| | |
|---|---|
| **Title: Electricity Market Reform – ensuring electricity security of supply and promoting investment in low-carbon generation [Delivery Plan update: July 2013]** | **Impact Assessment (IA)** |
| **IA No: DECC0143** | **Date:** 30 July 2013 |
| **Lead department or agency:** DECC | **Stage:** Final |
| | **Source of intervention:** Domestic |
| | **Type of measure:** Primary legislation |
| | **Contact for enquiries:** Robert Dixon Robert.Dixon@decc.gsi.gov.uk |
| **Summary: Intervention and Options** | **RPC:**N/A |

**Cost of Preferred (or more likely) Option**

| Total Net Present Value | Business Net Present Value | Net cost to business per year (EANCB in 2009 prices) | In scope of One-In, One-Out? | Measure qualifies as |
|---|---|---|---|---|
| £9.5bn | - | - | No | Tax and Spend[1] |

**What is the problem under consideration? Why is government intervention necessary?**

This Impact Assessment considers the impacts of measures to reduce the risks to future security of electricity supply and promote investment in low-carbon generation, while minimising costs to consumers. Current electricity market arrangements are not likely to deliver the required scale or pace of investment in low-carbon generation. Reasons include cost characteristics of low-carbon capacity (high capital cost and low operating cost) which means that it faces greater exposure to wholesale price risk than conventional fossil fuel capacity, which has a natural hedge given its price-setting role. Our analysis also suggests that there are a number of market imperfections that are likely to pose risks to future levels of electricity security of supply. These effects are likely to be exacerbated when there are significant amounts of intermittent low-carbon generation.

**What are the policy objectives and the intended effects?**

The three primary policy objectives are to reform the electricity market arrangements to: ensure security of supply; drive the decarbonisation of our electricity generation; and minimise costs to the consumer. These reforms should support delivery of DECC's other key objective of meeting the 2020 renewables target. The intended effects are that sufficient generation and demand-side resources will be available to ensure that supply and demand balance continues to be met and there will be sufficient investment in low-carbon generation to meet decarbonisation objectives.

**What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)**

As set out in previous impact assessments, the lead policy option to deliver low-carbon investment was identified as a feed-in tariff Contracts for Difference (FiT CfD) and the lead option to mitigate risks to electricity security of supply was an Administrative Capacity Market.

This IA has been updated to present Cost Benefit Analysis (CBA) and price and bill impacts based on the proposed choices for CfD strike prices and the reliability standard, as set out in the draft EMR Delivery Plan. This analysis uses DECC's in-house Dynamic Dispatch Model (DDM)[2] and reflects a range of updated input assumptions (e.g. technology costs, LCF cost profile, electricity demand), a summary of which are set out in Annex A.

Finally, to reflect the decision to take a power in the Energy Bill to set a decarbonisation target range and show the wider range of costs and benefits of EMR, this Impact Assessment – in addition to analysis based on a carbon emissions intensity of 100g$CO_2$/kWh for the power sector in 2030, consistent with previous EMR impact assessments – includes analysis based on an average emission level of both 50g$CO_2$/kWh and 200g$CO_2$/kWh in 2030. This shows that the design of EMR and specifically the FiT CfD will lower the cost of financing the large investments needed in electricity infrastructure, irrespective of the level of decarbonisation in the sector to 2030.

| **Will the policy be reviewed?** It will be reviewed. **If applicable, set review date: 2018** | | | | | |
|---|---|---|---|---|---|
| Does implementation go beyond minimum EU requirements? | | | **N/A** | | |
| Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base. | **Micro** No | **< 20** No | **Small** No | **Medium** No | **Large** No |

[1] The EMR package includes a low-carbon instrument (the CfD) and a Capacity Market, combined with an Emissions Performance Standard (EPS). The impact of the Emissions Performance Standard is considered in the EPS IA, which accompanied the Energy Bill.

[2] https://www.gov.uk/government/publications/dynamic-dispatch-model-ddm

| What is the $CO_2$ equivalent change in greenhouse gas emissions? (Million tonnes $CO_2$ equivalent) | **Traded:** - | **Non-traded:** |
|---|---|---|

***I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.***

Signed by the responsible Minister: Edward Davey Date: 31 July 2013

**Summary: Analysis & Evidence** **Policy Option 1**

**Description:** EMR: Feed-in Tariff Contracts for Difference (FiT CfD), based on proposed strike prices, combined with an administrative Capacity Market, using the proposed reliability standard.[3]

**FULL ECONOMIC ASSESSMENT**

| Price Base Year 2012 | PV Base Year 2012 | Time Period Years 20 | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| | | | Low: £ | High: £ | Best Estimate: £9,500 |

| COSTS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. transition, constant prices) | Total Cost (Present Value) |
|---|---|---|---|---|
| Low | N/A | - | N/A | **N/A** |
| High | N/A | | N/A | **N/A** |
| Best Estimate | N/A | | N/A | **£3,200** |

**Description and scale of key monetised costs by 'main affected groups'**

Under EMR, carbon costs up to 2030 are higher than the basecase, which achieves a similar decarbonisation profile using existing policy instruments (RO and carbon pricing). This reflects EMR's slightly slower decarbonisation profile; in NPV terms, carbon costs up to 2030 are **£1.3bn higher under EMR**.[4] In addition, there is a small generation cost impact associated with EMR (discussed further below).

The analysis also considers the impact of EMR on system costs, defined as the sum of the costs of building and operating the electricity system (TNUoS and BSUoS costs). These costs are calculated by National Grid models, based on DDM output. Under EMR, system costs are estimated to be **around £1bn higher** than the basecase, in NPV terms up to 2030.

The institutional costs of EMR consist of both National Grid delivering their EMR functions and those associated with setting up the single counterparty body. In addition, there will be associated administrative costs to energy sector businesses (the costs of which cover the whole of the UK). In total, these costs (in discounted NPV terms, over the period 2012 -2030) are estimated to range between £400m to £1.1bn (in 2012 prices) – a mid-point estimate of **£0.7bn up to 2030** is used.[5]

**Other key non-monetised costs by 'main affected groups'**

| BENEFITS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition, constant prices) | Total Benefit (Present Value) |
|---|---|---|---|---|
| Low | N/A | - | N/A | **N/A** |
| High | N/A | | N/A | **N/A** |
| Best Estimate | N/A | | N/A | **£13,000** |

[3] The results presented in this summary are based on a carbon emissions intensity of 100g$CO_2$/kWh for the power sector in 2030, which is consistent with previous EMR impact assessments. However, this IA also includes analysis based on average emissions levels of both 50g$CO_2$/kWh and 200g$CO_2$/kWh in 2030.

[4] This is a modelling result as a consequence of using carbon pricing to incentivise new nuclear under the basecases. It should be interpreted as a hypothetical modelling outcome from using carbon prices to decarbonise. It is discussed further in Annex C.

[5] The costs largely reflect staff, IT, building costs and any external expertise which may be required – both for the institutional body and the energy businesses bidding into the Capacity Market, as well as an estimate of the administrative costs of CfDs on energy sector businesses. The EMR White Paper IA presented estimates of the costs to energy sector businesses, both generators and suppliers; the same energy sector business cost assumptions are used here.

**Description and scale of key monetised benefits by 'main affected groups'**

The key benefits of decarbonising using EMR are reducing financing costs for investors and minimising generator rents under high wholesale prices. The greater price certainty from CfDs allows financing at a lower cost. The technology-specific hurdle rates used in this analysis are based on data and evidence drawn from various sources.[6] For the central assumption about 2030 carbon emission intensity (100g$CO_2$/kWh), these benefits are estimated to amount to **£4.8bn up to 2030** (including administrative costs).[7]

In addition, for the latest modelling the benefits of reductions in unserved energy are calculated using a new model using data from DDM outputs (this is described in more detail in Annex A). Using this model, relative to the basecase, EMR reduces unserved energy costs by **around £3.3bn up to 2030** (in NPV terms).

Finally, the capacity and generation mix realised under EMR, and the basecase we assess it against, are crucial in the assessment of the overall NPV of EMR. Different technologies have different operating and capital costs, therefore the CBA results will be influenced by any differences in the technology mixes realised under EMR and the basecase scenarios. In this latest modelling, the differences in technology mix attributable to CfDs under the EMR scenario and counterfactual is estimated to lead to capital costs benefits of **£2.8bn up to 2030**, in NPV terms.

There is a further benefit associated with interconnectors, which results from higher wholesale prices in the basecase relative to the EMR scenario; this leads to benefits of **£1.7bn up to 2030**, in NPV terms.

**Other key non-monetised benefits by 'main affected groups'**

For domestic consumers, EMR is estimated to reduce average annual household electricity bills by 9% (£63) over the period 2016-2030, relative to a basecase which achieves a similar decarbonisation level using existing policy instruments. The impact on average bills for businesses and energy-intensive industries is estimated to be similar.

Due to the reduction in consumer bills, it is likely that fuel poverty will fall. However, the Government has recently announced its intention to adopt a new measure of fuel poverty. We will provide updated projections for fuel poverty levels under EMR once revised estimates of fuel poverty using this new approach have been published.

| **Key assumptions/sensitivities/risks** | **Discount rate (%)** | 3.5% |
|---|---|---|

Estimates of EMR institutional costs must be regarded as tentative as the component costs have not yet been fully determined, as they depend on the final agreed activities to be undertaken by the organisations.[8]

This IA presents modelling assessing the impact of reaching different carbon emission intensities for the power sector in 2030 (100g$CO_2$/kWh (as reported above), 50g$CO_2$/kWh and 200g$CO_2$/kWh), as well as a range of fossil fuel price scenarios and alternative assumptions about post-2030 carbon prices.

Dispatch modelling is sensitive to a number of assumptions (e.g. inputs, methodology), which influence the capacity and generation mix under different scenarios. The assumptions on which this analysis based are set out in more detail in Annex A. This outcome therefore represents a specific state of the world and is not intended to be a prediction or forecast about what the future is expected to be.

**BUSINESS ASSESSMENT (Option 1)**

| **Direct impact on business (Equivalent Annual) £m:** [9] | | | **In scope of OIOO?** | **Measure qualifies** |
|---|---|---|---|---|
| **Costs: 8,100** | **Benefits: 9,700** | **Net: 1,600** | No | N/A |

[6] For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_16_07_13_amend.pdf

[7] Depending on the assumed level of decarbonisation in 2030, these benefits would amount to an NPV of between £3.3bn and £7.2bn up to 2030 (including administrative costs).

[8] These costs do not consider what costs might have been in the absence of EMR. For example, they do not consider what the additional administrative costs of greater reliance on carbon pricing or the RO might be in the basecase.

[9] Direct costs to business are calculated using the same methodology presented in the EMR White Paper. See Annex F for further details. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf

## Contents

## Section 1 Overview

1. This Impact Assessment (IA) is a further update to the series of IAs published in support of Electricity Market Reform (EMR), the latest of which was published in May 2013[10].

2. The analysis contained in this IA has now been updated to reflect the modelling undertaken for the draft EMR Delivery Plan[11]. This is based on the draft Contract for Difference (CfD) strike prices for renewable technologies (the full list of which were published in June 2013[12]) and the draft reliability standard (set at an annual level of 3 hours expected lost load[13]).

3. As for previous EMR IAs, this analysis assumes an illustrative carbon emissions intensity of 100g$CO_2$/kWh in 2030 and uses DECC's in-house Dynamic Dispatch Model (DDM).[14] It also incorporates analysis based on emission intensities of 50g$CO_2$/kWh and 200g$CO_2$/kWh, as well as a range of fossil fuel price scenarios. This modelling is also consistent with the upper limits on spending for electricity policies agreed under the Levy Control Framework[15].

4. The analysis presented in this IA is based on a standardised set of assumptions, including technology costs and electricity demand at the time the analysis was undertaken. These assumptions are set out in more detail in Annex A.

5. The analysis shows that the design of EMR (through FiT CFDs) will lower the financing costs of the large investments needed in electricity infrastructure, regardless of the level of decarbonisation targeted in 2030 – 50g$CO_2$/kWh, 100g$CO_2$/kWh and 200g$CO_2$/kWh.

---

10 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197904/cfd_ia_may_update.pdf

11 https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

12 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223650/emr_delivery_plan_consultation.pdf

13 For further details on the methodology for how the reliability standard has been set, please see Annex C of the Delivery Plan (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223653/emr_consultation_annex_c.pdf ).

14 A description of DECC's Dynamic Dispatch Model is available here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65709/5425-decc-dynamic-dispatch-model-ddm.pdf. Further details can also be found in Annex A.

15 For further detail, please see Annex D of the draft EMR Delivery Plan: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223654/emr_consultation_annex_d.pdf

6. EMR and Capacity Mechanism IAs of December 2010[16], July 2011[17], May 2012[18], November 2012[19] and May 2013[20] have analysed the policy options that would best deliver our decarbonisation, security of supply and affordability objectives. The key conclusions from these previous impact assessments are:

    - The FiT CfD is the preferred instrument to deliver investment in low-carbon technology compared to alternatives, including a premium feed-in tariff.[21]
    - A Capacity Market is the preferred instrument to mitigate security of supply risks compared to alternatives, including a strategic reserve and the 'do nothing' case.[22]
    - An Administrative Capacity Market is the preferred form of the capacity market compared with a reliability option.[23]

7. Section 2 of this IA presents updated Cost-Benefit Analysis (CBA) and price and bill impact analysis for the EMR lead policy package, a FiT CfD and an Administrative Capacity Market, based on the draft strike prices for renewable technologies and reliability standard set out in the draft EMR Delivery Plan[24]. Proposals to consider provision of additional support for projects on islands (where these have clearly distinct characteristics to typical mainland projects) will be published later this year, along with an assessment of potential impact.

---

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf

[17] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf

[18] http://webarchive.nationalarchives.gov.uk/20121025080026/http://decc.gov.uk/assets/decc/11/policy-legislation/Energy%20Bill%202012/5342-summary-of-the-impact-assessment.pdf

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66038/7105-contracts-for-difference-impacts-assessment-emr.pdf

[20] https://www.gov.uk/government/publications/energy-bill-impact-assessments

[21] This decision was assessed in the IA accompanying the White Paper in 2011 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf), and was represented in the IA accompanying the draft Energy Bill in May 2012.

[22] This decision was first presented in the December 2011 Technical Update to EMR (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42797/3883-capacity-mechanism-consultation-impact-assessment.pdf).

[23] An Administrative Capacity Market is one in which capacity providers receive a payment for offering capacity which is available when needed, but are able to keep their energy market revenues. Under a Reliability Market, capacity providers receive a payment for offering capacity which is available when needed, but are required to pay back any scarcity rents earned in the energy market.

[24] The conclusions on the relative attractiveness of the different options set out in previous IAs for EMR are considered robust. Therefore, there is no need to update the full analysis on all the potential policy packages previously assessed. Instead this analysis updates and presents the impact of the lead package only.

**Modelling changes since May 2013**

8. In addition to assumptions set out in the draft EMR Delivery Plan[25], the modelling is also consistent with the upper limits on spending for electricity policies agreed under the Levy Control Framework[26], which has resulted in revised modelling for the DDM baseline and EMR scenarios.[27]

9. When undertaking the cost-benefit analysis for EMR (i.e. CfD and a Capacity Market) in previous IAs, the policy package has been compared to two distinct basecases designed to achieve a similar decarbonisation profile to that realised under EMR using existing policy instruments, namely the Renewables Obligation and carbon price support. The distinction between these basecases resulted from the different ways in which the new build profile of EMR could be replicated.[28] As a result, the net welfare impact of EMR has previously been reported as a range.

10. However, with updated evidence and assumptions about technology costs, the approach used to replicate the EMR new build profiles in these two basecases has effectively aligned them[29]. There is no longer a clear difference between the technologies used to decarbonise the sector in Basecase A and Basecase B in the latest modelling.

11. Therefore, this IA presents the net welfare impact of EMR relative to a single basecase, which is equivalent to Basecase B in previous IAs. Whilst a range is not presented, the uncertainty over how Government might decarbonise without EMR remains, hence there is still significant uncertainty around the precise welfare impact of EMR.

12. The value of the changes in the NPV estimates between May 2013 and this update are shown in the table below. Overall, the Net Present Value for EMR (assessed up to 2030) has **increased from £4.2bn[30] in May 2013 to £9.5bn in the latest analysis**. Within this, the net welfare benefits associated with CfDs has increased from £4.8bn to £9.4bn,

---

[25] https://www.gov.uk/government/consultations/consultation-on-the-draft-electricity-market-reform-delivery

[26] This sets the budget for the levels of consumer levy spend up to 2020/21, including spend under the FIT CfD, Renewables Obligation and existing small-scale FITs mechanisms. For further details, please see Annex D of the draft EMR Delivery Plan: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223654/emr_consultation_annex_d.pdf

[27] Dispatch modelling is sensitive to a number of such assumptions (e.g. around inputs, methodology), which influence the capacity and generation mix under different scenarios. This outcome therefore represents a specific state of the world and is not intended to be a prediction or forecast about what the future is expected to be.

[28] Under the previous Basecase A, existing instruments were used to match as closely as possible the same profile in nuclear new build as under EMR; under Basecase B, they were used to match the same new build profile for both nuclear and CCS, as under EMR.

[29] The Carbon Price Floor in the basecase now rises to a higher level in the late 2010s, to replicate the nuclear new build profile under EMR. However, this increase is sufficient to incentivise some CCS build during the 2020s, making it impractical to recreate Basecase A (which replicated EMR's nuclear new build profile, but not EMR's CCS new build profile).

[30] For Basecase B only

while the net welfare associated with the Capacity Market has also increased – from a net cost of £0.6bn to a net benefit of £0.1bn (both assessed up to 2030) [31].

**Table 1: Change in Net Welfare (NPV) – combined EMR impact (2012-2030), comparison of May 2013 and July 2013 figures[32] (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | NPV, £bn (2012-2030, real 2012 prices) | | |
|---|---|---|---|
| | May 2013 | July 2013 | Difference* |
| **EMR: Total NPV** | **+4.2 to +7.6** | **+9.5** | **+5.3** |
| **Contracts for Difference** | **+4.8 to +8.2** | **+9.4** | **+4.6** |
| *- Financing impact* | *+3.0* | *+4.8* | *+1.8* |
| *- Technology mix impact* | *+1.8 to +5.1* | *+4.6* | *+2.8* |
| **Capacity market** | **-0.6** | **+0.1** | **+0.7** |

** Difference is calculated by comparing current estimates with Basecase B from previous estimates*
*Source: DECC modelling*

13. There are several key drivers of these changes in the overall NPV for EMR:

- **Financing impact**: There are a number of counteracting effects, which combine to increase the financing benefits associated with CfDs, relative to the previous analysis:[33]
  - Evidence suggests that the hurdle rate reduction associated with a generic nuclear CfD is greater than previously estimated[34], which (combined with a slight increase in costs[35]) means that the value of this hurdle rate reduction is greater (**+£1.8bn**).
  - In addition, the modelling now includes a broader range of technologies[36] to which the benefits of hurdle rate reductions can be applied (**+£0.8bn**).
  - These combined benefits are offset slightly by smaller hurdle rate reductions for both onshore and offshore wind, based on revised analysis[37], reducing the

[31] Consistent with the analysis conducted for the draft EMR Delivery Plan, the NPV estimates also include an estimate of the net impact of CfDs on Northern Ireland.
[32] Inclusive of administrative costs
[33] Due to rounding, the cumulative impact of the explanatory factors below do not sum to the figure in Table 1 (£1.8bn). The updated analysis also includes the financing cost impact in Northern Ireland.
[34] Increasing from 0.8% to 1.5% (see Annex A for further details)
[35] These are estimated costs for a generic nuclear plant, rather than a specific plant such as Hinkley Point C
[36] For example, hurdle rate reductions are now applied to CCS, biomass, CHP, sewage & landfill gas and a range of other renewable technologies (e.g. hydro, solar, wave, tidal)
[37] For more information, please see Annex 3 of DECC's Electricity Generation Costs 2013 report (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_16_07_13_amend.pdf)

pure cost of capital benefit associated with these technologies (**-£1.0bn**). Nevertheless, CfDs still offer clear financing benefits for all technologies[38].

