  - Coal generators: If the CPS is maintained, coal generators will retire early in the 2020s as the majority of them will be unable to cover their fixed costs through the wholesale or capacity market.
  - Gas generators: A higher CPS in the early 2020s will encourage new efficient gas capacity to come online as coal generators retire.
- **GB Generation:** If the CPS is kept beyond when coal capacity is closed, there are impacts on GB generators' competitiveness in Europe.
- **Emissions:** Keeping the CPS increases total emissions within Europe as a result of increased coal generation on the continent displacing GB gas generation. Reducing the CPS too soon can bring coal generators back into the stack which will increase GB emissions.
- **Wholesale prices:** The CPS increases wholesale prices. Removing the CPS will lower them. The extent of the reduction is dependent on the capacity mix.
- **Retail prices:** Keeping the CPS indefinitely negatively impacts residential consumers' bills. The capacity mix created as a result of tapering will also have an effect bills. The saving for consumers easily outweighs the difference in tax take over the horizon.
- **Conclusions**:
  - Given that the CPS can have such a large impact on generators' future competitiveness, the trajectory of the CPS should be clarified as soon as possible to provide investor confidence.
  - How the CPS affects the market will be dependent on future commodity prices. This will complicate the design of the CPS's path.
  - Whether European-based emissions from electricity imports are included in GB's carbon accounting could impact the CPS trajectory chosen.

	CPS remains	Flat	Rollercoaster
Large new gas capacity	Medium	Low	High
GB Generation in 2030	Low	Medium	High
GB Net imports	High	Medium	Low
GB Emissions	Low	Medium	High
EU (inc GB) emissions	High	Medium	Low
Wholesale price	High	Medium	Low
Retail Price	High	Medium	Low
Tax take	High	Medium	Low
Economic multiplier	Medium	Low	High

High/Medium/Low: Compares the quantum of the indicator between the scenarios.
Red/Amber/Green: Provides a view of whether the scenario provides the best outcome for GB. These will vary from stakeholder to stakeholder.

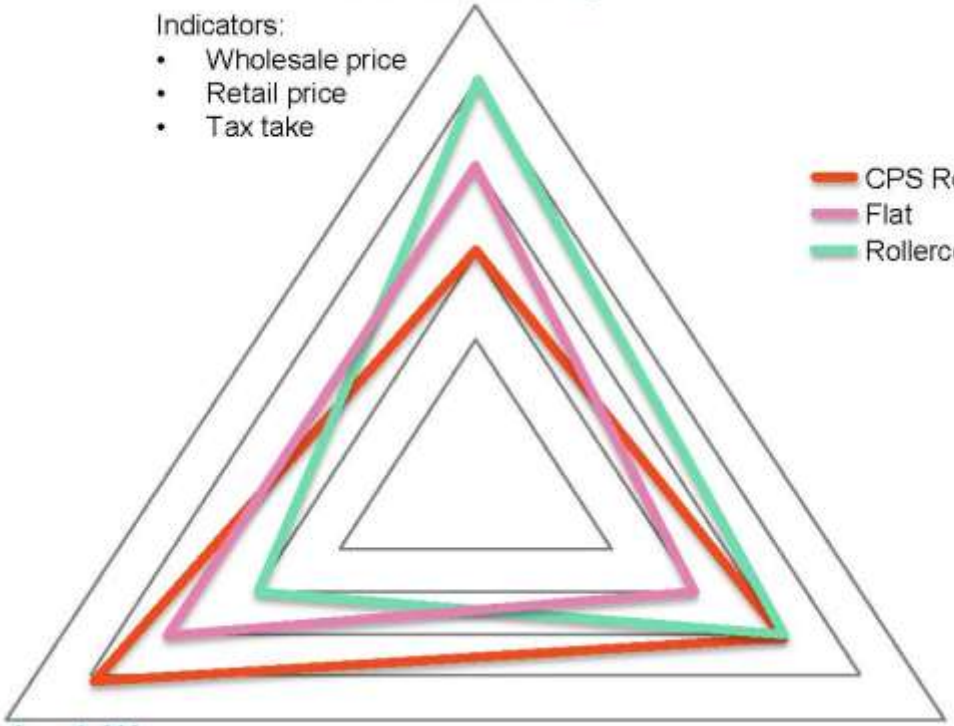
Executive summary

Retaining the CPS may not be the best long term solution for affordability or sustainability.

Consumers' bills are lowest when the CPS is removed in the long term

Affordability

Indicators:
- Wholesale price
- Retail price
- Tax take



Indicators:
- GB emissions

Sustainability

GB emissions are minimised under the CPS Remains scenario

Indicators:
- Large new gas capacity
- GB Generation in 2030

Security

The most large, new generating capacity is built under the CPS Remains and Rollercoaster scenarios

Capacity – Coal and new gas

Keeping the CPS and the Rollercoaster scenario lead to the highest likelihood of new CCGT build. Coal closes earliest in CPS Remains.

New gas build

- Maintaining the CPS causes old CCGT capacity to retire sooner than if the CPS is tapered. This CCGT capacity is largely replaced by new, more efficient CCGTs which are able to generate for a higher proportion of the year due to their low short run marginal cost. Maintaining the CPS at its current level leads to the most new gas generation build in the first half of the 2020s. This capacity is likely to be large CCGTs as more efficient generators are able to gain net revenue from higher short run marginal costs of older capacity in this scenario.
- The Flat scenario allows the most value for money to be extracted from the existing fleet as coal capacity remains online for longer. Little new gas capacity is seen in the early 2020s and there is a higher probability that new gas capacity is peaking capacity rather than large CCGTs. The cause of that is the short term revenues for new gas generators are lower in 2023 and 2024 as coal generation picks up. This provides a signal for lower capital cost peaking plant to enter the system through the capacity market.
- The Rollercoaster scenario leads to a higher likelihood of new CCGTs in the early 2020s being built than the Flat scenario. By keeping coal costs higher, new efficient gas generators are able to extract enough revenue from the wholesale market to bring their bids down below the bids of peaking capacity.

Existing gas Capacity

- If the CPS Remains, the most existing gas capacity will be closed as the potential for exports to Europe is lowered and inefficient capacity is penalised.
- The Flat and Rollercoaster scenarios increase the amount of existing capacity still online in 2030.

Coal closures

- We have assumed that all coal will be closed by 2025 irrespective of the economic case to remain open.
- The longer that the CPS is kept at its current level, the faster existing coal assets are taken off of the system, with 9GW shutting down between 2020 and 2023. 8.4GW of coal has closed already in recent years.
- By following different CPS trajectories, the amount of coal generation remaining online is altered.

Figure 2: Installed gas capacity including existing and new build (MW)

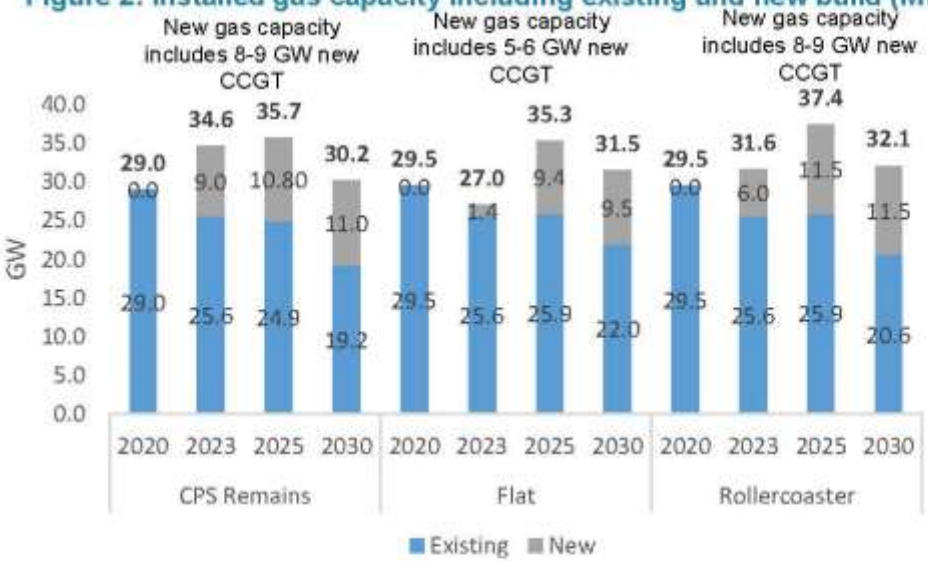
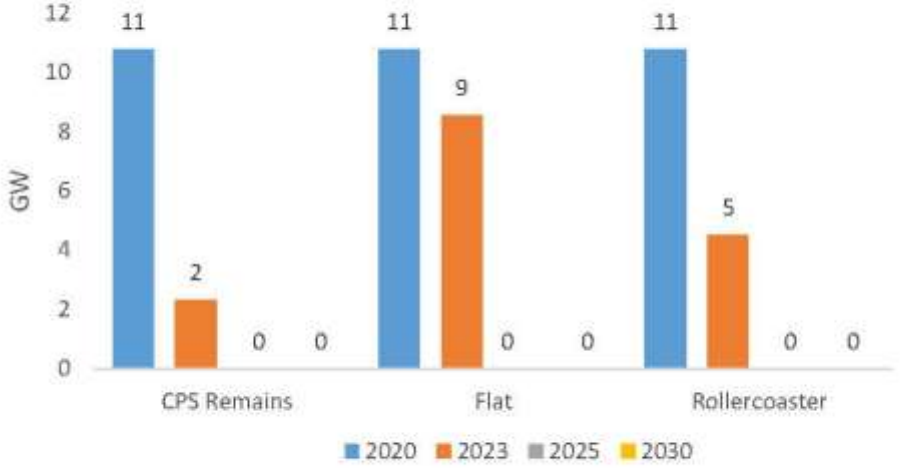


Figure 3: Installed coal capacity (MW)



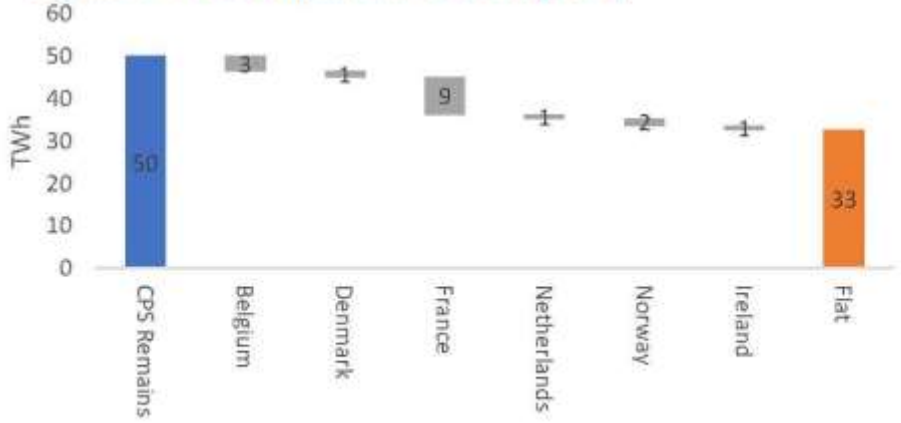
Interconnector flows

In CPS Remains, GB imports more from the continent due to the higher short run marginal costs of British generators compared to their European counterparts.