- **Technology mix impact**: There are differences between EMR and the basecase, which arise due to imperfections in matching the decarbonisation profile and generation mix under EMR and the counterfactual. If these differences were eliminated (i.e. the decarbonisation profile and generation mix were exactly the same), then this element would decrease to zero and the only source of benefits would be the pure financing benefits outlined above. The technology mix impact reflects the net impact of all the CBA categories (discussed below): carbon savings, generation cost savings, system cost savings, unserved energy savings and cost of interconnector energy saved. In addition, it reflects the portion of capital cost savings not due to financing cost impacts. In the updated analysis the portion of the capital cost savings explained by technology mix differences, rather than financing cost benefits, is equal to £2.8bn. This reflects:

    - Changes in the assumptions necessary to replicate the EMR build profile in the basecase lead to higher levels of renewables deployment and lower decarbonisation, meaning costs are higher in the basecase and increasing the relative benefits of EMR (**+£3.3bn**).

    - Estimates of the costs of the Carbon Capture & Storage demonstration projects[39] (which are included under EMR but not in the 'no-EMR' basecase) lower the overall benefits (**-£1.5bn**).

    - Changes in the composition of new gas plant built under EMR relative to the 'no-EMR' basecase, which is partly due to the capacity mechanism. This leads to less CCGT plant and more OCGT plant under EMR, meaning lower costs relative to the basecase and increasing the benefits of EMR (**+£1.1bn**).

    - The net impact of the other CBA categories is to increases the NPV of CfDs by £1.8bn, reflecting the generation, system and interconnector cost savings under CfDS, as well as unserved energy benefits, net of the higher carbon costs.

[38] For further detail on the financing benefits associated with CfDs, please see Annex B of the draft EMR Delivery Plan: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223652/emr_consultation_annex_b.pdf

[39] The CCS demonstration cost estimates do not reflect information provided as part of the CCS Competition for legal and confidentiality reasons. Demonstration costs remain uncertain, but this uncertainty should be reduced through the Front End Engineering and Design/Risk Reduction phase of the projects.

- The overall technology mix component remains significant in this latest analysis, having increased by around £2.8bn up to 2030 in NPV terms relative to the previous IA. There are a number of explanatory factors:

    - The portion of capital cost savings due to technology mix differences has increased by £3bn relative to the previous analysis. This reflects £900m net increase as a result of greater renewables deployment in the basecase relative to the EMR scenario, £1.6bn increase as a result of lower CCS costs and £500m increase as a result of lower CCGT and OCGT costs.

    - A £200m reduction in the net impact of the other CBA categories relative to the previous analysis, reflecting the net impact of higher unserved energy cost savings as well as higher interconnector and system cost savings, but lower generation cost savings, and larger carbon costs.

- **Capacity Market**: The latest analysis shows an overall net welfare benefit of £0.1bn in NPV terms, up to 2030 – in reality, we would expect the NPV of capacity market modelling to be at or near zero.[40] The draft reliability standard has been set to balance the costs of additional capacity with its associated security of supply benefits. However, the translation of the reliability standard to an optimal level of capacity does not account for forecasting error in demand and supply. Neglecting this uncertainty would lead to a systematic under-procurement of capacity, so when deciding how much capacity to target in the modelling, we aim higher than the level implied by the reliability standard.[41] This therefore represents an approximation within the modelling; however, we are seeking to improve this capability and hope to reflect this more accurately in the future.

    - The value of unserved energy is the main driver of the increase in this NPV, which reflects several changes in the modelling. Firstly, the assumption about the Value of Lost Load (VOLL) has increased from £10,000 to £17,000/MWh, based on evidence gathered through a study jointly commissioned with Ofgem[42]. Secondly, there have been changes in demand assumptions (where peak demand has increased) and plant availability (to reflect recent decisions around decommissioning and mothballing), which means that capacity

[40] This is because the DDM models an efficient energy-only market, which should in theory lead to the same level of investment as a Capacity Market – assuming that the optimal reliability standard is set. However, in practice there are some differences between this theoretical result and the modelling results, as the model assumes that investors have certainty about demand up to five years ahead when deciding whether to build capacity. This leads to understatement of the benefits of a Capacity Market, as it underestimates the efficient capacity margin in an energy-only market.
[41] The exact translation depends on how much uncertainty there is in the forecasts; this uncertainty increases the further out we wish to procure. In a capacity market we look to take a decision on what capacity is needed four years out, which in turn leads to 4-5 years of peak demand level uncertainty.
[42] Available at http://www.londecon.co.uk/publication/estimating-the-value-of-lost-load-voll

margins are tighter than in previous modelling, increasing the likelihood of unserved energy in a world without a capacity market. Lastly, the modelling is now conducted through a dedicated unserved energy module that uses data from DDM outputs. This provides a more granular and more sophisticated analysis of the frequency and duration of periods with unserved energy[43], leading to greater net benefits relative to the previous analysis (**+£2.3bn**).

- This is offset to some extent by the inclusion of system costs, which is an additional feature not previously accounted for in EMR modelling and has been provided by National Grid through their analysis (**-£1.2bn**).

**Overall impact of EMR**

14. In summary, for a scenario where power sector emissions are 100g$CO_2$/kWh in 2030, the Cost Benefit Analysis (CBA) suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers, up to 2030 and beyond. EMR could lead to an improvement in welfare of around **£9.5bn up to 2030**, with larger benefits up to 2050. Due to the methodological changes detailed above, this NPV is slightly higher compared to the range published in May 2013 (£4.2bn to £7.6bn).

**Table 2: Net Present Value (NPV) – Impact of EMR policy package relative to basecase, assumed emissions intensity of 100g$CO_2$/kWh in 2030**

| Total NPV, £bn (2012 prices) | 2012-2030 | 2012-2040 | 2012-2049 |
|---|---|---|---|
| | **+£9.5** | **+£23** | **+£31** |
| **Contracts for Difference** | **+£9.4** | | |
| *- Financing Impact* | *+£4.8* | | |
| *- Technology Mix impact* | *+£4.6* | | |
| **Capacity Market** | **+£0.1** | | |

*Source: DECC modelling*
*Inclusive of administrative costs of approximately £0.7bn up to 2030 (see section 2.4.1 for details)*

**Additional scenarios**

15. This IA also includes appraisals of EMR targeting a range of carbon emission intensities in 2030 (50g$CO_2$/kWh, 100g$CO_2$/kWh and 200g$CO_2$/kWh), as well as different fossil fuel price scenarios and alternative assumptions about post-2030 carbon prices. The impact of these various scenarios on the overall NPV for EMR is detailed below. However, there

[43] For a given annual demand and capacity mix in each scenario, the yearly unserved energy is derived through Monte Carlo simulation. This offers much greater granularity, using historical data on plant outage (duration and frequency) for each technology and historical wind speed data to calculate the distribution and mean expected unserved energy in each year. This modelling approach was designed to be closer to the Ofgem capacity assessment and was procured in collaboration with National Grid to ensure this was the case.

is a more comprehensive analysis of different scenarios in the Delivery Plan (Including technology costs and electricity demand)[44] – these are summarised in Annex G.

*Decarbonisation scenarios*

16. As shown in the table below, this updated analysis indicates that EMR is a cost-effective tool for decarbonising the power sector across a range of decarbonisation levels in 2030. This is shown by the overall NPV for EMR being positive across all emission intensities, up to 2030 – **£15.0bn for 50g**, **£9.5bn for 100g** and **£4.8bn for 200g**.[45] As for 100g, the figures for the 50g and 200g scenarios are different to those published in May 2013 (£5.3bn and £1.9bn respectively), with the current figures both being higher.

**Table 3: Change in Net Welfare (NPV) – combined EMR impact (2012-2030)[46], emission intensities of 50g, 100g and 200g$CO_2$/kWh**

| NPV, £bn (2012-2030, real 2012 prices) | Decarbonisation target in 2030 ($gCO_2$/kWh) | | |
|---|---|---|---|
| | 50 | 100 | 200 |
| **EMR: Total NPV** | **+15.0** | **+£9.5** | **+4.8** |
| **Contracts for Difference** | **+13.0** | **+£9.4** | **+5.5** |
| *- Financing impact* | *+7.2* | *+£4.8* | *+3.3* |
| *- Technology mix impact* | *+5.5* | *+£4.6* | *+2.2* |
| **Capacity market** | **+2.7** | **+£0.1** | **-0.8** |

*Source: DECC modelling*

17. The key benefits of decarbonising using EMR are reducing financing costs for investors – the greater price certainty offered by CfDs allows investors to access financing at a lower cost. As might be expected, the financing benefits associated with CfDs increase as the 2030 decarbonisation level becomes lower (hence requiring more low-carbon generation to be built): £3.3bn for the 200g scenario, £4.8bn for the 100g scenario and £7.2bn for the 50g scenario up to 2030.

18. The overall impact of CfDs on the NPV for EMR also depends on the technology mix impacts. These benefits are lowest for the 200g scenario (£2.2bn), £4.6bn for 100g and £5.5bn for 50g. These differences reflect the relative difficulty of matching exactly the

[44] Particularly Annex E of draft EMR Delivery Plan (National Grid EMR Analytical Report): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223655/emr_consultation_annex_e.pdf

[45] Further detail on the NPV of different decarbonisation scenarios is available in section 2.3; price & bill impacts are available in section 2.5. Due to the single basecase in relation to the 50g and 200g scenarios, the NPV results are generated as point estimates rather than a range.

[46] Inclusive of administrative costs

EMR new build profile and generation mix using existing policy instruments across the range of alternative decarbonisation scenarios.

19. Finally, the impact of the capacity market varies across the three decarbonisation scenarios:

- For 100g, the NPV of the capacity market is £0.1bn. Given that the model has been set to target a non-zero level of capacity, we would expect this result to be negative. The expected result of a net cost in the modelling is driven by the assumptions that there is no "missing money" in the energy market and that investors have certainty about demand up to five years ahead when deciding whether to build capacity.

- For 200g – where it might be expected that demand for a capacity mechanism is lower than for a 100g scenario, given the less pressing need for low-carbon generation up to 2030 – the capacity market has a net negative welfare impact of £0.8bn;

- However, for a 50g target in 2030, the NPV of the capacity market is positive (£2.7bn). For a scenario in which a greater proportion of intermittent and/or inflexible low-carbon generation is required in order to meet a lower decarbonisation level, it might be expected that a capacity mechanism would lead to more significant benefits.

20. The impact of EMR is also assessed against a basecase without any explicit decarbonisation ambition or tools to mitigate against security of supply risks (denoted Basecase C; see Annex E). This is provided purely as a point of comparison to earlier modelling results (i.e. pre-November 2012), as these were not based on achieving any particular decarbonisation ambition. However, if there is less decarbonisation in the power sector, carbon targets would need to be met by reductions in other sectors; such costs are not considered in EMR modelling. Therefore, this basecase will underestimate the costs of meeting long-term carbon targets, by failing to consider the costs of decarbonising in more expensive sectors outside the power sector (assuming that emission reductions are met domestically, rather than through trading).

21. Under this basecase, EMR produces a net negative welfare impact of **-£12bn up to 2030** (up from -£4.2bn in May 2013). The key driver of this change is the generation mix under Basecase C relative to the EMR scenario:

- Round 3 offshore wind: under Basecase C, relatively fewer sites are built compared to previous analysis, which leads to higher costs under EMR than Basecase C;

- Onshore wind/offshore round 2: as discussed above, the capital cost savings from CfDs for these technologies are lower under the new analysis, due to the slight fall in hurdle rate reductions associated with CfDs, following revised analysis;

- Updated assumptions: in particular, the costs and deployment of technologies not delivered under Basecase C (e.g. nuclear and CCS);

- System costs: The inclusion of system costs results in the NPV for EMR decreasing by around £1.3bn relative to the previous analysis; however, carbon cost benefits are higher in the updated analysis, improving the NPV by around £2.2bn.

22. The benefits associated with decarbonisation and from the EMR programme are seen over the longer term. In comparison to a counterfactual with no decarbonisation ambition (Basecase C), the NPV for EMR is positive in the period up to 2049 (£9.4bn). In this counterfactual there is lower electricity decarbonisation, implying greater ambition needed in other sectors to meet long-term decarbonisation ambitions (as outlined above), and there is no mitigation against security of supply risks.

*Fossil fuel price scenarios*

23. The robustness of EMR to different assumptions about fossil fuel prices has been tested using the 2013 update to DECC's annual fossil fuel price projections.[47] Of the three scenarios included in each update (high/central/low fossil fuel prices), the central fossil fuel price scenario has been used for the main modelling results. Here, the results from the 'high' and 'low' fossil fuel price scenarios are applied to a scenario that replicates as closely as possible the generation mix produced under EMR, on the basis of targeting an average emissions intensity for the power sector in 2030 of 100g$CO_2$/kWh.

24. Under high fossil fuel prices, EMR is a cost-effective tool to achieve decarbonisation, generating a positive impact of **£10.0bn up to 2030** relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). Under low fossil fuel prices, EMR also generates a positive impact, of **£10.2bn up to 2030**.

*Post-2030 carbon prices*

25. Within the modelling, the effective carbon price that fossil fuel generators will have to pay in the UK power market is the higher of the Carbon Price Floor and the traded carbon market price.[48] Previous EMR analysis assumed that the traded carbon market price would remain below the Carbon Price Floor, which was assumed (in the EMR scenario) to follow its announced profile to 2030[49], and then to remain flat in real terms at the 2030 value of £76/t$CO_2$e (2012 prices).

26. In this latest analysis, this assumption has been altered (under the auspices of a global deal on climate change action with a global carbon market), so that the traded carbon

[47] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

[48] At the moment, the traded carbon market is the EU Emissions Trading System. In the coming decades, a more global carbon market may emerge under the auspices of a global deal on climate change action.

[49] The profile for the CPF starts at £16/t$CO_2$ (2009 prices) and takes a linear path to £30/ t$CO_2$ (during 2013-2020) and then a linear path to £70/t$CO_2$ (during 2020-2030).

price rises above the Carbon Price Floor from 2030 onwards. The price rises progressively as more abatement is required and the cheaper options are used up.[50]

27. However, given the uncertainty over future carbon prices and to show results consistent with the previous IA, sensitivity analysis has been undertaken for EMR under a scenario where traded carbon prices stay below the Carbon Price Floor (i.e. assuming that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030). Under this alternative post-2030 carbon price scenario, EMR has a slightly higher net welfare benefit in 2049: £32bn (NPV, 2012 prices), compared to £31bn under the central EMR case.

**Delivery plan scenarios – reflecting uncertainty**

28. There is still considerable uncertainty over how the electricity sector will develop to 2030 and beyond. Dispatch modelling is sensitive to a number of such assumptions (e.g. around inputs, methodology), which influence the capacity and generation mix realised under different scenarios.

29. National Grid carried out analysis for DECC to explore the implications of a number of strike price scenarios for delivery of Government policy[51]. These illustrate alternative 'views of the world', which can be used to inform and guide strike price setting. In looking at the importance of different drivers for the setting of strike prices, we have focused on two sets of scenarios, relating to technology cost assumptions and high electricity demand (outlined in Annex G).

30. The outcomes outlined in the main body of this impact assessment therefore represent a specific state of the world based on central assumptions. However, we have undertaken sensitivity analysis across a range of potential alternative scenarios (2030 decarbonisation levels, fossil fuel prices, post-2030 carbon prices), as well as different counterfactuals (including one without any decarbonisation ambition).

**Prices & bills impacts**

31. For domestic consumers, EMR has the potential to **reduce average annual household electricity bills by around 9% (£63) over the period 2016-2030[52]**, relative to a basecase which achieves a similar decarbonisation level of 100g$CO_2$/kWh using existing policy

[50] The carbon price values for this scenario are sourced from modelling by DECC using the GLOCAF model. They are also used as the Government's carbon price values for policy appraisal purposes. See the appraisal guidance for further details at: https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

[51] Annex E of the draft Delivery Plan, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223655/emr_consultation_annex_e.pdf

[52] The comparable figure given in the Delivery Plan documentation published on 17th July gave an absolute figure for this reduction of £62; this has been amended here.

instruments. The impact on average bills for businesses and energy-intensive industries will be similar. For further detail, see section 2.5.

**Table 4: Price and Bill impact – Impact of EMR policy package on average annual domestic electricity bills, relative to basecase (assumed emissions intensity of 100g$CO_2$/kWh in 2030)**

| Time Period | Impact of EMR on average annual domestic electricity bills, relative to basecase (real 2012 prices) |
|---|---|
| **2016-2030** | -£63 (-9%) |

*Source: DECC modelling*

# Section 2 Updated Cost Benefit Analysis (CBA)

## 2.1 Rationale for intervention

### 2.1.1 Decarbonisation

32. The Government is committed to meeting the legally binding decarbonisation targets as set out in the Climate Change Act 2008, and economy-wide carbon budgets.

33. New Government clauses have been added to the Energy Bill which enable a 2030 decarbonisation target range for the power sector to be set in secondary legislation. The decision to set a target range will be taken once the Committee on Climate Change has provided advice on the 5th Carbon Budget, which will cover the corresponding period (2028 – 2032), and once the Government has set that budget, which is due to take place in 2016. The power will not be exercised until the Government has set the 5th Carbon Budget.

34. Whilst the UK is on target to reduce its greenhouse gas emissions in 2020 by 34% on 1990 levels, in line with carbon budgets and the EU target, the longer-term goals are more challenging. From 2020, further deep cuts in emissions from the power sector are likely to be necessary to keep us on a cost-effective path to meeting our 2050 commitments. Reducing emissions from the power sector will become increasingly important to help us decarbonise other sectors.

35. However, there are reasons to believe that the current market arrangements will not deliver decarbonisation at lowest cost.

36. Cost structures differ between low-carbon and conventional generation capacity investments. Low-carbon investments are typically characterised by high capital costs and low operational costs, while fossil-fuelled generation tend to have relatively low capital costs and high operational costs. The current electricity market was developed in an environment where large-scale fossil fuel plant made up the bulk of the existing and prospective generation capacity, which presents a particular challenge for investment in low-carbon generation.

37. In the current market, the electricity price is set by the costs of the marginal generator, which is typically a flexible fossil fuel-fired plant. Fossil fuel generation therefore sets the price for all generation in the market, including low-marginal cost low-carbon generation such as nuclear and wind. This means that the electricity price, and hence wholesale electricity market revenue, is typically better correlated with the costs of a fossil fuel-fired plant than it is to the costs of low-carbon plant.

38. Non price-setting plant is therefore exposed to changes in the input costs, including both fuel and carbon, of price-setting plant. If these costs increase, revenues for non-price setting plant increase; if they decline, revenues for non-price setting plant also decline.

Therefore whilst non price-setting plant can benefit from increases in the input costs of price-setting plant – costs which the price-setting plant can pass through – they are exposed to lower fuel or carbon prices in a way that price-setting plant are not. This increases the risk of investment in low-carbon capacity relative to investment in conventional capacity.

39. Fossil fuel generators have benefitted over many years from learning by doing and the exploitation of economies of scale. There is evidence that given the opportunity to deploy at scale, some low-carbon technologies could reduce in cost. However, at current relative generation costs these technologies would be unable to compete with mature technologies, even with the support of a carbon price. Therefore, in the short term there is a case for offering additional support to immature low-carbon technologies to drive innovation.

40. Under the current market arrangements, mechanisms such as the Renewables Obligation have been introduced to improve the risk-reward balance associated with renewable investment and drive innovation by providing an explicit revenue stream that is not dependent upon the wholesale electricity price. However, given the longer-term decarbonisation objectives, more is needed to provide an environment that is sufficiently attractive for low-carbon investment and to do so at lowest cost for consumers. The carbon price is unlikely to be strong enough to drive the necessary decarbonisation alone, particularly through current EU-ETS projections and even with the Carbon Price Floor trajectory.[53]

41. It is possible that for some technologies, the market will find ways of managing some elements of the revenue uncertainty, such as through contracting between generators and suppliers or through vertical integration. However this may result in unnecessarily high costs for consumers given the costs suppliers incur in managing this uncertainty.

42. As a result, the Government believes that the current arrangements will not be sufficient to support the required new investments in renewables, nuclear and CCS, and ensure these are delivered cost-effectively, as well as providing appropriate signals for investment in new and existing fossil fuel plant. Therefore, revisions need to be made in order to deliver a sustainable low-carbon generation mix in a cost-effective way.

### 2.1.2 Security of supply

43. Electricity markets are different to other markets in a number of ways, two of which are particularly significant: capacity investment decisions are very large and relatively infrequent; and there is currently a lack of a responsive demand side as consumers do not choose the level of reliability of supply they are willing to pay for (as load-shedding occurs at times of scarcity on a geographic basis, rather than according to supplier, and

[53] http://www.hm-treasury.gov.uk/d/consult_carbon_price_support_ia.pdf

as consumers do not respond to real time changes in the price of electricity). Smart Meters, which are expected to be rolled out by 2019, should help to enable a more responsive demand side but it is anticipated that it would take time for a responsive real-time market to evolve.