CPS Remains vs Flat scenario

- Our modelling assumes that 10GW of new interconnector capacity is online by 2030. This assumption is consistent between all of the scenarios.
- Tapering the CPS leads to a lower level of net imports into GB, primarily through lower imports from France.
- The Flat scenario sees net imports in 2030 falling by around a third, from 50TWh to 33TWh. In 2015, net imports into GB totalled 20.8TWh with 4GW of interconnection installed (Source: Enappsys).

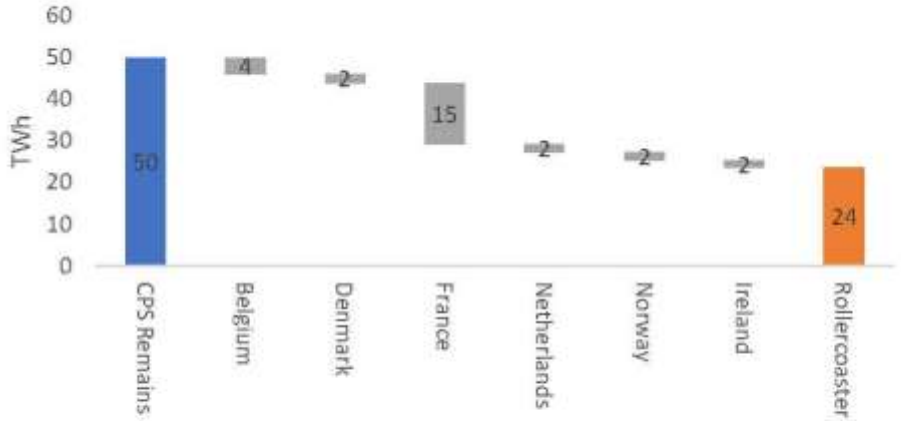
Figure 4: GB Net Imports in 2030, Flat (TWh)



CPS Remains vs Rollercoaster scenario

- The Rollercoaster scenario leads to the greatest fall in net imports due to the higher level of new CCGT build which is better able to export into Europe. Under this scenario the net imports are halved from 50TWh to 24TWh in 2030.
- Our modelling considers interconnector build as an exogenous impact. It is possible that under certain scenarios some new interconnector capacity would not be built which may alter these results.
- In the period to 2025 (not shown in this report), net imports are lowest in the Flat scenario as the short run marginal costs of GB generators become more competitive with European generators.

Figure 5: GB Net Imports in 2030, Rollercoaster (TWh)



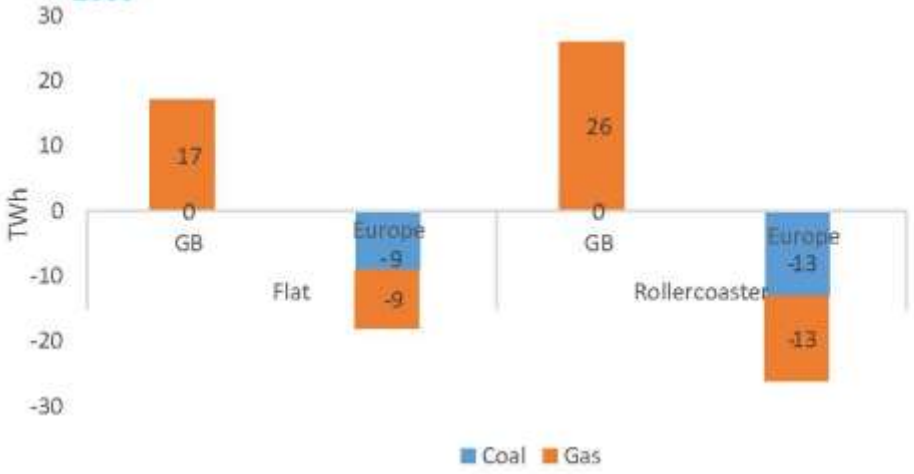
Generation and Emissions

Generation in GB increases when the CPS is tapered as capacity becomes more able to compete with generators in Europe. Emissions in Europe as a whole are lowest when the CPS is reduced.

Generation in GB and Europe

- By tapering the CPS, generation shifts from Europe into GB.
- This shift is greatest in the Rollercoaster scenario (26TWh vs 17TWh in the Flat scenario), which encourages the most efficient gas capacity to be installed.
- The majority of the additional generation in GB is met by recently built, or future new gas plant who are competitively placed in the generation stack and are able to take advantage of export opportunities.
- Around half of the generation offset in the continent is from coal.

Figure 6: Impact on generation in GB and Europe of tapering the CPS, in 2030



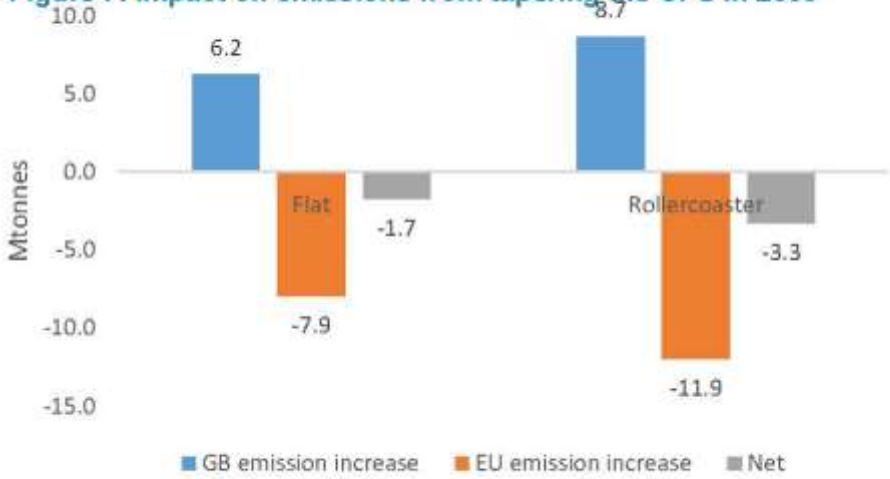
GB emissions

- Emissions in GB rise in 2030 in the Flat and Rollercoaster scenarios. This is due to the higher overall level of generation in GB. Depending on how carbon is accounted for, this rise in emissions could be viewed as a negative effect of removing the CPS.

EU emissions

- Our modelling does not cover every market in Europe, therefore the actual impact on emissions may vary from the results opposite.
- With half of the offset generation being coal, tapering the CPS leads to a net decrease in emissions in GB and Europe. If displaced emissions are counted in carbon accounting, tapering the CPS is the better option for long term emissions.

Figure 7: Impact on emissions from tapering the CPS in 2030



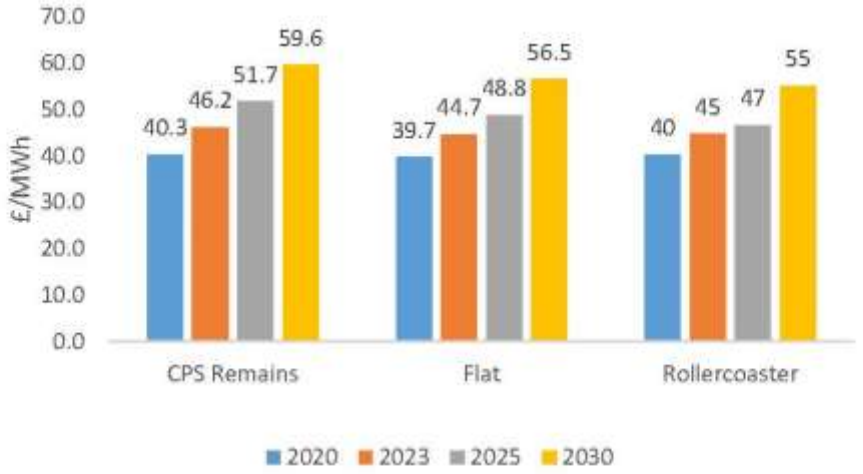
Wholesale Prices

Wholesale prices are lowest in the long term in the Rollercoaster scenario and highest in CPS Remains.

Development of wholesale electricity prices

- Differences in wholesale prices between the scenarios are driven by the differences in carbon prices and in the resulting capacity mixes. When the CPS Remains, the short run marginal cost of carbon-emitting generators is increased therefore the wholesale price is raised.
- The Rollercoaster scenario's higher level of new CCGT build leads to lower wholesale costs in the long term when compared to the Flat scenario. Demand in the Rollercoaster scenario is met by capacity with a lower short run marginal cost.

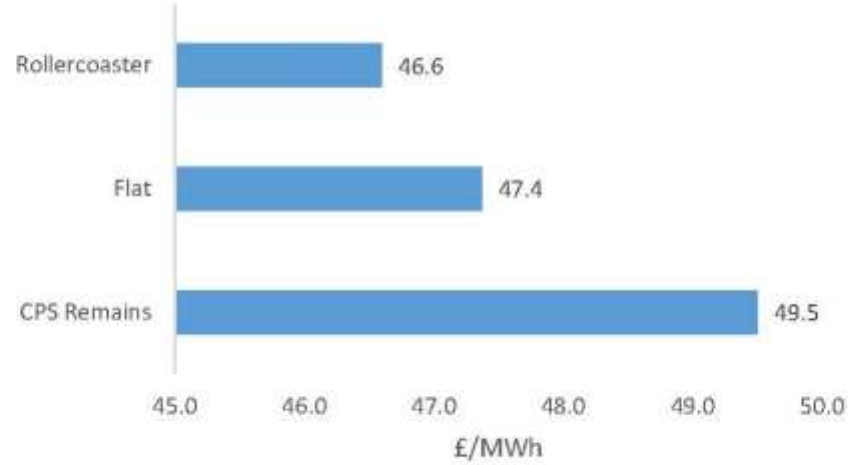
Figure 8: GB wholesale electricity price 2020 - 2030



Average wholesale prices

- Over the period 2019-2030, if the CPS Remains the average wholesale price increases by £2.10/MWh against the Flat scenario. The Rollercoaster scenario reduces the wholesale price by £2.90.
- In 2030 the price difference is £3.10/MWh under the Flat scenario and £4.6/MWh in the Rollercoaster scenario.
- Most of the difference in wholesale prices is evident in 2025 in both scenarios and then continues to 2030.

Figure 9: Average wholesale electricity price 2019-2030



*Prices shown in this document do not reflect Arup's current view on the future of wholesale electricity prices in GB.

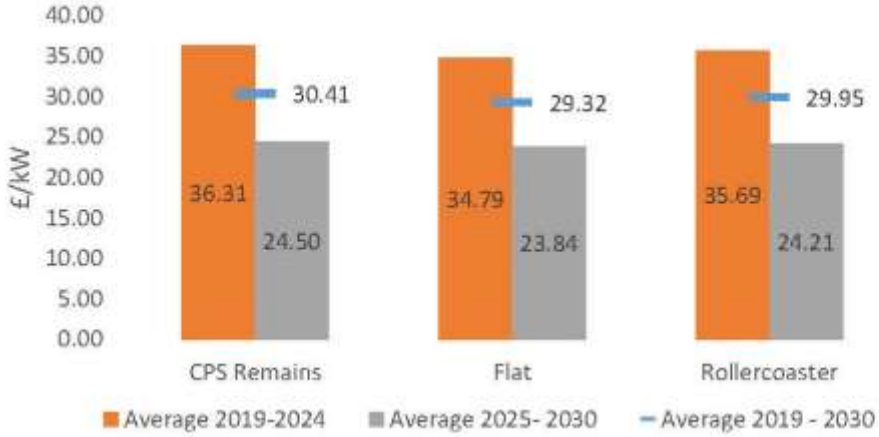
Capacity market prices

The Capacity Market incentivises new generators to come to the market. The costs of the capacity market are lowest when export opportunities are available to new capacity.