44. In the absence of a flexible demand side, an energy-only market may fail to deliver security of supply either:

- if the electricity price fails to sufficiently reward capacity for being available at times of scarcity; or
- if the market fails to invest on the basis of expected scarcity rents.

45. These conditions would tend to lead to under-investment in capacity and its reliability. While the market has historically delivered sufficient investment in capacity, the market may fail to bring forward sufficient capacity in the future as a fifth of generating capacity available in 2011 has to close this decade, as the power system decarbonises. The market may also fail to provide incentives for built capacity to be sufficiently reliable, flexible and available when needed. A Capacity Market mitigates against the risk of an energy-only market failing to deliver sufficient incentives for reliable and flexible capacity.

46. In the Electricity Market Reform White Paper[54], we set out the potential market and regulatory failures in the current market that could prevent these signals from being realised.

47. The principal market failure is that there is no market for reliability: customers cannot choose their desired level of reliability, as the System Operator does not have the ability to selectively disconnect customers.

48. In theory this problem is addressed in an energy-only market by allowing prices to rise to a level reflecting the average value of lost load (i.e. the price at which consumers would no longer be willing to pay for energy) and allowing generators to receive scarcity rents. This should lead to investment in the socially-optimal level of capacity.

49. However in reality an energy-only market may fail to send the correct market signals to ensure optimal security of supply. This is commonly referred to as the problem of 'missing money', where the incentives to invest are reduced, due to the two reasons below:

- Firstly, current wholesale energy prices cannot rise high enough to reflect the value of additional capacity at time of scarcity. This is due to the charges to generators

[54] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf

who are out of balance in the Balancing Mechanism ("cash out") not reflecting the full costs of balancing actions taken by the System Operator (such as voltage reduction).

- Secondly, at times when the wholesale energy market prices peak to high levels, investors are concerned that the Government/regulator will act on a perceived abuse of market power, for example through the introduction of a price cap.

50. The latter regulatory risk is exacerbated if there are significant barriers to entry, effectively restricting the number of participants in the wholesale electricity market. As margins become tighter and prices more volatile in the future, market participants may have more opportunities to withhold supply to drive up prices; particularly as demand is inelastic and so there are potentially significant gains from withholding at times of scarcity. This could result in a greater likelihood of gaming in the energy market and difficulties in differentiating such gaming from legitimate prices, which would increase the risk that the Government may want to intervene in the wholesale market to cap prices.

51. This has not previously been a significant concern as prices historically have not risen above £938/MWh[55] as a result of excess capacity on the system depressing wholesale market prices. In the future, analysis suggests that prices could need to rise to up to £10,000/MWh (or even higher) for short periods to allow flexible plant to recover investment. Investors are concerned that Government or the regulator would intervene if this were to happen. The perception of this regulatory risk could increase 'missing money' and under-investment.

[55] System buy price on 5th January 2009, settlement period 35. Balancing Mechanism Reporting System (BMRS), http://bmreports.com/

## 2.2 Option under consideration

52. The modelling presented here has estimated the overall costs and benefits to society, or 'net welfare', of the various policy options. Net welfare is measured in terms of the net present value (NPV), which is the sum of all the social costs (-) and benefits (+) associated with the policy, with an adjustment made to reflect the time at which the different costs and benefits occur (known as discounting). This uses the social discount rates as set out in the Green Book.[56]

53. To determine the net present value (NPV) of the EMR policy package, the electricity sector under EMR is modelled. The outcomes under this scenario are compared to a counterfactual (or basecase) scenario where EMR does not take place, and the costs and benefits of the outcomes realised under the different scenarios assessed. Further detail on the general modelling framework can be found in the Impact Assessments accompanying the EMR Consultation document and White Paper.[57]

### 2.2.1 EMR Package

54. This IA presents an updated analysis of the lead EMR package modelled against a range of basecases. This EMR package includes a low-carbon instrument (the CfD, based on proposed strike prices) and a Capacity Market (based on the proposed reliability standard), combined with an Emissions Performance Standard (EPS). Carbon pricing is included in the basecases against which the policy package is assessed.[58]

55. The Government added new clauses to the Energy Bill, which take a power to set a 2030 decarbonisation target range for the power sector in secondary legislation. The Government will take a decision on whether to set a decarbonisation target range for the power sector in 2016, once the Committee on Climate Change has provided advice on the 5th Carbon Budget and once the Government has set that budget in law.

---

[56] http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

[57] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf & https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf

[58] The inclusion of the Carbon Price Floor as part of the counterfactual is consistent with Government guidance to include all policies to which the government is already committed and which have funding (see 'Valuation of energy use and greenhouse gas emissions', available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68764/122-valuationenergyuseggemissions.pdf. Analysis of the incremental impact of the Carbon Price Floor (relative to a baseline traded sector carbon price, including social costs and benefits and distributional impacts) was undertaken in December 2010, and is accessible at: http://www.hm-treasury.gov.uk/d/consult_carbon_price_support_ia.pdf. Updated analysis of the impacts of energy and climate change policies on prices and bills, including CPF, is available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/172923/130326_-_Price_and_Bill_Impacts_Report_Final.pdf. Overall, it shows that by 2020 households will, on average, save £166 (11%) on their energy bills, compared to what they would have paid in the absence of government intervention.

56. To reflect this decision and show the wider range of costs and benefits of EMR, this Impact Assessment – in addition to analysis based on a carbon emissions intensity of 100g$CO_2$/kWh for the power sector in 2030, consistent with previous EMR impact assessments – includes analysis based on an average emissions level of 50g$CO_2$/kWh and 200g$CO_2$/kWh in 2030, as well as a range of fossil fuel price scenarios and changes to assumptions about post-2030 carbon prices. However, there is a more comprehensive analysis of different scenarios in the Delivery Plan (Including technology costs and electricity demand)[59] – these are summarised in Annex G.

57. The analysis shows that the design of EMR and FiT CFDs will lower the financing costs of the large investments needed in electricity infrastructure.[60] This is the case for all the 2030 decarbonisation levels outlined above (50g$CO_2$/kWh, 100g$CO_2$/kWh and 200g$CO_2$/kWh).

58. The modelling results presented show CfDs continuing to be issued post-2030.[61] These results depend strongly on the particular combination of assumptions made, and will be sensitive to many factors, including required levels of decarbonisation, levels of investor foresight, technology learning rates and underlying fossil fuel and carbon prices. While Government envisages eventual exit from CfDs, the focus of this IA is not on projecting the precise point of exit, but on assessing the EMR package relative to other policy options for meeting Government's long-term decarbonisation and security of supply goals.[62]

59. The analysis in this impact assessment is based on DDM modelling runs, using the range of strike prices proposed in the draft EMR Delivery Plan[63].

*Contracts for difference*

60. The Government's choice of the CfD as the preferred policy instrument was set out in full in the EMR White Paper (July 2011). The analysis presented in this IA updates the

---

[59] Particularly Annex E of draft EMR Delivery Plan (National Grid EMR Analytical Report):

[60] For further detail on the financing benefits associated with CfDs, please see Annex B of the draft EMR Delivery Plan:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223652/emr_consultation_annex_b.pdf

[61] This is also true for analysis of different decarbonisation scenarios and fossil fuel price sensitivities

[62] Government envisages that, by the late 2020s and beyond, its role in the electricity market will largely be restricted to the setting of high-level objectives for diversity and security of supply. The following conditions will need to be in place for Government to stop issuing CfDs, and for the wholesale market to support ongoing investment to ensure decarbonisation and security of supply goals are met at least cost:

- a sustainably high carbon price (either through the EU-ETS or carbon price floor);
- falling technology costs (i.e. through technological learning and economies of scale); and
- innovation in financial risk management products (e.g. to help manage long-term price risk).

[63] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209276/EMR_Spending_Review_Announcement_-_FINAL_PDF.pdf

costs and benefits associated with CfDs, based on the strike prices proposed in the draft EMR Delivery Plan.

61. As a result of lower exposure to fossil fuel price risk and the greater price certainty offered by CfDs, the cost of capital for investors in low-carbon generation is lower under a CfD. The technology-specific hurdle rates used in this analysis are based on data and evidence drawn from various sources – Oxera[64] (2011), Arup[65] (2011), Redpoint[66] (2010) and KPMG[67] (2013). For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report[68].

62. It is assumed that EMR instruments will be deployed to achieve a least-cost decarbonisation pathway, balancing least cost deployment of current technologies with support for those technologies that could make a material contribution to future decarbonisation. To take account of uncertainty in the future costs of alternative technologies, it has been assumed for modelling purposes that EMR supports a broader diversity of technologies to 2030 than would be the case based purely on current central projections for generation costs, demand and fossil fuel prices to 2030. There is uncertainty about how the electricity sector will develop over the longer term and supporting a diverse generation mix in the medium term will help manage some of the technology risks associated with achieving the sector's share of the 2050 economy-wide 80% decarbonisation target, under a range of different future scenarios. However, over time, it is expected that the benefits of competition can be brought in, moving to competitive price-setting for low-carbon technologies and a market determined generation mix. At this point in time, it is not possible to predict accurately what this future generation mix might be.

*Capacity Market*

63. In a Capacity Market, capacity providers receive a payment for offering capacity which is available when needed but are able to sell their energy into the energy market. They are then required to be available when needed.

64. The form of Capacity Market assessed here as part of the overall lead EMR package is an Administrative Capacity Market (where providers are subject to administrative penalties,

---

[64] http://hmccc.s3.amazonaws.com/Renewables%20Review/Oxera%20low%20carbon%20discount%20rates%20180411.pdf

[65] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42843/3237-cons-ro-banding-arup-report.pdf

[66] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42638/1043-emr-analysis-policy-options.pdf

[67] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225619/July_2013_DECC_EMR_ETR_Report_for_Publication_-_FINAL.pdf

[68] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_16_07_13_amend.pdf

in addition to energy market incentives, if they fail to be available at times of scarcity and providers are able to keep any revenues they earn in the energy market). More detail on the full options appraisal for mitigating security of supply risks is provided in the Capacity Market impact assessment.[69]

65. In its publication of 27 June 2013, the Government published further details of its design proposals for the Capacity Market and confirmed its intention to run the first Capacity Market auction in late 2014, for delivery in the winter of 2018/19, subject to State Aid clearance.[70]

66. The reliability standard will help to inform the amount of capacity to procure in a future Capacity Market. The analysis considered in this IA is based on the proposed reliability standard for the GB electricity market (i.e. a Loss of Load Expectation of 3 hours per year), as set out in the draft Delivery Plan[71]. This proposal is the result of an analytical approach to identify the optimal reliability standard for the GB market, and comparison with standards in neighbouring countries.[72] An optimal reliability standard balances the increased security of supply benefit of additional capacity (procured through the capacity market auction) with the costs of providing that capacity.

67. In theory, it would be better if consumers could decide and contract for their own levels of reliability. However, this is not possible at the moment, because we do not have an active demand side, and consumers do not face real-time prices to allow them to make the trade-off (between costs of capacity and security of supply) for themselves. A reliability standard is therefore a way of providing this trade-off on behalf of customers.

68. The Capacity Market design may need to evolve over time to reflect changing market conditions. This will prevent the Capacity Market being locked into an inefficient or ineffective design as the energy market evolves and improvements in the design of the Capacity Market are identified. Therefore, Government will continue to monitor these design proposals to ensure they are compatible with changing market conditions (e.g. cash out reform) that may occur between now and the first auction.

---

[69] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197911/capacity_market_ia.pdf

[70] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209280/15398_TSO_Cm_8637_DECC_Electricity_Market_Reform_web_optimised.pdf

[71] Please see Chapter 3 of the draft EMR Delivery Plan: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223650/emr_delivery_plan_consultation.pdf

[72] For further detail on the methodology used to calculate the reliability standard, please see Annex C of the draft Delivery Plan (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223653/emr_consultation_annex_c.pdf)

### 2.2.2 Basecase

69. In undertaking the cost-benefit analysis for EMR (based on CfDs with the proposed strike prices, and a Capacity Market which uses the proposed reliability standard), the policy package is compared to a basecase counterfactual, without the EMR package. The basecase includes existing policies such as the Renewables Obligation (RO) and the EU-ETS and policies which the Government has committed itself to delivering, such as the Carbon Price Floor (CPF) policy announced in the Budget 2011.[73]

70. Since the IA published alongside the introduction of the Energy Bill to Parliament in November 2012, we compare the EMR package against an alternative scenario which tries to match as closely as possible the decarbonisation profile achieved under EMR. However, the policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown. Therefore, the basecase attempts to achieve this similar decarbonisation profile using existing policy instruments, namely the RO and carbon pricing.[74]

71. There are a number of different ways the RO and carbon pricing could be combined to achieve Government's decarbonisation ambitions. Due to this uncertainty, in previous IAs two separate hypothetical basecases had been developed, leading to a range of NPV estimates. The first of these (Basecase A) sought to achieve the same profile in nuclear new build as under EMR; the second (Basecase B) was designed to achieve the same profile in nuclear and CCS new build as under EMR.

72. However, with updated evidence and assumptions about technology costs, the approach used to replicate the EMR new build profiles in these two basecases has effectively aligned them [75]. There is no longer a clear difference between the technologies used to decarbonise the sector in Basecase A and Basecase B in the latest modelling.

---

[73] The inclusion of the Carbon Price Floor as part of the counterfactual is consistent with Government guidance to include all policies to which the government is already committed and which have funding (see 'Valuation of energy use and greenhouse gas emissions', available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68764/122-valuationenergyuseggemissions.pdf. Analysis of the incremental impact of the Carbon Price Floor (relative to a baseline traded sector carbon price, including social costs and benefits and distributional impacts) was undertaken in December 2010, and is accessible at: http://www.hm-treasury.gov.uk/d/consult_carbon_price_support_ia.pdf. Updated analysis of the impacts of energy and climate change policies on prices and bills, including CPF, is available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/172923/130326_-_Price_and_Bill_Impacts_Report_Final.pdf. Overall, it shows that by 2020 households will, on average, save £166 (11%) on their energy bills, compared to what they would have paid in the absence of government intervention.

[74] As the focus of the no-EMR basecase is EMR's relative efficiency in meeting the 2030 decarbonisation ambition, in the basecase the 2040 and 2049 emission intensity levels are met by increasing carbon prices post-2030, leading to an emissions intensity in 2040 and 2049, consistent with that achieved under EMR.

[75] The Carbon Price in the basecase now rises to a higher level in the late 2010s, to replicate the nuclear new build profile under EMR. However, this increase is sufficient to incentivise some CCS build during the 2020s, making it impractical to recreate Basecase A (which replicated EMR's nuclear new build profile only).

73. Therefore, this IA presents the net welfare impact of EMR relative to a single basecase, which is equivalent to Basecase B used in previous IAs. Whilst a range is not presented, the uncertainty over how Government might decarbonise without EMR remains, and therefore a degree of uncertainty around the welfare impact of EMR also remains.

74. Under this basecase, carbon prices increase pre-2030, in order to achieve the same profile in nuclear new build and a similar profile in CCS new build as under EMR. To realise deployment of the first nuclear plant (as under EMR), the carbon price is increased to £150 per tonne in 2019; this increase is sufficient to bring on some of the early CCS plant.[76] To generate investment in CCS technology by the end of the 2020s the carbon price rises to around £175/tonne by 2030. The carbon price value is held at this level until 2049. The RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies, similar to that delivered under EMR. These assumptions are summarised in Table 5 below.

**Table 5: Summary of basecase assumptions**

| | 2030 emissions intensity $gCO_2/KWh$ | 2049 emissions intensity $gCO_2/KWh$ | Carbon pricing | Renewables Obligation (RO) |
|---|---|---|---|---|
| Basecase | 96 | 18[77] | Carbon prices increase to £150/tonne in 2019, and rises to £175/tonne in 2030 and remains at that level until 2049 (broadly consistent with long-term decarbonisation ambitions). | RO support to meet 2020 renewable target and 2030 carbon emissions ambition. RO stays open to new renewable plants beyond 2017, closing in 2037. |

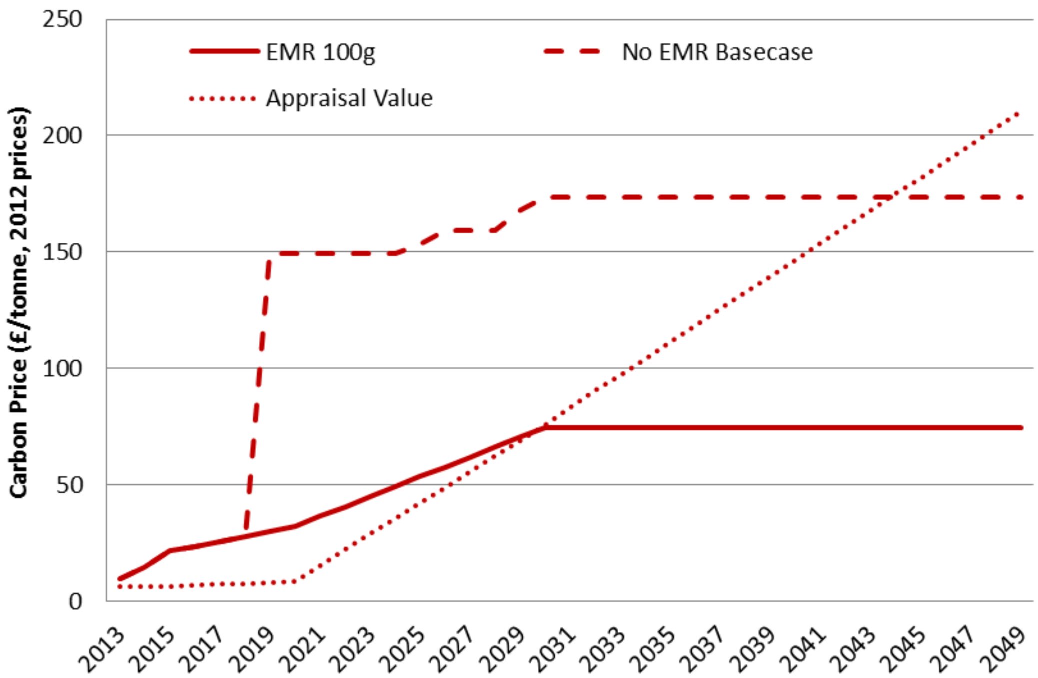
75. Chart 1 presents the assumed profile of carbon prices under EMR and the no-EMR basecase. Further details, including decarbonisation profiles and generation mixes, are presented in Annex C[78].

[76] This eliminates the previous distinction between Basecase A (which replicated EMR's nuclear new build only) and Basecase B (which replicated EMR's nuclear and CCS new build)

[77] The basecase 'overachieves' the required emissions intensity target in 2049 and 2040, reaching $18gCO_2/KWh$ and $34gCO_2/KWh$ respectively. This is due to the increased carbon price in the late 2020s (in order to bring on CCS plant) leading to 'undershooting' – for further details, see Annex C.

[78] Within the modelling, the effective carbon price that fossil fuel generators will pay is the higher of the Carbon Price Floor and the traded carbon market price (defined as the appraisal value in the relevant chart). In

**Chart 1: Carbon price profiles – EMR and basecase (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




*Source: DECC modelling*

*Security of supply under the basecase*

76. Modelling of the basecase assumes that there is no "missing money" and that energy prices rise to the Value of Lost Load (VoLL) if load is shed. This means that an energy-only market in the basecase delivers the "economically efficient" capacity margin, albeit based on the simplifying assumption that energy investors have perfect foresight of future energy demand up to five years ahead and that energy prices rise to the VoLL (assumed to be £17,000/MWh[79]) at times of scarcity. Modelling also assumes that investors have certainty about demand when deciding whether to build capacity.

77. Risks to the security of supply objective are not mitigated against in the basecase, as we do not believe it would be possible to meet the same objective without a capacity mechanism.

---

this latest analysis the traded carbon price rises above the Carbon Price Floor from 2030 onwards. From 2030, the working assumption under the EMR scenario is that there will be a functioning global carbon market with a price of £70/tCO2e in 2030, rising to £200/tCO2e in 2050 (2009 prices) – i.e. that the Carbon Price Floor is non-binding after 2030. During the adjustment phase between the EU and global carbon markets, the appraisal value is linearly interpolated between the values in 2020 and 2030. Therefore, after 2020 the appraisal value is above the EUA price estimates.