Capacity market prices

- Capacity market prices are minimised in the Flat scenario as it leads to the best utilisation of existing capacity and offers export opportunities post-2025.
- Capacity market prices in the Rollercoaster scenario are higher than in the Flat scenario due to more expensive CCGT capacity being built and lower wholesale prices.
- The capacity market prices fall in the second half of the decade as new capacity required to replace coal and aging gas generation has been granted contracts prior to 2026.

Figure 10: GB Capacity market prices, average over periods



Capacity market costs

- The total cost of the Capacity market is minimised in the Flat and Rollercoaster scenarios.
- CPS Remains produces the highest cost as CCGTs are incentivised to be built in the early 2020s but the opportunity to export into Europe is smaller.
- The Flat scenario leads to the lowest capacity market cost. The higher level of cheaper, peaking plant built under this scenario helps to reduce the overall cost of the new capacity.

Figure 11: GB Capacity market costs, average over periods

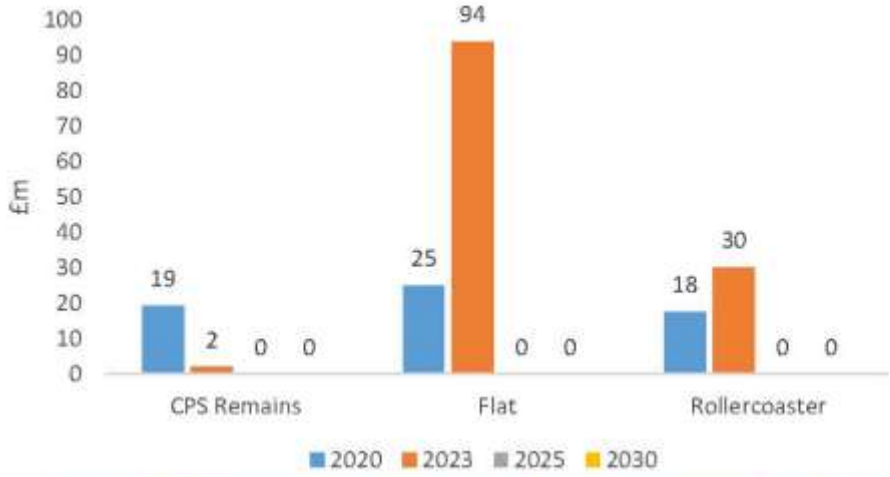
Wholesale market revenues to GB generators

Coal generators are able to take advantage of higher clean dark spreads in the medium term of the Flat and Rollercoaster scenarios. If the CPS Remains, revenues to coal generators will remain low.

GB Coal generators

- The Flat and Rollercoaster scenarios allow coal generators to capture higher revenues before they are taken offline in 2025. These revenues are at the expense of CCGTs' revenues leading to the slower build of new CCGT generators.

Figure 12: Net revenue to GB coal generators (£m)



GB Existing nuclear generators

- We show net revenue to existing nuclear generators on a £m/MW in Figure 13.
- Net revenues to existing nuclear capacity are highest when the CPS Remains due to the higher wholesale prices. The Rollercoaster scenario, with the lowest wholesale prices, leads to the lowest net revenues to existing nuclear generators.

Figure 13: Net revenue to existing GB nuclear generators (£m/MW)

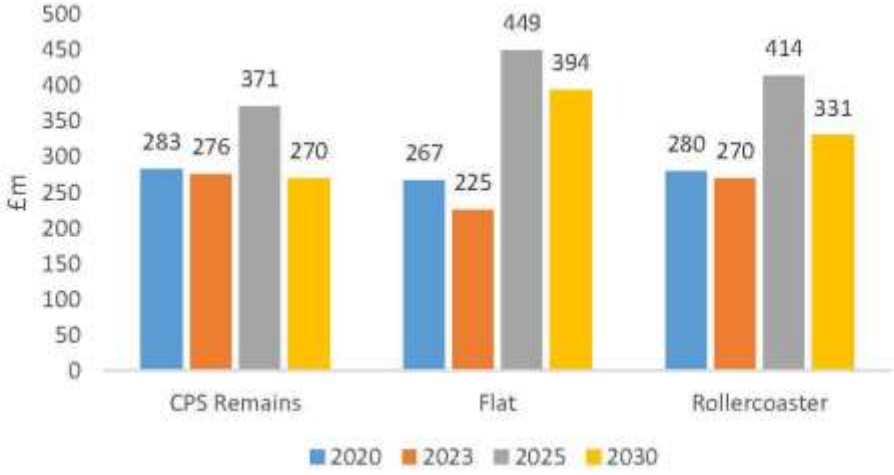
Wholesale market revenues to GB generators

Net revenues for existing gas generators are highest when the CPS is reduced and a higher proportion of peaking plant is added to the system.

GB Gas generators

- In the short term, net revenues to gas generators benefit from the CPS Remains at current levels as coal generation is minimised.
- After 2025, gas generators capture the most benefit in the Flat and Rollercoaster scenarios which allow increased generation through replacing imports from Europe. In the Flat scenario most of this benefit is captured by existing gas generators whilst in the Rollercoaster scenario most of the benefit is accrued by new capacity.
- More peaking plant build in the Flat scenario leads to higher prices than in the Rollercoaster scenario, increasing overall revenues to gas generators.

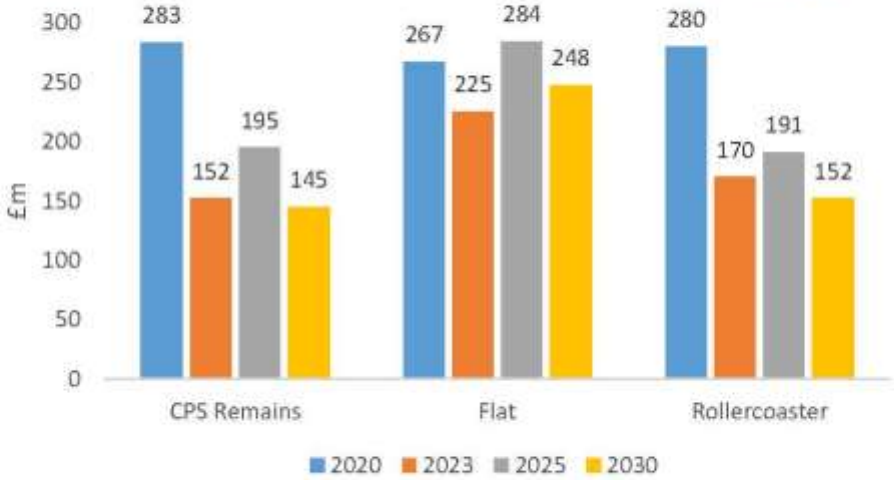
Figure 14: Net revenue to GB gas generators inc. to new capacity



Existing Gas generators

- Compared to the Flat scenario, the Rollercoaster scenario leads to more efficient gas capacity being installed in the early 2020s, which lowers the net revenue received by existing gas generators.
- Existing gas generators benefits most when less new CCGT capacity has been added to the system, but European imports are less competitive. Therefore, for existing gas generators, the Flat scenario provides the best outcome in terms of net revenue.

Figure 15: Net wholesale market revenue to existing GB gas generators



Retail prices and carbon tax take

Between 2019 and 2030, residential consumers could save up to £5bn through the removal of the CPS.

- The lower short run marginal cost of carbon-emitting generators under a tapered CPS scenario leads to lower prices for consumers. These differences are shown in Figure 16.
- The faster taper leads to lower prices than the slower taper due to the higher CCGT build that it encourages, which helps to lower the wholesale price.
- The lower wholesale prices in the Rollercoaster scenario are offset by higher capacity market and LCF costs then in the Flat scenario. The total savings to residential consumers over the period is up to £4.9bn in the Rollercoaster scenario, shown in Figure 17.
- Compared to CPS Remains, the tax take to GB and the EU over the horizon is £555mn lower in the Flat scenario, shown in Figure 18. In the Rollercoaster scenario, the tax take is £652mn lower. In both of these scenarios tax take is higher than CPS Remains until 2025 as coal generators load factors are higher. Beyond 2025, tax take is higher under CPS Remains.
- The potential saving for residential consumers is approximately eight times the size of the reduction in tax take through reducing the CPS. The change in tax take between the scenarios is relatively small due to the tax take before 2025 being higher in the Flat and Rollercoaster scenarios as coal generation increases.

Figure 16: Difference in residential consumer bills between CPS remains and tapering the CPS, 2030

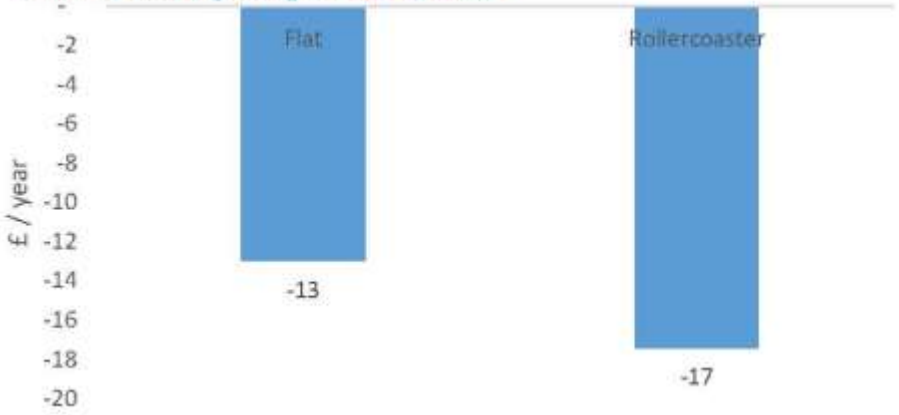


Figure 17: Difference cost to consumers between CPS remains and the Flat and Rollercoaster scenarios, total 2019-2030

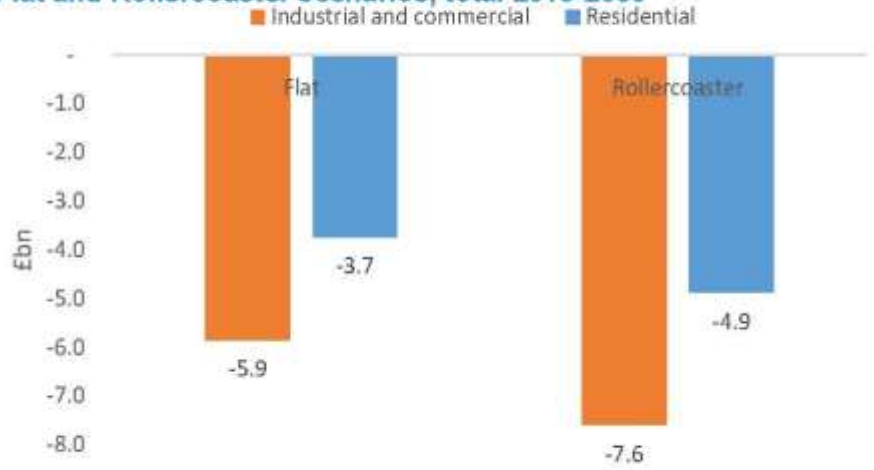
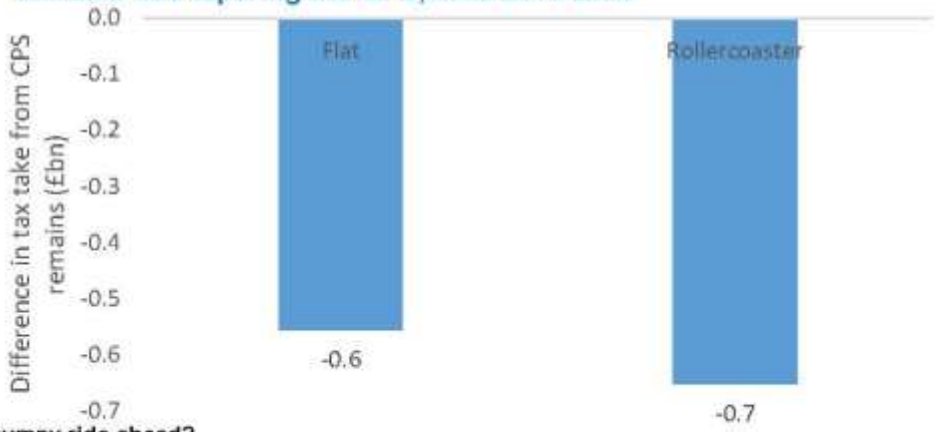