[79] This has risen from a previous assumption of £10,000/MWh, based on evidence gathered in a recently published report, available at: http://www.londecon.co.uk/publication/estimating-the-value-of-lost-load-voll

*Renewables targets under the basecase*

78. Under the basecase, the EU target for 15% renewable energy consumption across the UK economy by 2020 is assumed to be met, with over 30% of electricity generated coming from renewables by 2020.[80] The latest modelling is also consistent with the analysis supporting the draft EMR Delivery Plan.[81] Renewable policy objectives after this date vary across the different decarbonisation scenarios (discussed further below).

*Decarbonisation ambitions under the basecase*

79. Given that the Climate Change Act sets out a process leading to statutory targets (in the form of Carbon Budgets) on the way to an 80% economy-wide emissions reduction by 2050, assuming no decarbonisation ambition in the basecase may underestimate the likely true costs in a world without EMR.[82]

80. Therefore, since the IA published alongside the introduction of the Energy Bill to Parliament in November 2012, we compare the EMR package against an alternative scenario which tries to match as closely as possible the decarbonisation profile achieved under EMR. Following the approach adopted in previous EMR impact assessments, this analysis focuses on an average emissions intensity for the power sector of around 100g$CO_2$/kWh in 2030, 50g$CO_2$/kWh in 2040 and 25g$CO_2$/kWh in 2049. Analysis is also undertaken for two other emission intensity pathways – 50g$CO_2$/kWh in 2030 (leading to 50g$CO_2$/kWh in 2040 and 25g$CO_2$/kWh in 2049) and 200g$CO_2$/kWh in 2030 (leading to 50g$CO_2$/kWh in 2040 and 25g$CO_2$/kWh in 2049).

81. To provide further sensitivity tests on the cost-effectiveness of EMR, the impact of EMR is assessed against a basecase without any explicit decarbonisation ambition (denoted Basecase C, set out in Annex E). This provides a point of comparison to earlier modelling results (i.e. pre-November 2012), as these were not based on achieving any particular decarbonisation target.

---

[80] DECC, The UK Renewable Energy Strategy, 2009

[81] The analysis presented in this IA is based on a standardised set of assumptions, including technology costs and electricity demand at the time the analysis was undertaken, which are set out in Annex A.

[82] Analysis of EMR prior to November 2012 was not based on a like-for-like comparison of decarbonisation or security of supply objectives achieved under EMR and the basecase. The 'no EMR' basecase did not have the same decarbonisation trajectory or meet the same security of supply objectives as achieved under EMR. Across the relevant publications the emissions intensity achieved under the various basecases has ranged from around 165 to 200g$CO_2$/kWh. This compares to an indicative target of 100g$CO_2$/kWh in the EMR case. Implicit in earlier modelling was an assumption that with lower decarbonisation in the power sector, carbon targets would be met by reductions in other sectors. These costs are not considered in the EMR modelling conducted previously. The HMG Carbon Plan, and the CCC, suggest that carbon-targets can be met cost-effectively by early decarbonisation of the power sector. A basecase which assumes lower decarbonisation in the power sector in 2030 will therefore underestimate the costs of meeting long-term carbon targets by failing to consider the costs of decarbonising in more expensive sectors outside the power sector (assuming that emission reductions are met domestically rather than through trading).

82. This basecase provides a partial assessment of the impact of not decarbonising the electricity sector and not meeting Government’s long-term ambitions, since in such a counterfactual, emissions reductions in the electricity sector would be displaced by reductions elsewhere in the economy.

## 2.3 Net Present Value of EMR

83. This section assesses the benefits of EMR as a whole (i.e. combined impact of CfDs with the proposed strike prices, and a Capacity Market based on the proposed reliability standard), before the individual impact of CfDs and the Capacity Market are presented.

84. As set out in section 2.2 above, the tables below present the NPV results from assessing EMR (across different decarbonisation levels) relative to a basecase which achieves a similar decarbonisation ambition using the Renewables Obligation (RO) and the carbon price, but does not mitigate against security of supply risks.[83]

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

85. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 100g$CO_2$/kWh in 2030 through EMR compared to the basecase results in welfare improvements of around **£9.5bn**. Assessed up to 2049, EMR results in net welfare improvements of around **£31bn**.[84]

**Table 6: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| Net Welfare | Value of carbon savings | -1,300 | -4,100 | -7,200 |
| | Generation cost savings | -80 | 2,100 | 4,300 |
| | Capital cost savings | 7,700 | 17,000 | 25,000 |
| | System cost savings | -1,000 | -1,100 | -980 |
| | Unserved energy savings | 3,300 | 7,100 | 8,500 |
| | Cost of Interconnector energy saved | 1,700 | 2,100 | 2,000 |
| | **Change in Net Welfare** | **10,000** | **23,000** | **31,000** |
| | **Change in Net Welfare*** | **9,500** | | |

*Source: DECC modelling*

**Inclusive of administrative costs of approximately £0.7bn up to 2030 (see section 2.4.1 for details)*

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

86. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 50g$CO_2$/kWh in 2030 through EMR compared to a basecase, results in a net welfare improvement of **£15bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£48bn**.

[83] A description of the different CBA categories is provided in Annex B. All results are rounded to two significant figures.

[84] Administrative cost estimates are not estimated beyond 2030; the estimates up to 2030 must be regarded as tentative as the component costs have not yet been fully determined, as they will depend on the final agreed activities to be undertaken by the relevant organisations. For this reason, the NPV figures post-2030 relate to energy market-only impacts.

**Table 7: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 50g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Net Welfare** | Value of carbon savings | -1,500 | -5,800 | -12,000 |
| | Generation cost savings | 1,300 | 2,800 | 2,200 |
| | Capital cost savings | 8,800 | 24,000 | 41,000 |
| | System cost savings | -2,300 | -3,400 | -4,000 |
| | Unserved energy savings | 7,300 | 17,000 | 18,000 |
| | Cost of Interconnector energy saved | 2,600 | 3,700 | 3,600 |
| | **Change in Net Welfare** | **16,000** | **38,000** | **48,000** |
| | **Change in Net Welfare*** | **15,000** | | |

*Source: DECC modelling*
**Inclusive of administrative costs of approximately £0.7bn up to 2030 (see section 2.4.1 for details)*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

87. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 200g$CO_2$/kWh in 2030 through EMR compared to a basecase[85], results in a net welfare improvement of **£4.8bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£13bn**.

**Table 8: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 200g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Net Welfare** | Value of carbon savings | -1,800 | -1,400 | -900 |
| | Generation cost savings | -3,000 | -1,700 | 1,300 |
| | Capital cost savings | 7,000 | 4,600 | 1,800 |
| | System cost savings | 270 | 990 | 1,600 |
| | Unserved energy savings | 1,400 | 5,100 | 7,200 |
| | Cost of Interconnector energy saved | 1,600 | 2,000 | 2,100 |
| | **Change in Net Welfare** | **5,500** | **9,500** | **13,000** |
| | **Change in Net Welfare*** | **4,800** | | |

*Source: DECC modelling*
**Inclusive of administrative costs of approximately £0.7bn up to 2030 (see section 2.4.1 for details)*

88. The overall NPV figures for all decarbonisation scenarios are higher than the equivalent estimates previously presented in May 2013 – £4.2bn to £7.6bn for 100g, £5.3bn for 50g and £1.9bn for 200g – all assessed up to 2030. There are two key explanatory factors:

[85] As for the analysis of emissions intensity of 50g$CO_2$/kWh, there is only a single basecase

- **Capital cost savings**: The driver behind the increase in this component is the change in the underlying carbon price assumptions. As outlined earlier, the carbon price is now higher in the basecase by the end of this decade, which induces greater renewables deployment, particularly onshore and offshore wind. This increases capital costs in the basecase (for all decarbonisation scenarios), increasing the comparative benefit of EMR for this element of the analysis. The level of the carbon price is sufficient to induce this deployment without any additional incentive necessary from the RO (which is already at zero in the basecase). Therefore, the cumulative impact of this additional wind capacity is to displace (or 'crowd out') some gas generation.

- **Unserved energy savings**: The value of unserved energy is the main driver of this increase, which reflects several changes in the modelling. Firstly, the assumption about the Value of Lost Load (VOLL) has increased from £10,000 to £17,000/MWh, based on evidence gathered through a jointly-commissioned study with Ofgem[86]. Secondly, there have been changes in demand assumptions (where peak demand has increased) and plant availability (to reflect recent decisions around decommissioning and mothballing), which means that capacity margins are tighter than in previous modelling, increasing the likelihood of unserved energy in a world without a capacity market. Lastly, the modelling is now conducted through a dedicated unserved energy module that uses data from DDM outputs. This provides a more granular and more sophisticated analysis of the frequency and duration of periods with unserved energy[87], leading to greater net benefits relative to the previous analysis. These benefits are particularly pronounced for the 50g scenario, where there is a greater proportion of renewable generation (hence greater risks of unserved energy).

89. The overall EMR NPV results reflect the combined impact of decarbonising through CfDs (at the proposed strike prices) and mitigating against risks to security of supply through a Capacity Market (based on the proposed reliability standard). In the following section, the impact of each of these two policy instruments is assessed in turn.[88]

---

[86] Available at http://www.londecon.co.uk/publication/estimating-the-value-of-lost-load-voll

[87] For a given annual demand and capacity mix in each scenario, the yearly unserved energy is derived through Monte Carlo simulation. This offers much greater granularity, using historical data on plant outage (duration and frequency) for each technology and historical wind speed data to calculate the distribution and mean expected unserved energy in each year. This modelling approach was designed to be closer to the Ofgem capacity assessment and was procured in collaboration with National Grid to ensure this was the case.

[88] The analysis presented in this IA is based on one set of assumptions, including assumed technology costs. These are described in more detail in various reports outlined at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65713/6883-electricity-generation-costs.pdf. Assumptions about technology costs are uncertain and future costs depend on assumptions including rates of learning and deployment of particular technologies (including global deployment). As such, actual future technology costs may differ from those assumed within the modelling; for example, costs could change more quickly or slowly than assumed. The modelling results will be sensitive to

### 2.3.1 Net Present Value of CfDs only

90. To assess the relative merits of CfDs as a tool for meeting decarbonisation ambitions, independently of the Capacity Market, the basecases are compared to a scenario which decarbonises through CfDs but does not include a Capacity Market. The results are presented in Tables 9-12.

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

91. Relative to the basecase outlined above, the impact of CfDs alone in decarbonising the power sector to an average emissions level of 100g$CO_2$/kWh in 2030 would result in a positive NPV of around £**9.4bn** to 2030.[89] The key benefit of CfDs is their ability to lower the capital costs associated with decarbonisation – up to 2030 such benefits are estimated to be around **£8.1bn**.[90] The benefit is higher than in figures published in May 2013.

**Table 9: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| Net Welfare | Value of carbon savings | -1,100 | -3,100 | -5,000 |
| | Generation cost savings | 280 | 2,300 | 4,600 |
| | Capital cost savings | 8,100 | 17,000 | 23,000 |
| | System cost savings | 200 | 770 | 1,300 |
| | Unserved energy savings | 760 | 920 | 240 |
| | Cost of Interconnector energy saved | 1,700 | 2,200 | 2,200 |
| | **Change in Net Welfare** | **9,900** | **20,000** | **26,000** |
| | **Change in Net Welfare*** | **9,400** | | |

*Source: DECC modelling*
** Inclusive of administrative costs of approximately £0.5bn up to 2030 (see section 2.4.1 for details)*

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

92. In reaching an average emissions level of 50g$CO_2$/kWh for the power sector in 2030, the impact of CfDs alone results in a positive NPV of **£13bn up to 2030**.[91] The key benefit of CfDs is their ability to lower the capital costs associated with decarbonisation – up to 2030, such benefits are estimated to amount to **£8.9bn**.

changes in technology cost assumptions, and any differences between the realised costs and the assumed value.

[89] Inclusive of CfD administrative costs up to 2030; post-2030 estimates do not include administrative costs, due to uncertainty over estimated costs.

[90] The capital cost reductions reported in these tables reflect the combined impact of two factors – a financing cost impact and a technology mix impact. These are separated and explained in more detail below.

[91] As above, this figure is inclusive of CfD administrative costs up to 2030, but not beyond.

**Table 10: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 50g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| Net Welfare | Value of carbon savings | -1,200 | -4,100 | -8,200 |
| | Generation cost savings | 490 | 490 | 400 |
| | Capital cost savings | 8,900 | 22,000 | 35,000 |
| | System cost savings | -940 | -1,000 | -970 |
| | Unserved energy savings | 3,300 | 7,800 | 7,400 |
| | Cost of Interconnector energy saved | 2,600 | 3,800 | 4,000 |
| | **Change in Net Welfare** | **13,000** | **29,000** | **38,000** |
| | **Change in Net Welfare*** | **13,000** | | |

*Source: DECC modelling*

**Inclusive of administrative costs of approximately £0.5bn up to 2030 (see section 2.4.1 for details)*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

93. Finally, in reaching an average emissions level of 200g$CO_2$/kWh for the power sector in 2030, the impact of CfDs alone results in a positive NPV of **£5.5bn to 2030**.[92] The key benefit of CfDs is their ability to lower the capital costs associated with decarbonisation – up to 2030, such benefits are estimated to amount to **£7.0bn.**

**Table 11: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 200g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| Net Welfare | Value of carbon savings | -1,500 | -260 | 1,500 |
| | Generation cost savings | -2,900 | -2,500 | 25 |
| | Capital cost savings | 7,000 | 5,200 | 1,800 |
| | System cost savings | 1,200 | 2,600 | 3,600 |
| | Unserved energy savings | 510 | -360 | -1,200 |
| | Cost of Interconnector energy saved | 1,600 | 2,100 | 2,200 |
| | **Change in Net Welfare** | **6,000** | **6,800** | **8,000** |
| | **Change in Net Welfare*** | **5,500** | | |

*Source: DECC modelling*

**Inclusive of administrative costs of approximately £0.5bn up to 2030 (see section 2.4.1 for details)*

94. The lower capital costs reported in the tables above reflect the combined impact of two factors.

[92] As above, this figure is inclusive of CfD administrative costs up to 2030, but not beyond.

- **Financing cost impact:** Benefits of decarbonising through CfDs rather than the RO and a higher carbon price, in terms of the impact on costs of finance.

- **Technology mix impact**: Relative benefits of CfDs being better able to target a cost-effective generation mix, in comparison to existing policy instruments.

*Financing cost impact*

95. EMR reduces market risk by providing greater price certainty to low-carbon investors through the contract for difference (CfD) mechanism. This greater certainty means that, all other things being equal, financing costs are lower, as investors can borrow money at a lower cost of capital (or equivalently that the hurdle rates for a project can be lower).

96. Initial analysis for the EMR White Paper suggested that CfDs could reduce hurdle rates for low-carbon investments by up to 1.5 percentage points.[93] Independent verification of the cost of capital impacts showed broadly similar results.[94] The technology-specific hurdle rates used in this analysis (set out in Annex A) are based on data and evidence drawn from various sources – Oxera[95] (2011), Arup[96] (2011), Redpoint[97] (2010) and KPMG[98] (2013). For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report.[99]

97. In order to isolate the savings due to reductions in the costs of capital, modelling runs for EMR (with and without CfD hurdle rate reductions) are compared. The results suggest that, depending on the assumed level of decarbonisation in 2030, CfDs would generate an NPV of between £3.3bn and £7.2bn from lower costs of capital (up to 2030, including administrative costs), £11bn-£21bn up to 2040 and £17bn-£30bn up to 2049.[100] This reflects the efficiency of delivering low-carbon investment through CfDs,

---

[93] Electricity sector dispatch modelling by Redpoint Energy Consultants, 2011

[94] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf & https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48136/2174-cepa-paper.pdf

[95] http://hmccc.s3.amazonaws.com/Renewables%20Review/Oxera%20low%20carbon%20discount%20rates%20180411.pdf

[96] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42843/3237-cons-ro-banding-arup-report.pdf

[97] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42638/1043-emr-analysis-policy-options.pdf

[98] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225619/July_2013_DECC_EMR_ETR_Report_for_Publication_-_FINAL.pdf

[99] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_16_07_13_amend.pdf

[100] For individual decarbonisation levels, the figures are as follows:

- 100g = £4.8bn up to 2030 (including administrative costs), £15bn up to 2040 and £22bn up to 2049;
- 50g = £7.2bn up to 2030 (including administrative costs), £21bn up to 2040 and £30bn up to 2049, and
- 200g = £3.3bn up to 2030 (including administrative costs), £11bn up to 2040 and £17bn up to 2049

relative to an alternative mechanism that would deliver the same generation mix but without financing savings.[101]

*Technology Mix Impact*

98. The capacity and generation mix realised under EMR, and the basecase we assess it against, are crucial in the assessment of the overall NPV of EMR. Different technologies have different operating and capital costs, therefore the CBA results will be influenced by any differences in the technology mixes realised under EMR and the basecase scenario. Of particular importance is the role CCS plays in decarbonising.[102]

99. A critically important factor is the difference in the new build profile under EMR and the basecase. For example, the level of carbon price in the basecase by 2020 (necessary to replicate EMR's nuclear new build profile) results in higher investment in onshore and offshore wind during the 2020s.[103]

100. This relatively higher renewable new build profile is reflected in all parts of the CBA, as it changes the generation mix in the basecase. However, it will have a particular impact on the capital cost benefits of EMR. For example, in the 100g basecase, the greater amount of new wind capacity means that capital costs are comparatively higher than the EMR scenario. Therefore, part of capital cost benefit reported above reflects the comparative 'bluntness' of existing instruments in targeting decarbonisation and renewable generation across a range of technologies.

101. In contrast to the basecase (which uses carbon prices as a relatively blunt instrument for achieving decarbonisation), CfDs allow technology-specific targeting. This means that nuclear and CCS investments can be deployed without directly impacting the investment and generation decisions of alternative technologies, such as unabated coal and gas[104].

102. Comparing EMR and the basecase, there are also differences in the generation mix induced by the capacity market, with a greater proportion of OCGT plant and a lower

---

[101] The comparison is made using the EMR modelling without a capacity market. Comparing the capital cost savings under EMR with a Capacity Market does not change the results materially.

[102] CCS demonstration projects also have an important role to play in the technology mix and NPV results. The assumption in the basecase is that in the absence of EMR, there would be no CfDs to fund early-stage CCS projects. This is because the hypothetical basecase only includes existing policy instruments. However, in the absence of EMR, a likely scenario is that alternative funding would be sought for CCS consistent with the Government's commitment to help support the development of this technology. The NPV results for EMR are particularly sensitive to how the CCS projects are treated in the basecase, due to their modelled delivery date. If the CCS demonstration projects are included in the basecase, the EMR NPV would increase from £9.5bn to £12.5bn (NPV up to 2030, 2012 prices). The increased benefit of EMR reflects capital cost savings, as the demonstration projects costs are accrued under both scenarios (all estimates include expected administrative costs).

[103] The basecase also results in higher total renewables generation in 2020, in comparison to EMR

[104] As set out above, the effect of this higher carbon price in the basecase is to lead to greater renewables deployment (especially wind); this leads to displacement/'crowding out' of gas generation

proportion of CCGT plant built under EMR. As OCGT is comparatively cheaper, this reduces costs relative to the basecase and increasing the benefits of EMR.

103. The technology mix also drives the differences in carbon and generation costs. Against the basecase carbon costs up to 2030 are higher under CfDs, reflecting the slightly slower decarbonisation profile followed. This is driven by a focus on targeting a cost-effective generation mix, at the expense of fuel switching.[105]

104. The above factors are also important in explaining the changes for the various decarbonisation scenarios, though to differing degrees. For example, the comparative contribution of greater renewable deployment (induced by the higher carbon price towards the end of this decade) is greater for the 200g scenario, as there is comparatively little decarbonisation required in the 200g basecase after 2020. In contrast, CCS costs are much higher in the 50g basecase, due to the decarbonisation required up to 2030.

### 2.3.2 Net Present Value of the Capacity Market

105. Our analysis shows that a Capacity Market is expected to have a marginally positive net welfare impact of **£0.1bn**[106], relative to a scenario of an efficient energy market – i.e. where the energy price reflects consumer's Value Of Lost Load and where the market is able to invest on the basis of scarcity rents.

106. Given that the model has been set to target a non-zero level of capacity, we would expect this result to be negative. The expected result of a net cost in the modelling is driven by the assumptions that there is no "missing money" in the energy market and that investors have certainty about demand up to five years ahead when deciding whether to build capacity.