Figure 18: Difference in carbon tax take to GB and the EU between CPS remains and tapering the CPS, total 2019-2030



Gross Value Added and Employment

Gross Value Added is highest in the Rollercoaster scenario as the new gas capacity is highest with a large share of new CCGTs meaning a higher capital expenditure.

Gross Value Added

- The economic impact of the different scenarios derives from an investment effect (i.e. the economic value added by new energy investment) and an operational effect (i.e. the economic value added by running and operating energy assets). On average, in the power sector the investment effect tends to be significantly higher than the operational effect. In our analysis we also consider direct and indirect effects.
- Gross Value Added is maximised in the Rollercoaster scenario. The higher level of large gas capacity built requires the most capex of all of the scenarios. GVA from generation is also highest in the Rollercoaster scenario. The Rollercoaster scenario generates £0.17bn higher GVA than CPS Remains.
- The Flat scenario creates the lowest Gross Value Added as new capacity is focused on low-cost peaking plant.

Employment

- Employment is highest in the Rollercoaster Scenario as the higher capital expenditure enters the economy. There are an extra 2,000 jobs created in the Rollercoaster scenario compared to the CPS Remains.
- The Flat scenario leads to the lowest increase in employment. The lower capital expenditure reduces the overall benefit to the economy versus CPS Remains.

Figure 19: Difference in Gross Value Added between CPS remains and the Flat and Rollercoaster scenarios

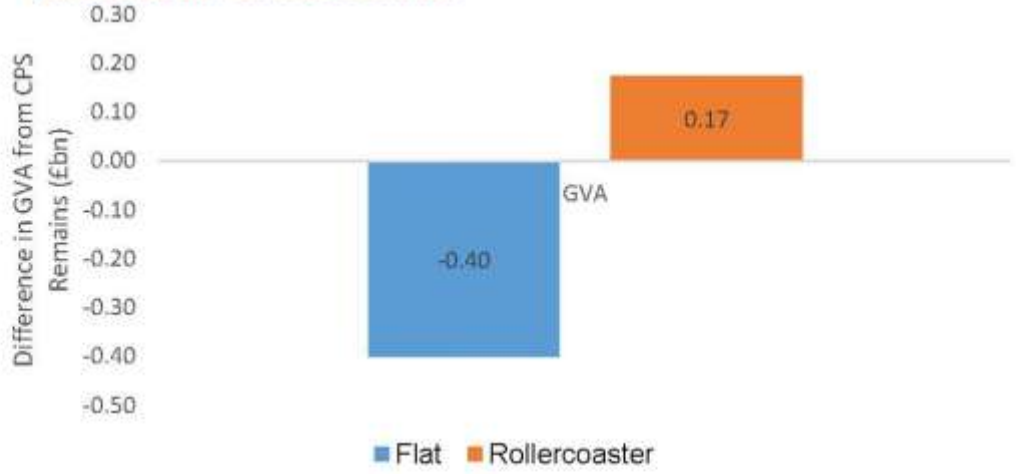
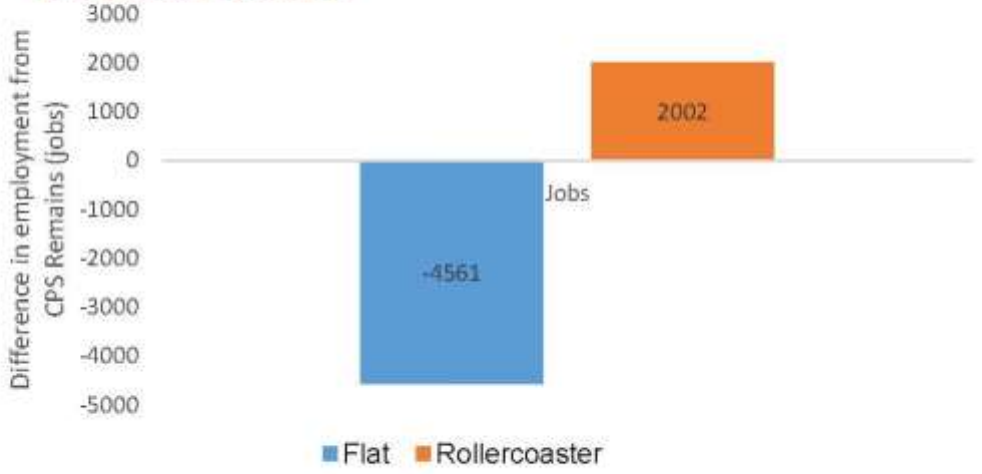