107. The draft reliability standard has been set to balance the costs of additional capacity with its associated security of supply benefits. However, the translation of this reliability standard to an optimal level of capacity does not account for forecasting error in demand and supply. Neglecting this uncertainty would lead to a systematic under-procurement of capacity, so when deciding how much capacity to target in the modelling, we aim higher than the level implied by the reliability standard.[107] This therefore represents an approximation within the modelling; however, we are seeking to improve this capability and hope to reflect this more accurately in the future.

[105] For more detail see Annex C

[106] Value shown for a emissions intensity of 100g$CO_2$/kWh in 2030 (including administrative costs of around £0.2bn up to 2030), comparable figures for 50g$CO_2$/kWh (£2.7bn) and 200g$CO_2$/kWh (-£0.8bn) are given below

[107] The exact translation depends on how much uncertainty there is in the forecasts; this uncertainty increases the further out we wish to procure. In a capacity market we look to take a decision on what capacity is needed four years out, which in turn leads to 4-5 years of peak demand level uncertainty.

108. The model therefore understates the optimal reliability standard and hence overestimates the cost of the Capacity Market, which has a reliability standard that reflects the degree of uncertainty that exists in practice over capacity requirements four years ahead.

109. A key driver of the increase in the NPV relative to the previous analysis (by over £2bn up to 2030) is modelling the value to society of unserved energy, through the use of a bespoke module within the DDM. This provides a more granular and more sophisticated analysis of the frequency and duration of periods with unserved energy.

110. Previous modelling estimated the amount of unserved energy from a single relationship with the capacity margin, derived from analysis carried out by Redpoint for the Carbon Plan in 2011. This gave values of the expected energy unserved for different capacity margins under a range of scenarios. By pooling the data from each scenario, the energy unserved could be derived from a given capacity margin.

111. For the latest modelling we have procured a dedicated unserved energy module that uses data from DDM outputs. For the given annual demand and capacity mix in each scenario, the unserved energy per year is derived through Monte Carlo simulation. This offers much greater granularity using historical data on plant outage duration and frequency for each technology and historical wind speed data to calculate the distribution and mean expected unserved energy in each year. However, there is no feedback from the unserved energy module to the DDM investment decisions. Therefore, while unserved energy benefits are calculated specifically for CBA analysis, the investor decisions in the DDM are still based on a more conservative central view of the probability of lost load.

112. This modelling approach was designed to be closer to the Ofgem capacity assessment and was procured in collaboration with National Grid to ensure this was the case. The new approach showed higher estimates of unserved energy which, when combined with the increase in VOLL from £10,000 to £17,000/MWh, meant there was a large increase in the expected benefits of the capacity market from reducing unserved energy.

113. These increased benefits are offset to some extent by the inclusion of system costs (amounting to just over £1bn up to 2030), which is an additional feature not previously accounted for in EMR modelling. In order to cover these additional areas, National Grid has used both external software and in-house models. The models use DDM outputs on the capacity/generation mix as inputs and present results for each separate area of

interest. These areas comprise Transmission Network Use of System (TNUoS) charges[108] and Balancing Services Use of System (BSUoS) charges[109].

114. The DDM model is non-spatial and therefore does not take into account the variability of TNUoS charges by generator location. In order to address the spatial element, the TNUoS model was built in-house by National Grid as an addition to the DDM.[110]

115. Nevertheless, in practice the energy market does not work perfectly. We remain concerned that the market may fail to deliver an adequate level of reliable capacity due to imperfections in the current cash-out arrangements and due to the lack of liquid forward markets for investors to attain project finance.

116. Modelling is also likely to overstate the cost of a Capacity Market, as it assumes that investors have perfect foresight of demand and other factors up to five years ahead – and so concludes that an efficient capacity margin is close to zero. In practice, demand predictions five years ahead are highly uncertain and an efficient market may be likely to bring forward a higher capacity margin to mitigate against the risk of demand being higher than expected. This means that the model understates the optimal reliability standard and so overestimates the cost of the Capacity Market, which has a reliability standard that reflects the degree of uncertainty that exists in practice over capacity requirements four years ahead.

### 2.3.3 Disaggregated NPV Impact

117. Based on the results presented thus far, it is possible to break down the overall NPV result presented above into its constituent parts, for different levels of emissions intensity in 2030. The results are presented in Tables 12-14.

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

118. The CBA suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers up to 2030, leading to an improvement in welfare of **around £9.5bn up to 2030** (under an assumed emissions intensity of 100g$CO_2$/kWh).

[108] Transmission Network Use of System (TNUoS) charges recover the costs of transmission network investment and maintenance costs incurred by all GB Transmission Owners (NGET, SHET, SPETL, OFTOs). The purpose of TNUoS tariffs is twofold: firstly to reflect the impact that transmission users at different geographical locations have on transmission costs; and secondly to recover the total allowed revenue of the transmission licences.

[109] Balancing Services Use of System (BSUoS) charges are paid by suppliers and generators based on their energy taken from or supplied to the National Grid in each half-hour Settlement Period. These charges are paid to cover the costs of keeping the system in electrical balance and maintaining the quality and security of supply.

[110] Source: Annex E of draft EMR Delivery Plan (National Grid EMR Analytical Report, July 2013)

**Table 12: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices [111] (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| **EMR (CfD + Capacity Market)** | | |
|---|---|---|
| CfDs | | 9,400 |
| | *- Financing Impact* | *4,800* |
| | *- Technology Mix Impact* | *4,600* |
| Capacity Market | | 110 |
| | | |
| **Net Impact** | | **9,500** |

*Source: DECC modelling*

119. This reflects **£9.4bn** worth of net benefits as a result of decarbonising through CfDs, and a small benefit **£0.1bn** from mitigating against security of supply risks through the Capacity Market. Of the £9.4bn benefit from decarbonising through CfDs, around **£4.8bn** can be attributed to the benefit of lower financing costs under CfDs, with the remaining **£4.6bn** of the benefits attributable to the different technology mix generated by EMR, relative to the basecase.[112]

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

120. Targeting an emissions intensity of 50g$CO_2$/kWh in 2030, EMR leads to an improvement in welfare of **£15bn**, up to 2030. This comprises **£13bn** worth of net benefits as a result of decarbonising through CfDs (of which around **£7.2bn** can be attributed to the benefit of lower financing costs under CfDs and **£5.5bn** to the different technology mix, relative to the basecase), and a further **£2.7bn** net benefit of mitigating against security of supply risks through the Capacity Market.

[111] Inclusive of administrative costs

[112] The technology mix impact reflects the impact of the different generation mixes between the basecase and EMR scenarios.

**Table 13: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices (emissions intensity in 2030 = 50g$CO_2$/kWh)**

| EMR (CfD + Capacity Market) | | |
|---|---|---|
| CfDs | | 13,000 |
| | *- Financing Impact* | *7,200* |
| | *- Technology Mix Impact* | *5,500* |
| Capacity Market | | 2,700 |
| **Net Impact** | | **15,000** |

*Source: DECC modelling*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

121. Targeting an emissions intensity of 200g$CO_2$/kWh in 2030, EMR leads to an improvement in welfare of **£4.8bn up to 2030**. This comprises **£5.5bn** worth of net benefits as a result of decarbonising through CfDs (of which **£3.3bn** can be attributed to the benefit of lower financing costs under CfDs and **£2.2bn** to the different technology mix, relative to the basecase), and an offsetting net cost of -**£0.8bn** from mitigating against security of supply risks through the Capacity Market.

**Table 14: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices (emissions intensity in 2030 = 200g$CO_2$/kWh)**

| EMR (CfD + Capacity Market) | | |
|---|---|---|
| CfDs | | 5,500 |
| | *- Financing Impact* | *3,300* |
| | *- Technology Mix Impact* | *2,200* |
| Capacity Market | | -780 |
| **Net Impact** | | **4,800** |

*Source: DECC modelling*

### 2.3.4 Implied investment under EMR

122. At the time of the EMR White Paper in mid-2011, the level of investment required in energy infrastructure by 2020, as implied by the modelling at that time, was estimated to be £110bn. Of this figure, around £35bn was attributable to networks (transmission & distribution) and £75bn to generation capacity. There have since been three major analytical changes, suggesting that now is a suitable time to update these estimates:

- updated technology (levelised) cost assumptions,

- a move from externally-commissioned modelling (Redpoint) to in-house modelling (the Dynamic Dispatch Model, DDM),
- updated modelling capabilities (a broader range of generation technologies) and revised network requirements, evidenced in part through Ofgem's RIIO price control process.[113]

123. On a like-for-like basis (i.e. an estimate of the level of investment required by 2020 that is implied by the latest EMR modelling), the comparable update to the original £110bn figure is estimated to be £125bn-140bn, comprising £75-90bn in generation (up from £75bn) and £50bn in networks (up from £35bn).[114] There are several reasons for the increase in both generation and network costs:

- **Higher cost assumptions**: revised estimates and new evidence has led to higher generation costs for some technologies;
- **Increase in number of modelled technologies**: the capability to model a wider range of generation technologies modelling has meant that overall investment figures for generation have increased;
- **Revised network estimates from Ofgem and network companies**: As set out above, recent regulatory price control agreements provide more accurate estimates, particularly for onshore network investment. In addition, more information is now available on offshore transmission costs.

124. However, rather than solely updating a figure with backward-looking elements, we have also estimated the level of implied investment between now and the end of the decade, according to the latest EMR modelling. This estimate is required investment of £100bn-110bn, of which £60bn-70bn is attributable to generation and around £40bn to networks.

[113] Revenue = Incentives + Innovation + Outputs, which applies to both distribution (http://www.ofgem.gov.uk/Networks/ElecDist/PriceCntrls/riio-ed1/Pages/index.aspx) and transmission (http://www.ofgem.gov.uk/Networks/Trans/PriceControls/RIIO-T1/Pages/RIIO-T1.aspx)
[114] The estimated ranges above reflect the potential deployment scenarios set out in the EMR Delivery Plan

## 2.4 Distributional Analysis

125. This section looks at how the impact on net welfare for the economy as a whole is distributed between different segments of society, namely between consumers and producers of electricity. The assessment of the distributional impact highlights the direction and nature of transfers between these. The results are presented below.

126. Consumer surplus is a measure of welfare to consumers, and results from a combination of the differences in costs facing the consumer (wholesale electricity costs, low-carbon payments and capacity payments), between the EMR scenario and the basecase.

127. Producer surplus is defined here as a measure of the change in profitability of the generation sector. Profitability is measured as the difference between producers' revenues (electricity sales, low-carbon support and capacity payments) and producers' costs.

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

128. Consumer welfare is improved under EMR when assessed across all time periods up to 2049, relative to the basecase. The driver of this result is the reduction in wholesale prices realised under EMR in comparison to the 'no EMR' scenario, which benefit consumers and hence increase consumer surplus. Compared to previous analysis, the scale of this effect has increased slightly up to 2030 (due to higher wholesale prices in the basecase[115]), but decreased over the longer term (due to alternative post-2030 carbon price assumptions under the EMR scenario[116]).

129. This benefit outweighs the greater low-carbon and capacity payments to suppliers in the EMR scenario, which appear as a cost to consumers and hence reduce consumer surplus. Both of these effects have increased relative to previous analysis, up to 2030 – the former reflects the higher carbon price in the basecase, meaning that low-carbon payments are lower for a given level of decarbonisation; the latter is primarily due to the capacity market being initiated earlier under the latest modelling (2019, relative to 2023 previously).

130. In contrast, the effect on producers' welfare is more ambiguous under the EMR scenario. Relative to the basecase, producers are worse off under EMR up to 2030 (shown by a negative change in producer surplus), mainly as a result of the reduction in the wholesale price. However, up to 2040 and beyond, this is outweighed by increasing capacity payments and reductions in producer costs. This now results in producer surplus becoming positive by 2049, implying that producers are better off under EMR over a longer time period, relative to the basecase.

[115] Driven by the higher carbon price, relative to previous analysis
[116] See Annex E for further detail

131. The impact of EMR on consumer electricity prices and bills is presented in Section 2.5. However, the impact of EMR on total consumer costs can be inferred from the distributional analysis and assessed over a longer period up to 2049 (the price and bill impact analysis can only assess the impact of EMR up to 2030). Total discounted consumer costs are 10% lower under EMR when assessed up to 2030, 7% lower up to 2040 and 4% lower up to 2049, relative to the basecase.[117]

132. In contrast, returns for producers are 15% lower up to 2030, 1% lower up to 2040 and 42% higher up to 2049.[118]

133. The negative impact of EMR on environmental tax revenue reflects the different mechanisms used to decarbonise the electricity sector. The lower carbon price under EMR will generate lower environmental tax revenues, in comparison to the reliance on a carbon price in the basecase. Environmental taxes are a transfer from producers to the Exchequer.

**Table 15: Distributional analysis: Combined EMR impact (CfD with Capacity Market), compared to basecase (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Distributional analysis** | | | | |
| Consumer Surplus | Wholesale price | 91,000 | 120,000 | 110,000 |
| | Low carbon payments | -26,000 | -44,000 | -47,000 |
| | Capacity payments | -16,000 | -24,000 | -29,000 |
| | System cost savings | -1,000 | -1,100 | -980 |
| | Unserved energy | 3,300 | 7,100 | 8,500 |
| | **Change in Consumer Surplus** | **52,000** | **58,000** | **42,000** |
| Producer Surplus | Wholesale price | -89,000 | -120,000 | -110,000 |
| | Low carbon support | 26,000 | 44,000 | 47,000 |
| | Capacity payments | 16,000 | 24,000 | 29,000 |
| | Producer costs | 35,000 | 49,000 | 56,000 |
| | **Change in Producer Surplus** | **-13,000** | **-420** | **24,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-29,000** | **-35,000** | **-35,000** |
| **Net Welfare** | **Change in Net Welfare** | **10,000** | **23,000** | **31,000** |

Source: DECC modelling

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

134. In terms of achieving an emissions intensity of 50g$CO_2$/kWh in 2030, consumers are better off under EMR across all time periods, as shown by the positive change in

[117] Consumer costs include wholesale costs, low carbon payments, capacity payments and system costs; unserved energy costs are not reflected in this estimate

[118] Producer returns are defined as revenues (wholesale price, low carbon payments and capacity payments) net of producer costs

consumer surplus. In contrast, producers are now worse off under EMR over all periods, relative to a 'no EMR' scenario (in which decarbonisation ambitions are met using existing instruments), as shown by sustained negative changes in producer surplus.

135. Compared to previous analysis, the increased differential in consumer surplus under EMR is due to wholesale price impacts (i.e. the wholesale price under EMR is now even lower in comparison to the basecase than under previous analysis). This is due to increases necessary in the carbon price to match the EMR new build profile, which drives up the wholesale price in the basecase. This impact is to some extent offset by the negative impact of the low-carbon payment component on consumer surplus (i.e. compared to the basecase, low-carbon payments under EMR have increased in this new analysis, thereby reducing consumer surplus for the EMR scenario). Similarly to the 100g scenario above, this reflects the higher carbon price in the basecase, meaning that low-carbon payments are lower for a given level of decarbonisation.

136. These two effects also impact on producer surplus, albeit in the opposite direction to the effects on consumers outlined above – in this case, the greater wholesale price differential reduces producer surplus, sufficient to outweigh the positive impact of greater low-carbon payments, relative to the basecase. This results in a net negative change in producer surplus for all time periods.

**Table 16: Distributional analysis: Combined EMR impact (CfD with Capacity Market) compared to 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Distributional analysis** | | | | |
| **Consumer Surplus** | Wholesale price | 150,000 | 240,000 | 230,000 |
| | Low carbon payments | -46,000 | -100,000 | -110,000 |
| | Capacity payments | -14,000 | -22,000 | -27,000 |
| | System cost savings | -2,300 | -3,400 | -4,000 |
| | Unserved energy | 7,300 | 17,000 | 18,000 |
| | **Change in Consumer Surplus** | **99,000** | **130,000** | **110,000** |
| **Producer Surplus** | Wholesale price | -150,000 | -240,000 | -230,000 |
| | Low carbon support | 46,000 | 100,000 | 110,000 |
| | Capacity payments | 14,000 | 22,000 | 27,000 |
| | Producer costs | 47,000 | 70,000 | 84,000 |
| | **Change in Producer Surplus** | **-45,000** | **-43,000** | **-7,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-38,000** | **-49,000** | **-53,000** |
| **Net Welfare** | **Change in Net Welfare** | **16,000** | **38,000** | **48,000** |

Source: DECC modelling

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

137. Under a scenario in which EMR is used to target an emissions intensity of 200g$CO_2$/kWh in 2030, consumers are again better off under EMR across all time periods, compared to achieving this emission intensity using existing instruments (as shown by the positive change in consumer surplus). As for the 50g scenario, change in producer surplus is again negative across all time periods, implying that they are worse off under EMR, compared to a basecase in which an emissions intensity of 200g$CO_2$/kWh is achieved using existing instruments.

**Table 17: Distributional analysis: Combined EMR impact (CfD with Capacity Market) compared to basecase (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**

| | | NPV, £m (real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Distributional analysis** | | | | |
| **Consumer Surplus** | Wholesale price | 86,000 | 110,000 | 120,000 |
| | Low carbon payments | -18,000 | -28,000 | -37,000 |
| | Capacity payments | -15,000 | -24,000 | -30,000 |
| | System cost savings | 270 | 990 | 1,600 |
| | Unserved energy | 1,400 | 5,100 | 7,200 |
| | **Change in Consumer Surplus** | **55,000** | **67,000** | **59,000** |
| **Producer Surplus** | Wholesale price | -85,000 | -110,000 | -120,000 |
| | Low carbon support | 18,000 | 28,000 | 37,000 |
| | Capacity payments | 15,000 | 24,000 | 30,000 |
| | Producer costs | 37,000 | 45,000 | 46,000 |
| | **Change in Producer Surplus** | **-15,000** | **-14,000** | **-2,300** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-35,000** | **-43,000** | **-43,000** |
| **Net Welfare** | **Change in Net Welfare** | **5,500** | **9,500** | **13,000** |

Source: DECC modelling

138. Up to 2030, the change in consumer surplus under the new analysis is greater than for previous modelling. This is primarily driven by a larger wholesale price impact, which is again due to the higher carbon price in the basecase. However, this difference is smaller after 2030 (due to alternative post-2030 carbon price assumptions under the EMR scenario[119]), so that the change in consumer surplus is now smaller in 2049 than under previous analysis.

139. These changes are mirrored in producer surplus – the change in producer surplus is more negative up to 2030, but less negative when assessed up to 2049.

[119] See Annex E for further detail

### 2.4.1 Institutional costs

140. The institutional costs of EMR consist of both National Grid delivering their EMR functions and those associated with setting up a new institutional body – the single counterparty body. In addition there will be associated administrative costs to energy sector businesses (the costs of which cover the whole of the UK). The total discounted costs (NPV, 2012 -2030) are estimated to range between around £400m to £1.1bn (2012 prices). The costs largely reflect staff, IT, building costs and any external expertise which may be required – both for the institutional body and the energy businesses bidding into the Capacity Market, as well as an estimate of the administrative costs of CfDs on energy sector businesses.[120] They reflect the expected costs of both the CfD and CM instruments. The estimates must be regarded as tentative as the component costs have not yet been fully determined, as they depend on the final agreed activities to be undertaken by the organisations. The table below presents the NPV for EMR, taking into account administrative costs.[121]

**Table 18: NPV with administrative costs (NPV 2012-2030, real 2012, £bn)[122]**

| | NPV – Energy market only | NPV – Energy market and administrative costs* |
|---|---|---|
| **NPV (£bn)** | 10.3 | **9.5** |
| **Of which: CfDs** | 9.9 | **9.4** |
| **Of which: CM** | 0.4 | **0.1** |

*Source: DECC modelling (* These correspond with the impacts presented in the summary section)*

[120] The EMR White Paper IA presented estimates of the costs to energy sector businesses, both generators and suppliers. These include application for CfD allocation and the costs of settlement (see section 3.8). The same CfD energy sector business cost assumptions presented in the White Paper IA are used in this analysis.

[121] A midpoint estimate of around £700m is used. The costs reflect a gross estimate of additional institutional costs from National Grid delivering their EMR functions and those associated with setting up a new institutional body – the single counterparty body under EMR; for example they do not consider what costs might have been in the absence of EMR. For example, they do not consider what the additional institutional costs of greater reliance on carbon pricing or the RO might be in the basecase scenarios.

[122] All 2030 results presented above include an administrative cost adjustment. They are presented here to illustrate the relative differences clearly.

## 2.5 Updated Price and Bill Impacts[123]

141. This section considers the price and bill impacts of the CfD and Capacity Market (based on the strike prices and reliability standard proposed in the draft Delivery Plan). This EMR package is assessed against the basecase described above.

142. Final consumer electricity bills are made up of wholesale energy costs, network costs, metering and other supply costs, supplier margins, VAT and the impacts of energy and climate change policies. Wholesale electricity prices, and therefore bills, are also strongly influenced by the prevailing capacity margin in the wholesale electricity market.

143. The EMR policy package affects electricity bills in three main ways:

- **EMR support costs:** CfD low-carbon payments and capacity payments which are assumed to be funded through electricity bills.
- **Lower RO support costs:** less new generation will be covered by the Renewables Obligation.
- **Wholesale price effect:** resulting from changed generation mix and capacity margins

144. Direct EMR support costs would increase retail prices against the basecase, as it is assumed that the support costs are passed on to consumers by suppliers. Nevertheless, the introduction of CfDs also leads to a reduction in the cost of the Renewables Obligation against the basecase, because relatively fewer plant will receive RO payments.

145. The impact on wholesale prices relative to the basecase varies between years. In general, a decarbonised electricity system should result in a lower average wholesale price, due to a higher proportion of capacity having a relatively low short-run marginal cost. In addition, higher carbon prices under the basecase are assumed to be passed through to consumers through higher wholesale prices, resulting in higher wholesale prices in the basecase, and correspondingly lower prices under EMR.

146. In addition, EMR policies will affect the capacity margin on the system, to deliver larger capacity margins than in the basecase, and therefore contribute to a dampening effect on wholesale prices.

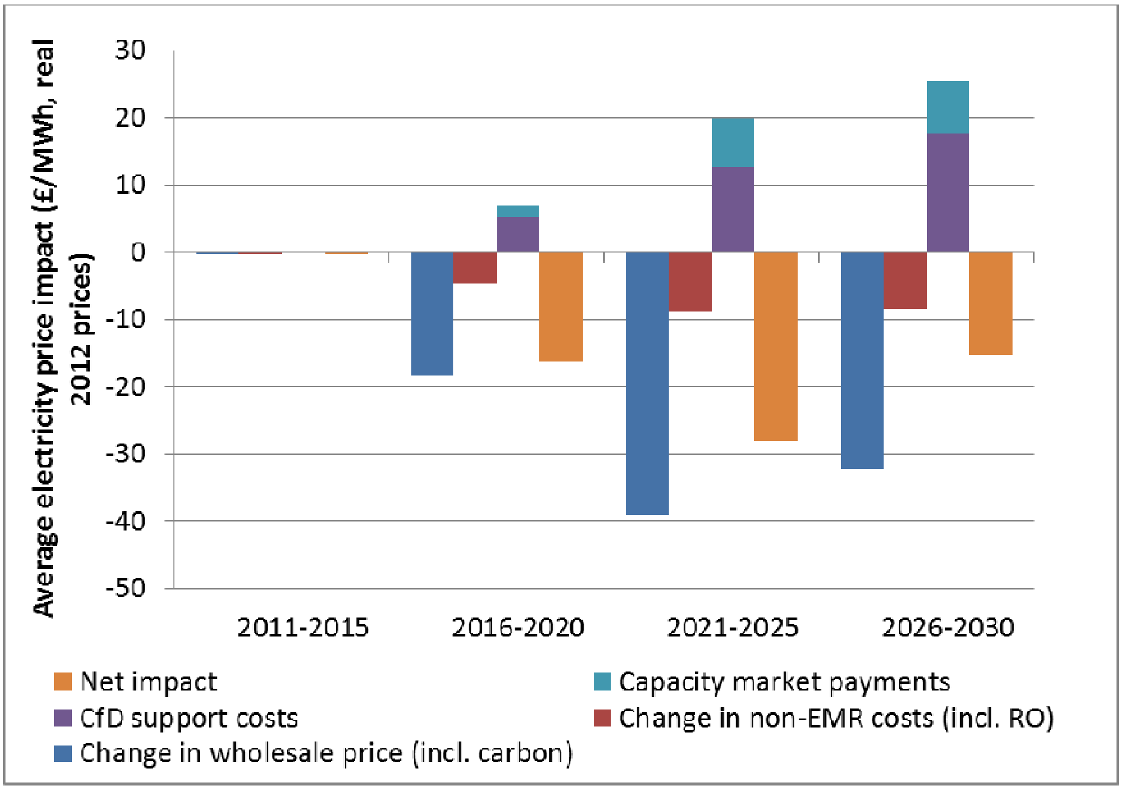
[123] The analysis presented in this IA is based on an agreed set of assumptions, including technology costs and electricity demand at the time the analysis was undertaken, which are set out in Annex A. This approach is consistent with the analysis presented in the Government's latest analysis of the impacts of its energy and climate change policies on energy prices and bills, in March 2013: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/172923/130326_-_Price_and_Bill_Impacts_Report_Final.pdf

147. The charts below present the average net impact of EMR on domestic retail prices, for three different emission intensities in 2030 (100g$CO_2$/kWh, 50g$CO_2$/kWh and 200g$CO_2$/kWh).

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

148. Relative to the base case, EMR results in lower average retail prices over the 2016-2030 period.[124] Over the period 2016-2030, domestic prices would be around 9% lower under EMR on average, in comparison to what they would be under the basecase. Despite the increases due to EMR support payments, lower wholesale prices and smaller RO support costs offset this increase in all periods, resulting in lower prices relative to the basecase.[125]

**Chart 2: Net Impact of EMR on domestic electricity prices, relative to basecase[126] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




*Source: DECC modelling*

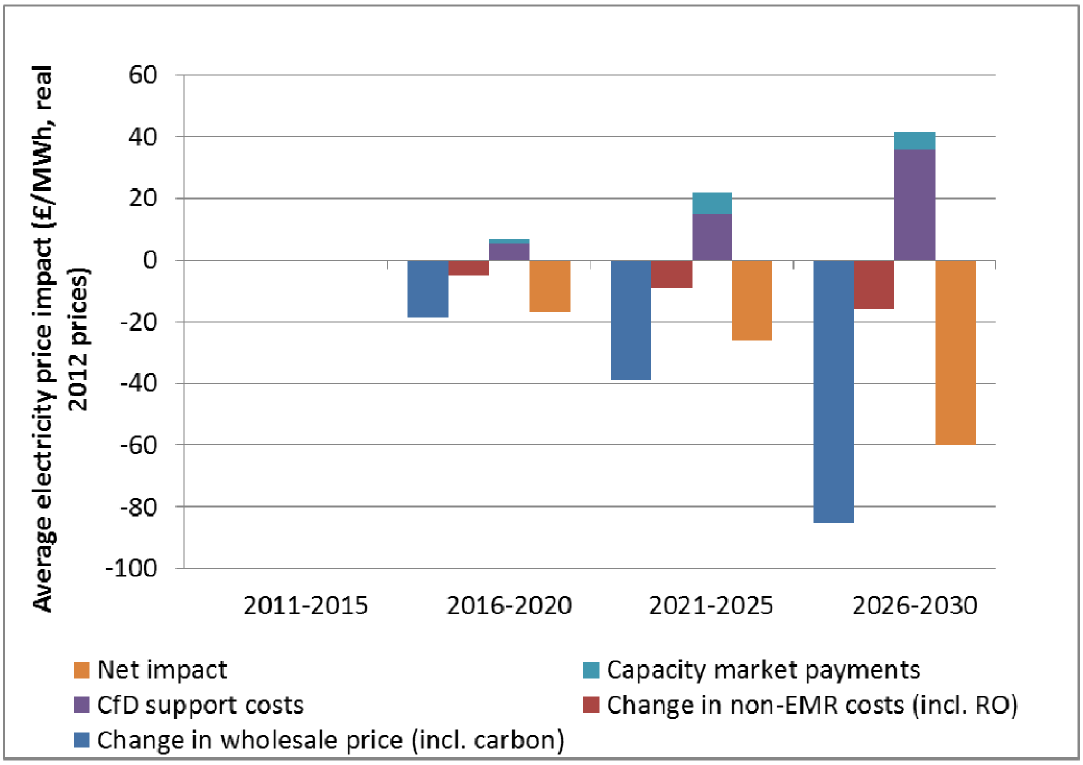
*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

149. Relative to a basecase in which an emissions intensity of 50g$CO_2$/kWh in 2030 is targeted using existing instruments, EMR still results in lower retail prices over the 2016-

[124] Within the modelling EMR support costs begin in 2016, therefore the price and bill impacts are averaged over the period 2016 to 2030.
[125] Much of the lower wholesale costs under EMR reflect the lower carbon prices relative to the basecase, as CfDs are used to incentivise nuclear and CCS investment in place of additional carbon pricing.
[126] Non-EMR costs principally refer to lower Renewables Obligation support costs as a result of EMR.

2030 time period – it is estimated that average domestic electricity prices would be 14% lower under EMR. The cost to consumers of EMR support payments is again outweighed by lower wholesale prices and smaller RO support costs in all periods, resulting in lower prices relative to the basecase, becoming increasingly lower over time. This is particularly the case for the 2026-2030 period, when average domestic prices are 22% (£60/MWh) lower than the basecase.

**Chart 3: Net Impact of EMR on Domestic Electricity prices, relative to 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

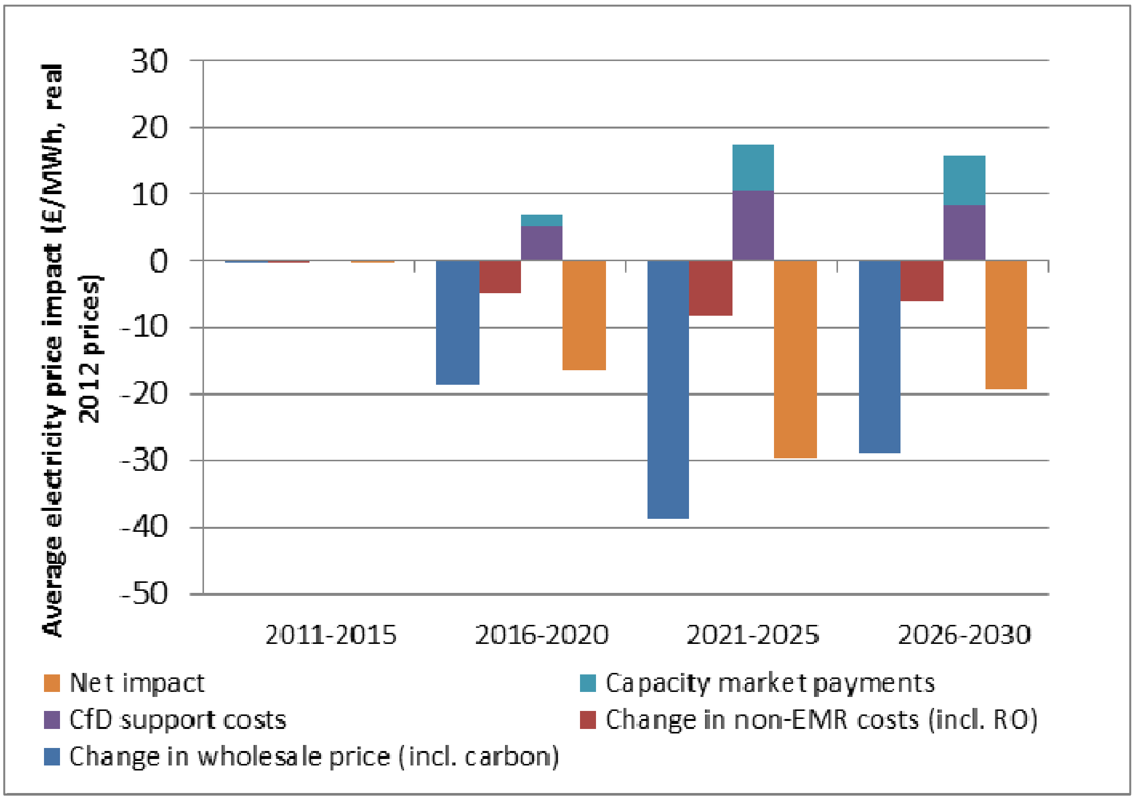



*Source: DECC modelling*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

150. Relative to a basecase in which an emissions intensity of 200g$CO_2$/kWh in 2030 is targeted using existing instruments, EMR still results in lower retail prices over the 2016-2030 time period – it is estimated that average domestic electricity prices would be 10% lower under EMR. The cost to consumers of EMR support payments is again outweighed by lower wholesale prices and smaller RO support costs in all periods, resulting in lower prices relative to the basecase. However, there is a slight change in the profile of these impacts, as the greatest reduction is in the 2021-2025 period, when average domestic prices are estimated to be 13% (£30/MWh) lower.

**Chart 4: Net Impact of EMR on Domestic Electricity prices, relative to 200g basecase (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




*Source: DECC modelling*

### 2.5.1 Bill Impacts by consumer type

151. The impact of the EMR package on bills for different types of consumer, distinguishing between domestic, non-domestic and energy-intensive users, are presented in Table 19 to Table 23.

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

<u>Domestic customers</u>

152. For domestic consumers, EMR has the potential to reduce average annual household electricity bills by around 9% (£63) over the period 2016-2030, relative to a basecase which achieves the same decarbonisation objective using existing policy instruments[127]. Household bills would be lower under EMR, reflecting the higher carbon prices in the basecase, and therefore the benefit to consumers of incentivising low-carbon investment using CfDs.

[127] In the Draft Delivery Plan a bill reduction of £62 was reported. That estimate did not reflect higher RO support costs payments in Northern Ireland under the basecase, relative to those assumed under EMR. This IA adjusts the RO support costs under the basecase to reflect the higher volume of renewables delivered via the RO in the basecase.

**Table 19: Domestic Bill Impacts[128] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | Bill under basecase(s), £ | Change in bill as a result of EMR, £ (%) |
|---|---|---|
| Domestic, (£) real 2012 prices | | |
| 2011-2015 | 567 | - |
| 2016-2020 | 649 | -£50 (-8%) |
| 2021-2025 | 719 | -£86 (-12%) |
| 2026-2030 | 760 | -£52 (-7%) |
| **2016-2030** | **709** | **-£63 (-9%)** |

*Source: DECC modelling*

Non-domestic customers

153. The table below presents the impact of EMR on non-domestic electricity bills. Average annual bills are around 10% lower under EMR for the period 2016-2030, relative to the basecase. Electricity bills are estimated to be 13% lower on average under EMR over the period 2021-2025 and around 7% lower for the period 2026-2030, in comparison to the basecase.

**Table 20: Non-domestic Bill impacts (with CRC)[129] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | Bill under basecase(s), £000's | Change in bill as a result of EMR, £000's (%) |
|---|---|---|
| Non-Domestic, with CRC (£ 000's) (rounded) real 2012 prices | | |
| 2011-2015 | 1,090 | - |
| 2016-2020 | 1,480 | -150 (-10%) |
| 2021-2025 | 1,730 | -230 (-13%) |
| 2026-2030 | 1,690 | -120 (-7%) |
| **2016-2030** | **1,630** | **-160 (-10%)** |

*Source: DECC modelling*

Energy-intensive industry

154. The table below presents the modelled bill impacts of EMR on Energy-Intensive Industries (EII). The modelling suggests EMR could reduce annual average EII electricity

[128] Results for the household sector are based on a representative average annual electricity demand level for households, derived from historical total domestic consumption, and is set at 4.5MWh of electricity per year (before policies).

[129] Non-domestic users are based on the consumption of a medium-sized fuel user in industry, with an electricity usage of 11,000 MWh per year (before policies), and includes the effects of the CRC. Bills and impacts will vary with electricity consumption. Similar impacts will occur for non-CRC non-domestic users.

bills by around 11% relative to the basecase (over the period 2016-2030). The greatest reduction is achieved over the period 2021-2025, when average annual electricity bills are estimated to be around 14% lower under EMR, in comparison to the basecase.[130]

**Table 21: Energy Intensive Industry (EII) Bill impacts[131] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | Bill under basecase(s) £000's | Change in bill as a result of EMR, £000's (%) |
|---|---|---|
| EII, (£ 000's) (rounded) real 2012 prices | | |
| 2011-2015 | 7,930 | -10 (-0.1%) |
| 2016-2020 | 11,730 | -1,300 (-11%) |
| 2021-2025 | 14,380 | -2,060 (-14%) |
| 2026-2030 | 13,900 | -1,000 (-7%) |
| **2016-2030** | **13,330** | **-1,450 (-11%)** |

*Source: DECC modelling*

*Security of supply impacts*

155. In addition, as discussed above, the impact of EMR on consumer bills will reflect the impact of decarbonising and mitigating against security of supply risks. EMR bill impacts therefore reflect the combined impact of decarbonising through CfDs, relative to existing instruments, and the cost of mitigating against security of supply risks through the Capacity Market (which the basecase does not).

156. The Capacity Market is estimated to **add around £17 to average annual household bills from 2016 to 2030**[132]. However, in practice the costs of a Capacity Market could be lower, as it should help reduce financing costs for investment in new capacity.

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

157. Relative to the 100g basecase scenario outlined above, the impact on domestic bills from using EMR to target an emissions intensity of 50g$CO_2$/kWh in 2030 is higher – i.e. EMR achieves a larger reduction in bills, when compared to a basecase of achieving the same emissions intensity using existing instruments. For example, the average reduction over the period 2016-2030 for domestic customers is £111. Under such a scenario, the

[130] As announced in the Chancellor's Autumn Statement 2011, the Government is exploring ways to mitigate the impact of electricity costs arising from EMR on the most Energy-Intensive Industries (EIIs), where this significantly impacts their competiveness, and subject to value for money and State Aid considerations. The work to deliver this exemption will be part of the EMR programme, delivering on the same timescale, subject to further consultation. Currently, no exemption is assumed in this analysis.

[131] For the energy-intensive industry sector, illustrative users consume (before policies) 100,000MWh of electricity. Bills and impact will vary with amount of electricity consumption.

[132] However, this includes 3 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

Capacity Market is estimated to increase average annual household bills by around £14 over the period 2016 to 2030[133].

**Table 22: EMR Bill Impacts relative to 50g basecase (assumed emissions intensity in 2030 = 50gCO2/kWh)**

| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 567 | - | 1,090 | - | 7,930 | -10 (-0.1%) |
| 2016-2020 | 649 | -50 (-8%) | 1,480 | -150 (-10%) | 11,740 | -1,310 (-11%) |
| 2021-2025 | 718 | -80 (-11%) | 1,720 | -210 (-12%) | 14,300 | -1,900 (-13%) |
| 2026-2030 | 927 | -201 (-22%) | 2,120 | -510 (-24%) | 17,700 | -4,530 (-26%) |
| **2016-2030** | **765** | **-111 (-14%)** | **1,770** | **-290 (-16%)** | **14,580** | **-2,580 (-18%)** |

*Source: DECC modelling*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

158. Relative to the 100g scenario outlined above, the impact on domestic bills from using EMR to target an emissions intensity of 200g$CO_2$/kWh in 2030 is similar. Decarbonisation through EMR still results in a reduction in bills – 10% in average annual household bills over the period 2016 to 2030, relative to a basecase in which decarbonisation is achieved using existing instruments. However, this reduction is not as great when compared to 50g decarbonisation scenario.

159. Under such a scenario, the Capacity Market is estimated to add around £18 to average annual household bills over the period 2016 to 2030[134].

[133] As for the 100g analysis, this includes 3 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

[134] As for the 100g (and 50g) analysis, this includes 3 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

**Table 23: EMR Bill Impacts relative to 200g basecase (assumed emissions intensity in 2030 = 200gCO2/kWh)**

| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 567 | - | 1,090 | - | 7,930 | -10 (-0.1%) |
| 2016-2020 | 649 | -50 (-8%) | 1,480 | -150 (-10%) | 11,730 | -1,300 (-11%) |
| 2021-2025 | 718 | -91 (-13%) | 1,730 | -240 (-14%) | 14,380 | -2,190 (-15%) |
| 2026-2030 | 754 | -65 (-9%) | 1,700 | -160 (-10%) | 13,970 | -1,440 (-10%) |
| **2016-2030** | **707** | **-69 (-10%)** | **1,640** | **-180 (-11%)** | **13,360** | **-1,640 (-12%)** |

*Source: DECC modelling*

*Conclusion*

160. Energy prices are volatile, and there are significant uncertainties around estimates, in particular, of wholesale electricity prices for the next 20 years. Therefore these estimates are likely to change further, as projections change over time. However, the latest results suggest that average electricity bills are likely to be lower under EMR, relative to a basecase that achieves the same decarbonisation ambition using existing policy instruments, across a range of potential decarbonisation ambitions (50g, 100g and 200g$CO_2$/kWh in 2030) – this reinforces the cost-effectiveness of EMR as a tool for decarbonising the power sector.