Figure 20: Difference in employment between CPS remains and the Flat and Rollercoaster scenarios



Appendix: Assumptions

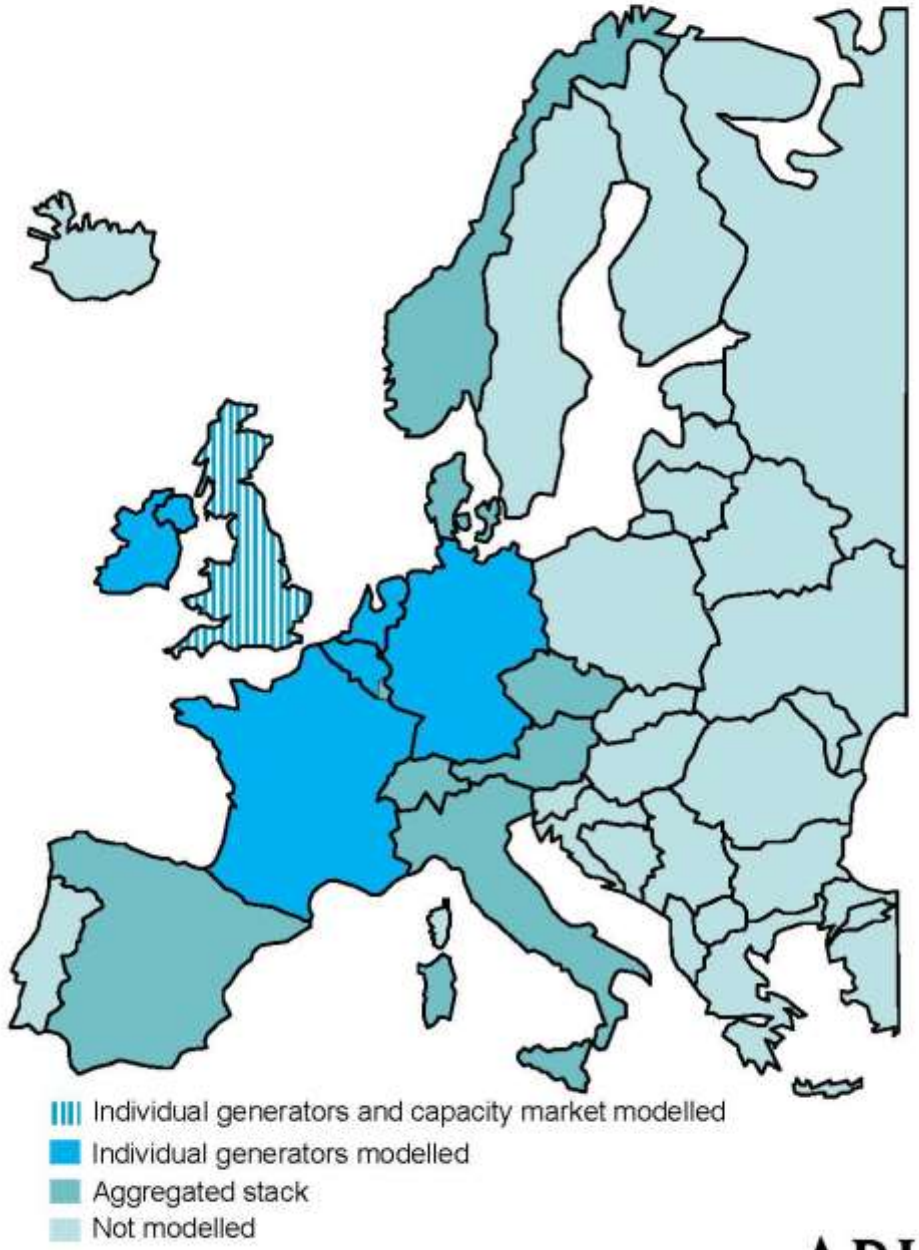
Inputs	Assumption
Commodity prices	Growing from the current forward curve up to the BEIS/DECC November 2015 long term view of prices
Demand	FES 2016 Consumer Power scenario demand
Renewables	16GW offshore wind, 13GW onshore wind, 15GW solar in 2030
Interconnectors	10GW interconnection built by 2030, following the current project pipeline
French CPS	No French CPS assumed in any of the scenarios
Nuclear	Hinkley commissioned in 2026/2027 and Horizon commissioned in 2029/2030

Further details on our assumptions are available upon request.

Appendix: Markets modelled

Arup's GB power model

- Arup has developed the Delphi UK Power Market Model which comprises both dispatch (DM), renewables (RM) and capacity market (CM) models. Wholesale market prices, interconnector flows and emissions forecasts are developed in the DM.
- The DM is developed in Plexos, an integrated energy market modeling software. The DM develops short—run marginal costs (SRMC) on the basis of plant dispatch costs including fuel, carbon and variable operating and maintenance (VOM) expenses.
- Arup models a commercial and technical start cost to short—run marginal costs (SRMCs) as part of price modelling process.
- Our GB model includes detailed modelling of current and future interconnected markets including:
  - Ireland (SEM)
  - France
  - Belgium
  - Netherlands
  - Norway
  - Germany
- We also model indirectly connected markets where they have an impact on pricing in directly connected markets.
- Arup's market modelling capability also extends to the Italian and Nordpool systems.



Key contacts

Filippo Gaddo

Associate Director, Business Investment Advisory
8 Fitzroy Street, London W1T 4BQ

Email: Filippo.Gaddo@arup.com
T +44 20 7755 2015
M +44 78 7687 1478

Pete Thornton

Senior Consultant, Business Investment Advisory
8 Fitzroy Street, London W1T 4BQ

Email: pete.thornton@arup.com
T +44 20 7755 5091
M +44 74 648 8862

Policy Exchange

ISBN: 978-1-910812-22-8