### 2.5.2 Wider Impacts

161. Changes in electricity bills will have impacts on the wider economy. These have not been quantified here. However, household disposable income will be impacted by electricity prices and the competitiveness of UK industry is also affected by the impact of EMR measures on businesses electricity bills.

162. The Government has recently announced its intention to adopt a new measure of fuel poverty, based on the Low Income High Costs framework outlined by Professor John Hills in his independent review of fuel poverty[135]. Revised estimates of fuel poverty using this new approach will be published on 8th August 2013. Following this, we will be able to provide updated projections for future fuel poverty levels under the different (EMR) scenarios.

163. As set out in the EMR White paper IA, it is not envisaged that the EMR options consulted on will impact measures of equality as set out in the Statutory Equality Duties

[135] https://www.gov.uk/government/publications/fuel-poverty-a-framework-for-future-action

Guidance.[136] Specifically, options would not have different impacts on people of different racial groups, disabled people and men and women, including transsexual men and women. There are also no foreseen adverse impacts of the options on human rights and on the justice system.

[136] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf

## Section 3 Update on CfD payment model

164. Investment costs of capital for projects are determined by risk and reward. The relative riskiness of a project will affect the hurdle rates of each provider of capital (including project lenders) as well as the level of gearing, thus in turn affecting the weighted average cost of capital for that project. Generators need to manage a range of risks in order to operate effectively in the wholesale market. The FiT CfD specifically addresses the price risks faced by low-carbon generation (subject to receiving the reference price), and this forms the basis of the costs of capital assessment set out as part of the cost-benefit analysis above.

165. Importantly, the analysis assumes that contracts are bankable, to ensure that the necessary certainty to industry is provided. Stakeholders raised concerns that this might not be the case, in relation to the payment model proposed as part of the draft Energy Bill. This was a multi-party arrangement, where effectively all suppliers were counterparty to a legislative instrument in place of a contract. In particular, generators were concerned that this was complex, unclear about what would happen in a dispute, and fused public and private law in a way that could be off-putting to investors.

166. In response to these concerns, the Energy Bill published in November 2012 introduced a single counterparty in the form of a Government-owned company. It will sign contracts with generators and raise monies from suppliers. This is a simpler system that creates a private law contract (a model that investors will be familiar with) and gives certainty through an enforceable statutory obligation that monies will be raised from suppliers. This meets the concerns raised by generators and creates a credible and investable model, as assumed in our analysis.[137]

167. The Energy and Climate Change (ECC) committee reported that they believed a single counterparty body, underwritten by Government, would be the best way to reduce the cost of capital.[138] However, if it was not underwritten, DECC should assess the impacts of this.

168. Whilst the counterparty is owned by Government, payments will come from suppliers to match payments to generators, rather than Government stepping in to make payments. The obligation on suppliers to pay will be in statute and a requirement of their licence, regulated by Ofgem. The risk of supplier default impacting on payment flows is mitigated by a series of backstops that will feature as part of the design of the supplier obligation, including the advance posting of credit and collateral to cover any payment period and the mutualisation of any remaining unsecured losses across

[137] For further details, please see Chapter 4 of Annex A of the documents supporting the Energy Bill, published in November 2012, available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65635/7077-electricity-market-reform-annex-a.pdf

[138] http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/275/275.pdf

suppliers. In the event of an insolvency, the ‘supplier of last resort’ regime, which effectively moves customers to a new supplier, and the Energy Company Administration Scheme, whereby an administrator continues to supply and meet obligations, would be in place to ensure that payments would continue.

169. Therefore Government believes that this model provide investors with a credible counterparty.

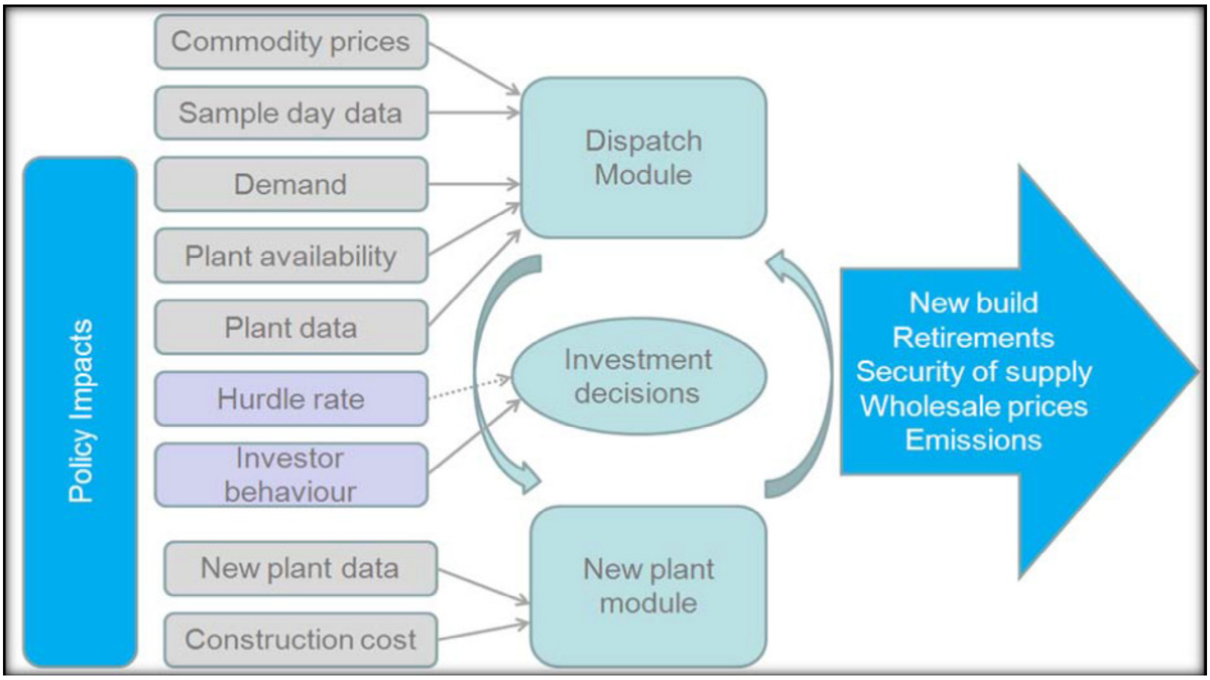
## Annex A: The Dynamic Dispatch Model (DDM)

170. The Dynamic Dispatch Model (DDM) is a comprehensive fully integrated power market model covering the GB power market over the medium to long term. The model enables analysis of electricity dispatch from GB power generators and investment decisions in generating capacity from 2010 through to 2050. It considers electricity demand and supply on a half hourly basis for sample days. Investment decisions are based on projected revenue and cashflows allowing for policy impacts and changes in the generation mix. The full lifecycle of power generation plant is modelled, from construction through to decommissioning. The DDM enables analysis comparing the impact of different policy decisions on generation, capacity, costs, prices, security of supply and carbon emissions, and also outputs comprehensive and consistent Cost-Benefit Analysis results.

### Overview

171. The DDM is an electricity supply model, which allows the impact of policies on the investment and dispatch decisions to be analysed. Figure 1 illustrates the structure of the model.

**Figure 1: Structure of the Dynamic Dispatch Model (DDM)**




The purpose of the model is to allow DECC to compare the impact of different policy decisions on capacity, costs, prices, security of supply and carbon emissions in the GB power generation market.

### Dispatch Decisions

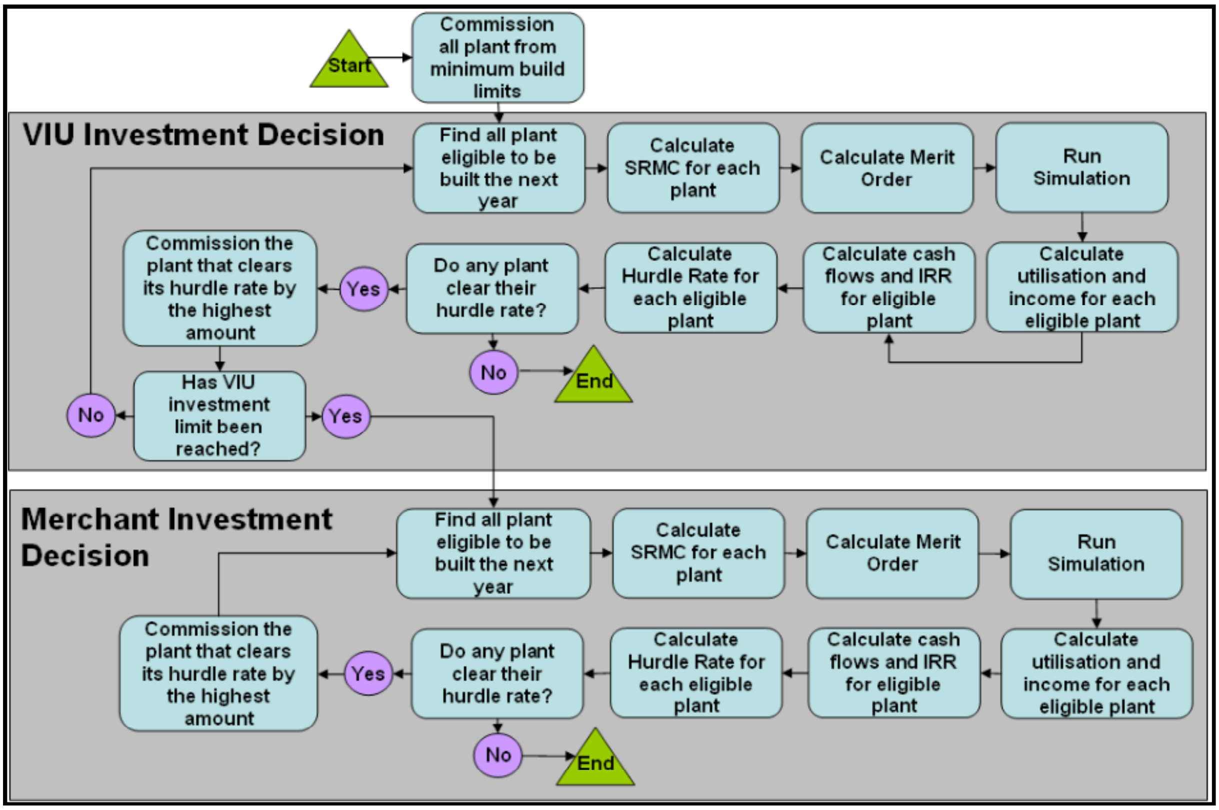
172. Economic, energy and climate policy, generation and demand assumptions are external inputs to the model. The model runs on sample days, including demand load curves for both business and non-business days, including seasonal impacts and are

variable by assumptions on domestic and non-domestic sectors and smart meter usage. Also, there are 3 levels of wind and solar load factor data applied to the sample days to reflect the intermittency of solar power, on- and offshore wind. The generation data includes outage rates, efficiencies and emissions, and also planned outages and probabilities of unplanned outages.

173. The Short Run Marginal Cost (SRMC) for each plant is calculated which enables the calculation of the generation merit order. Demand for each day is then calculated taking wind profiles into account and interconnector flows, pumped storage, autogeneration and wind generation. Once the required reserve is calculated the system SRMC is calculated by matching the demand against the merit order and taking the SRMC of the marginal plant to meet demand. The wholesale price is equal to the system marginal price plus the mark up. The mark up is derived from historic data and reflects the increase of system marginal price above marginal costs at times of reduced capacity margins. Plant income and utilisation are calculated and carbon emissions, unserved energy, and policy costs are reported.

**Investment Decisions**

**Figure 2. Investment decisions in the DDM**




174. The model requires input assumptions of the costs and characteristics of all generation types, and has the capability to consider any number of technologies. In investment decision-making, the model considers an example plant of each technology and estimates revenue and costs in order to calculate an IRR. This is then compared to a

user-specified, technology-specific hurdle rate and the plant that clears the hurdle rate by the most is commissioned. This is then repeated allowing for the impact of plants built in previous iterations until no plant achieves the required return or another limit is reached. The model is also able to consider investment decisions of both Vertically Integrated Utilities (VIUs) and merchant investors (see Figure 2). Limitations can be entered into the model such as minimum and maximum build rates per technology, per year, and cumulative limits.

**Policy Tools**

175. The model is able to consider many different policy instruments, including potential new policies as well as existing ones. Policies are implemented by making adjustments to plant cashflows which either encourage or discourage technology types from being built in future and impact on their dispatch decisions. The policy modelling has been designed flexibly and policies can be applied to all technologies or specific ones, only new plants or include existing plants and can be varied over time and duration. Policies can be financed through Government spending/taxation or charged to consumers.

**Outputs**

176. The model can be run in both deterministic and stochastic modes – this enables analysis to be carried out with different levels of randomness, allowing for more realistic treatment of uncertainty to be incorporated into the model outputs and better understanding of investment behaviour. The model outputs many metrics on the electricity market and individual plant that enables the policy impacts to be interpreted. Using these outputs a Cost Benefit Analysis is carried out on the model run including a distributional analysis.

177. The DDM therefore enables analysis to be carried out on policy impacts in different future scenarios, allowing DECC to consider and compare the estimated impacts of different potential policies on the electricity market.

**Peer Review**

178. The model was peer reviewed by external independent academics to ensure the model is fit for the purpose of policy development. Professors David Newbery and Daniel Ralph of the University of Cambridge undertook a peer review to ensure the model met DECC's specification and delivered robust results. The DDM was deemed an impressive model with attractive features and good transparency. For the Peer Review report see 'Assessment of LCP's Dynamic Dispatch Model for DECC' (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48385/5427-ddm-peer-review.pdf).

**Levy Control Framework**

179. On 23 November 2012, the Government agreed a Levy Control Framework (LCF) to 2020/21, which is set at a total of £7.6bn (in real, 2012 prices).[139] This will help diversify our energy mix by increasing the amount of electricity coming from renewables (from 11% today to just over 30% by 2020), as well as supporting new nuclear power and carbon capture and storage commercialisation. It also helps to provide certainty to investors across a range of generation technologies and protection to consumers.

**Scenario-based analysis**

180. The baseline for DDM analysis represents a plausible outcome of Electricity Market Reforms, characterised by a diversified supply mix[140] and an assumed carbon emissions intensity of 100g$CO_2$/kWh in 2030, which is an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments.

181. Dispatch modelling is sensitive to a number of such assumptions (e.g. around inputs, methodology), which influence the capacity and generation mix realised under different scenarios (as discussed further in Annex C). This outcome therefore represents a specific state of the world and is not intended to be a prediction or forecast about what the future is expected to be.

[139] https://www.gov.uk/government/news/government-agreement-on-energy-policy-sends-clear-durable-signal-to-investors

[140] Diversification reflects (in part) the objective of support for the development of a portfolio of low-carbon generation technologies, in order to reduce the technology risks associated with the decarbonisation objective for the power sector

**Input assumptions**
**Fossil fuel price assumptions**

DECC's fossil fuel price assumptions are used in the DDM as set out below to 2030. Details can be found at: https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

| 2012 prices | Oil | | | Gas | | | Coal | | |
|---|---|---|---|---|---|---|---|---|---|
| | $/bbl | | | p/therm | | | $/tonne | | |
| | **Low** | **Central** | **High** | **Low** | **Central** | **High** | **Low** | **Central** | **High** |
| 2012 | 111.6 | 111.6 | 111.6 | 60.1 | 60.1 | 60.1 | 92.3 | 92.3 | 92.3 |
| 2013 | 93.0 | 107.7 | 122.4 | 53.0 | 62.3 | 71.7 | 85.0 | 89.5 | 94.0 |
| 2014 | 91.8 | 109.0 | 125.7 | 50.6 | 65.3 | 86.4 | 85.9 | 95.6 | 105.2 |
| **2015** | 90.5 | 110.4 | 129.0 | 48.3 | 68.3 | 88.7 | 86.7 | 101.8 | 110.4 |
| 2016 | 89.2 | 111.7 | 132.4 | 45.9 | 69.1 | 91.1 | 87.6 | 105.5 | 115.6 |
| 2017 | 88.1 | 113.0 | 135.9 | 43.7 | 70.7 | 93.4 | 88.3 | 109.2 | 120.8 |
| 2018 | 86.8 | 114.4 | 139.6 | 41.3 | 72.3 | 95.9 | 89.2 | 112.9 | 126.0 |
| 2019 | 85.6 | 115.8 | 143.2 | 41.3 | 72.3 | 98.4 | 90.0 | 116.7 | 131.1 |
| **2020** | 84.4 | 117.2 | 147.0 | 41.3 | 72.3 | 101.1 | 90.9 | 120.4 | 136.3 |
| 2021 | 83.3 | 118.6 | 150.9 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 141.6 |
| 2022 | 82.1 | 120.1 | 154.9 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 146.8 |
| 2023 | 81.0 | 121.5 | 159.1 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 152.0 |
| 2024 | 79.8 | 123.0 | 163.3 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 157.2 |
| **2025** | 78.7 | 124.5 | 167.6 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |
| 2026 | 77.7 | 126.0 | 172.0 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |
| 2027 | 76.6 | 127.5 | 176.6 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |
| 2028 | 75.5 | 129.1 | 181.3 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |
| 2029 | 74.5 | 130.7 | 186.1 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |
| **2030** | 73.5 | 132.2 | 191.0 | 41.3 | 72.3 | 103.2 | 90.9 | 120.4 | 162.4 |

## Carbon Prices

The DDM uses DECC's projected carbon price for the traded sector as well as the appraisal values of carbon, as set out below.

**Projected EU-ETS carbon price for the traded sector, 2012 £/tonne of $CO_2e$**

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Central** | 6 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 15 | 22 | 29 | 35 | 42 | 49 | 56 | 62 | 69 | 76 |

**DECC appraisal values for greenhouse gas emissions impacts in the traded sector, 2012 £/tonne of $CO_2e$**

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Central** | 6 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 15 | 22 | 29 | 35 | 42 | 49 | 56 | 62 | 69 | 76 |

In addition to this the Carbon Price Floor is included in the model following the trajectory set out in the government's response to the consultation on the Carbon Price Floor:
http://www.hm-treasury.gov.uk/d/carbon_price_floor_consultation_govt_response.pdf

**Carbon Price Floor, 2012 £/tonne of $CO_2e$**

| 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 14 | 21 | 23 | 25 | 28 | 30 | 32 | 36 | 41 | 45 | 49 | 53 | 58 | 62 | 66 | 70 | 75 |

## Technology Assumptions

Cost and technical data for new plant is taken from DECC's Electricity Generation Costs 2013 report for all renewable and non-renewable technologies. Details can be found at:

https://www.gov.uk/government/publications/electricity-generation-costs

**Hurdle Rate Reductions by technology type under FiT CfDs**

| Technology type | Reductions under FiT CfDs* (percentage points) | Reductions under previous analysis (percentage points) |
|---|---|---|
| ACT advanced | -0.6 | - |
| ACT CHP | -0.4 | - |
| ACT standard | -0.4 | - |
| AD >5MW | -0.6 | - |
| AD CHP | -0.7 | - |
| Biomass Conversion | -0.7 | 0.0 |
| Coal CCS | -1.0 | 0.0 |
| Dedicated Biomass CHP | -0.8 | 0.0 |
| EfW CHP | -0.7 | - |
| Gas CCS | -0.7 | 0.0 |
| Geothermal | -1.4 | - |
| Geothermal CHP | -1.5 | - |
| Hydro | -0.3 | - |
| Landfill gas | -0.4 | - |
| Large Solar Photo-Voltaic | -0.4 | - |
| Nuclear | -1.5 | -0.8 |
| Offshore Wind R3** | -0.6 | -1.1 |
| Offshore Wind** | -0.6 | -1.2 |
| Onshore Wind | -0.4 | -0.5 |
| Sewage Gas | -0.4 | - |
| Tidal stream (pre-commercial) | -0.7 | -1.0 |
| Wave (pre-commercial) | -0.6 | -1.0 |

*These have been updated for the Effective Tax Rate work, explained further in DECC's Electricity Generation Costs 2013 report: https://www.gov.uk/government/publications/electricity-generation-costs

**There is unlikely to be a clear distinction between all R2 and all R3 projects, as pre-tax real hurdle rates will vary on a project-by-project basis

**Electricity Demand**

The DDM uses Electricity Demand from the 2012 Updated Emissions Projection (UEP). These can be found in Annex C of the following link:

https://www.gov.uk/government/publications/2012-energy-and-emissions-projections

Note: The UEP numbers are then adjusted downwards by 2.7% before use in the DDM model as they include Northern Ireland, while the DDM models Great Britain alone. Northern Ireland is reflected in the modelling through the analysis conducted by National Grid and the System Operator Northern Ireland (SONI), as presented in the draft Delivery Plan.[141]

Electricity demand post 2030 is based on assumptions consistent with the Carbon Plan. This can be found at the following link.

http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48073/2270-pathways-to-2050-detailed-analyses.pdf

**Upper limits to electricity policy spending under LCF (£bn, 2011/12 prices)**

| 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 |
|---|---|---|---|---|---|
| 4.30 | 4.90 | 5.60 | 6.45 | 7.00 | 7.60 |

141 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223655/emr_consultation_annex_e.pdf

## Annex B: CBA Categories

### Net welfare

Net welfare is the sum of a number of quantities, defined below.

### Carbon costs

The total carbon emissions for a year are multiplied by the appraisal value in that year to determine the total carbon costs for that year. An increase in carbon cost, other things remaining constant, leads to a decrease in net welfare.

In valuing emissions, the UK Government adopts a target-consistent approach, based on estimates of the abatement costs that will need to be incurred in order to meet specific emissions reduction targets.[142] Policies that change emissions in sectors covered by the EU Emissions Trading System (ETS), and in the future other trading schemes, are appraised using the "traded price of carbon (TPC)". This is based on estimates of the future price of EU emissions Allowances (EUAs) and, in the longer term, estimates of future global carbon market prices. Up to 2020, the TPC is the estimated price of EUAs.

From 2030, the working assumption is that there will be a functioning global carbon market with a price of £70/tCO2e in 2030, rising to £200/tCO2e in 2050 (2009 prices) – i.e. that the Carbon Price Floor is non-binding after 2030[143]. During the adjustment phase between the EU and global carbon markets, the appraisal value is linearly interpolated between the values in 2020 and 2030. Therefore, after 2020 the appraisal value is above the EUA price estimates.

### Generation costs

Generation costs are the sum of variable and fixed operating costs. The carbon component of the variable operating costs is removed – the EUA price is accounted for in the carbon costs, and the carbon price floor cost is a transfer between producers and the Exchequer so appears in the surplus calculations but not in the net welfare. An increase in generation costs leads to a decrease in net welfare.

### Capital costs[144]

All new build is included (plants built by the model, and pipeline plants). Construction costs are annuitised over the economic lifetime of the plant, based on the hurdle rate[145]. An increase in capital costs leads to a decrease in net welfare.

[142] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68764/122-valuationenergyuseggemissions.pdf

[143] This means that the carbon price is appraised at the appraisal value, rather than the CPF

[144] This is distinct from the cost of capital, which is the overall required return on investment and, as such, it is often used to determine the economic feasibility of a project. When assessing the return on a particular project, the cost of capital is the discount rate used for cash flows and is affected by the relative proportions of debt and equity financing employed.

**System costs**

System costs are the sum of the costs of building and operating the electricity system (TNUoS and BSUoS costs). These costs are calculated by National Grid models, based on DDM outputs. An increase in system costs leads to a reduction in net welfare.

For network infrastructure costs, the model currently focuses on transmission costs (TNUoS), as this is the main infrastructure needed to connect large-scale generation. As we continue to develop and refine our modelling, we will explore the possibility of including more distribution-related costs (DUoS).

It has not been possible to include inertia costs. However, we do not believe that such would have a significant impact to the cost-benefit analysis in this impact assessment. Nevertheless, in the interests of completeness we will look to incorporate them in the future.

**Unserved energy**

Expected unserved energy is estimated using an Unserved Energy Module in addition to the DDM. This takes plant outage probabilities, technology mix, demand and historical wind data and uses stochastic modelling to estimate a probability distribution of energy unserved. The mean unserved energy is valued at VOLL (defined by the user, assumed to be £17,000/MWh[146]). An increase in unserved energy leads to a decrease in net welfare.

**Interconnectors**

This measures the cost of electricity imported via the interconnectors net of the value of exports. If imports are greater or wholesale prices are higher than the cost of imported electricity is increased, scored as a reduction in net welfare.

**Consumer surplus**

Consumer surplus is the sum of a number of quantities, defined below.

- ***Wholesale price***
  This is the wholesale cost of electricity calculated by taking total demand in each year, subtracting off auto-generation and DSM, and multiplying by the volume-weighted electricity price in that year. An increase in the total cost of electricity consumed leads to a decrease in the consumer surplus.

- ***Low-carbon payments***

[145] The hurdle rate reflects the minimum required rate of return which evidence suggests is necessary for a project or investment to proceed
[146] As before, this has been revised upwards from £10,000/MWh on the basis of evidence gathered through an independent externally-commissioned report by London Economics (http://www.londecon.co.uk/publication/estimating-the-value-of-lost-load-voll)

This is the sum of all subsidy payments e.g. ROCs, LECs and CfDs. As these are assumed to be paid (either directly or indirectly) by consumers, an increase in subsidy payments leads to a decrease in the consumer surplus.

Low carbon payments are a transfer between consumers and producers.

- ***Capacity payments***

This is the sum of capacity payments. An increase in capacity payments leads to a decrease in the consumer surplus.

Capacity payments are a transfer between consumers and producers.

- ***Unserved energy***

This is calculated in the same way as for the net welfare calculation.

**Producer surplus**

Producer surplus is the sum of a number of quantities, defined below.

- ***Wholesale price***

This is calculated in a similar way to the same entry in the consumer surplus, except that total demand is defined as total demand minus autogeneration, DSM and net interconnector generation, and the sign is opposite. Interconnectors are excluded because producers in the UK do not receive any benefit from electricity delivered from the interconnector. An increase in the wholesale price leads to an increase in the producer surplus.

- ***Low carbon support price***

This is calculated in the same way as for consumers but has the opposite sign. An increase in low carbon support leads to an increase in the producer surplus.

- ***Capacity payments***

This is calculated in the same way as for consumers but has the opposite sign. An increase in capacity payments leads to an increase in the producer surplus.

- ***Producer costs***

This is the sum of carbon costs, generation costs, capital costs and the additional carbon cost imposed by the carbon price floor. An increase in producer costs leads to a decrease in the producer surplus.

**Environmental tax**

This is the amount received by the Exchequer as a result of the carbon price floor. This is effectively the Exchequer surplus. An increase in environmental tax revenue leads to a increase in the Exchequer surplus.

Environmental tax is a transfer between producers and the Exchequer.

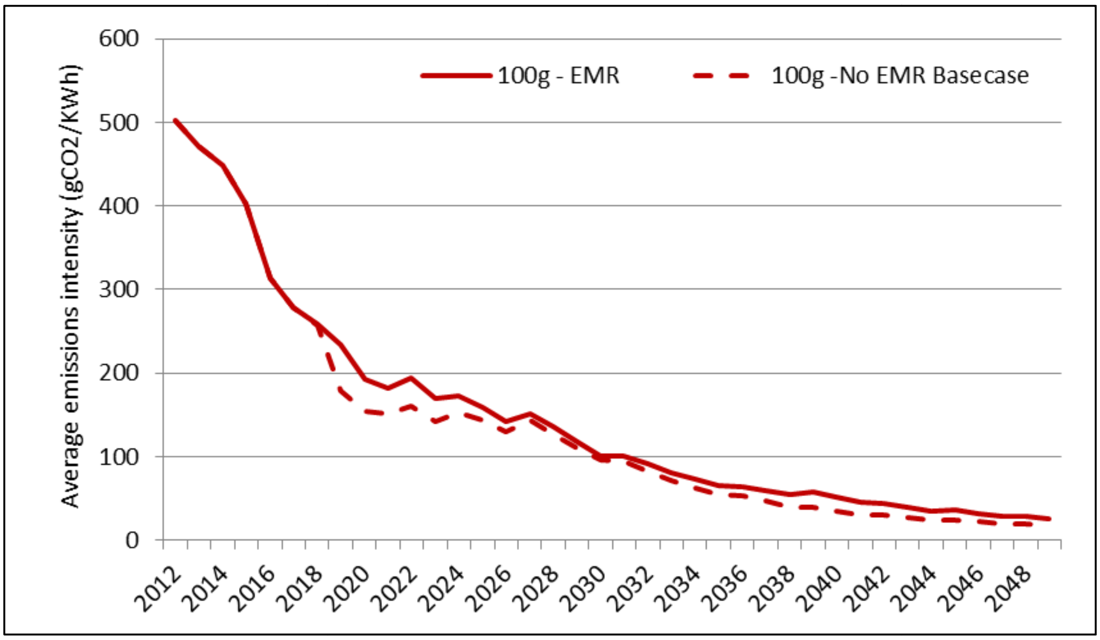
## Annex C: Basecase – decarbonisation trajectory and generation mix

### Decarbonisation Profiles

*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

182. Chart 5 below presents the decarbonisation profiles under EMR and basecase in the 100g decarbonisation scenario. The introduction of a higher carbon price to incentivise nuclear investment under the basecase results in a sharper reduction in emissions around 2020. Within the modelling, the higher carbon price in 2019 to incentivise investment in nuclear at the same rate as under EMR has additional impacts on the modelled generation mix. In response to the higher carbon price level under the basecases, unabated coal plants retire more quickly than they do under EMR, and as a result gas generation substitutes for coal generation in the basecase scenarios.[147] As a consequence, the basecases have a lower emission intensity level in the early 2020s.

**Chart 5: Decarbonisation Profiles – EMR and no-EMR basecase (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




*Source: DECC modelling*

183. These higher carbon prices in the basecase, relative to the EMR scenario (as shown in Chart 1 earlier), mean that this lower level of decarbonisation is achieved at greater cost relative to EMR. Looking at the decomposition of these savings (as set out in Table 6 earlier), despite the value of carbon savings being around £1bn lower under EMR up to 2030, these are more than outweighed by the capital cost savings (£7.7bn up to 2030). This is also reflected in the price & bill impacts (as set out in section 2.5), with average

[147] This is a modelling result as a consequence of using carbon pricing to incentivise new nuclear under the basecases. It is highlighted to emphasise differences in generation mix, and should be interpreted as a hypothetical modelling outcome from using carbon prices to decarbonise.

annual household bills for 2016-2030 being around 9% cheaper under EMR, relative to the basecase.

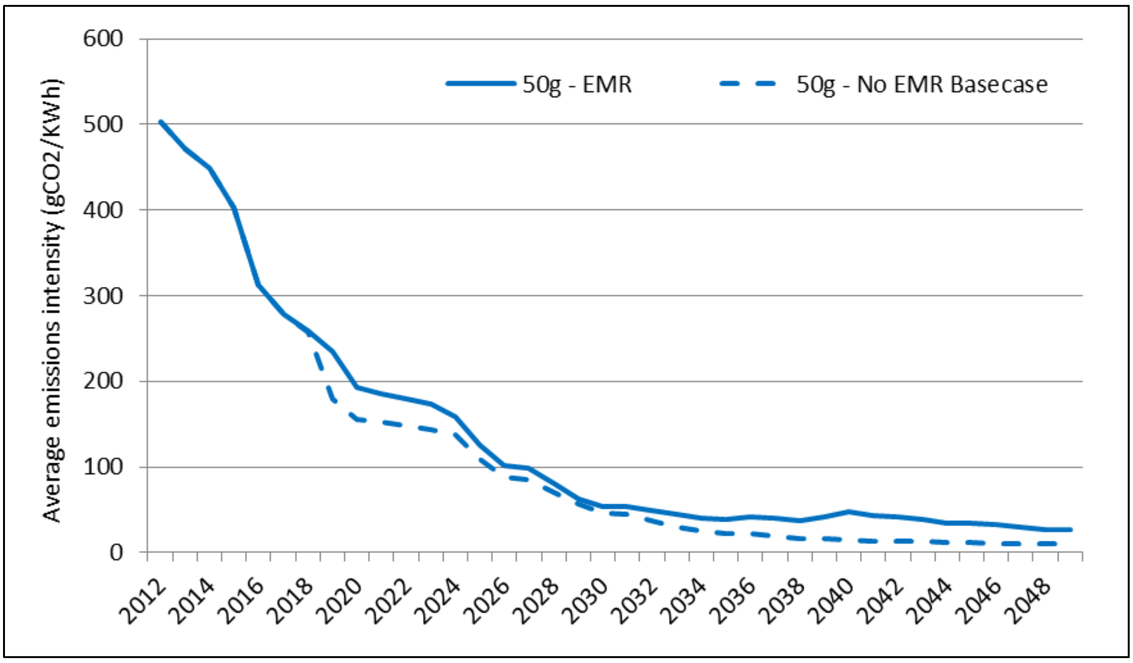
184. The increase in the carbon price in the basecase also has significant impacts on the decarbonisation trajectory during the 2030s and early 2040s. As result of the higher carbon price under the basecase in the late 2020s (in order to bring on CCS, as well as new nuclear plants) a lower decarbonisation profile is achieved during the 2030s, such that the carbon emissions intensity in 2040 (at 34g$CO_2$/kWh) is significantly lower than the EMR scenario (52g$CO_2$/kWh). By 2049 the differences have narrowed but remain (18 and 25g$CO_2$/KWh respectively.

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

185. When targeting an emissions intensity of 50g$CO_2$/kWh in 2030, the decarbonisation trajectory of the EMR scenario is slightly higher up to the late 2020s, when significant increases in the carbon price under the counterfactual are necessary to bring on sufficient low-carbon generation to achieve the required reduction in carbon emissions by 2030.

186. This relatively high level of the carbon price, which persists up to 2050, therefore results in a slightly lower emissions profile than the EMR scenario throughout the remainder of the assessment period.

**Chart 6: Decarbonisation Profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

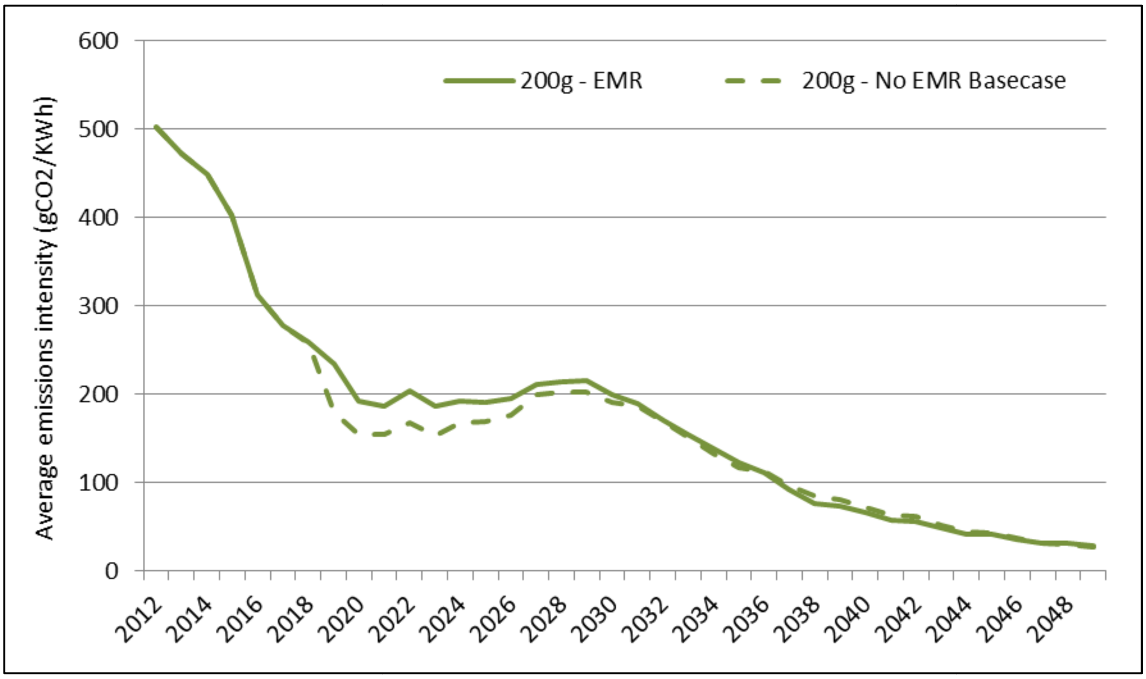



*Source: DECC modelling*

*Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

187. When targeting an emissions intensity of 200g$CO_2$/kWh in 2030, the decarbonisation trajectory of the EMR scenario is again slightly higher at the beginning of the assessment period, but only up to the early 2020s. As the emissions intensity is already below 200g$CO_2$/kWh at this point, the carbon price under the counterfactual does not need to change (i.e. no further low-carbon generation needs to be induced) in order to meet the 2030 target. As such, the average emissions profile of both the EMR scenario and the counterfactual rise over this period. The carbon price remains flat from 2030, which produces a similar emissions profile to that achieved under EMR.

**Chart 7: Decarbonisation Profiles – EMR and 200g basecase (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




*Source: DECC modelling*

## Generation mix

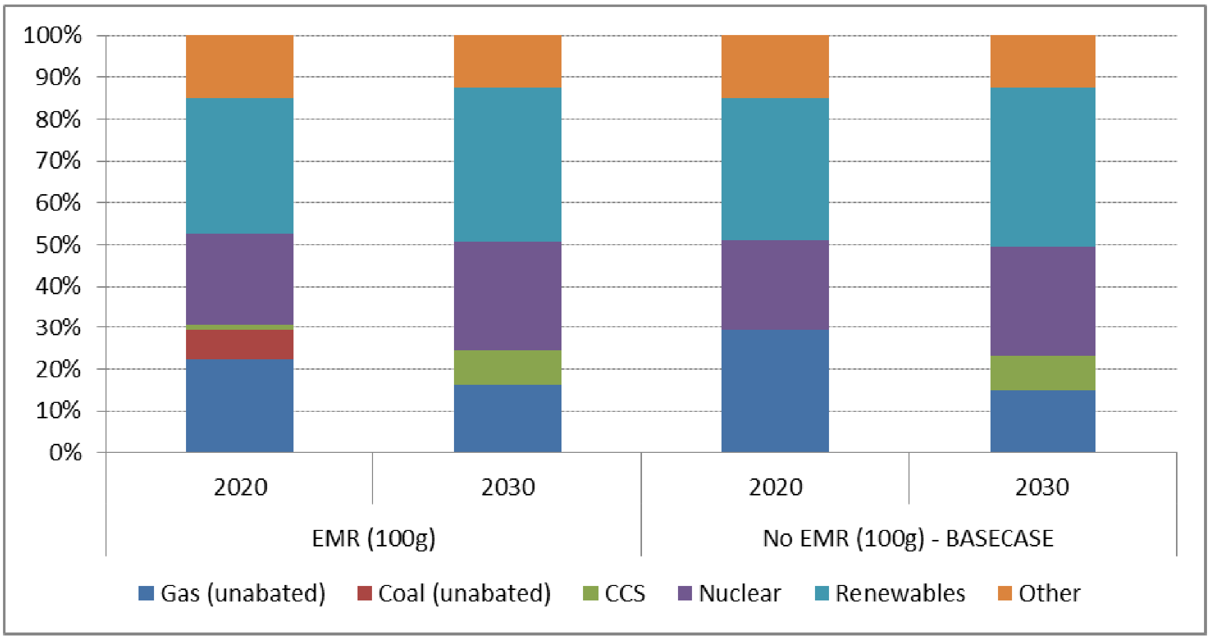
*Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030*

188. Chart 8 presents generation mix profiles in 2020 and 2030 under EMR, and the basecase.[148] Under the basecase, carbon prices are set such that nuclear and CCS investments take place at the same rate as under EMR. As a result, the proportion of electricity generated from nuclear and CCS is similar to that realised under EMR. The

[148] Under a basecase where no decarbonisation ambition is targeted the basecase would become increasingly gas dependent. Without EMR, wholesale prices are insufficient to incentivise new nuclear or CCS investment and no new nuclear is built under the basecase until after 2030 (it is assumed that CCS demonstration projects do not take place without CfDs). Without nuclear, coal and CCS generation, under the no targeting basecase gas generation accounts for a proportionately larger amount of total generation by 2030. As a result the emission intensity of the no targeting basecase in 2030 is roughly double the level targeted under EMR, at around 200g$CO_2$/kWh (further details are provided in Annex E).

difference in unabated coal generation in 2020 (and to a lesser degree CCS), reflects the impact of the higher carbon price in the basecase (and the fact the CCS demonstration projects do not take place in the basecase) [149].

**Chart 8: Generation mix profiles – EMR and no-EMR basecase (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**



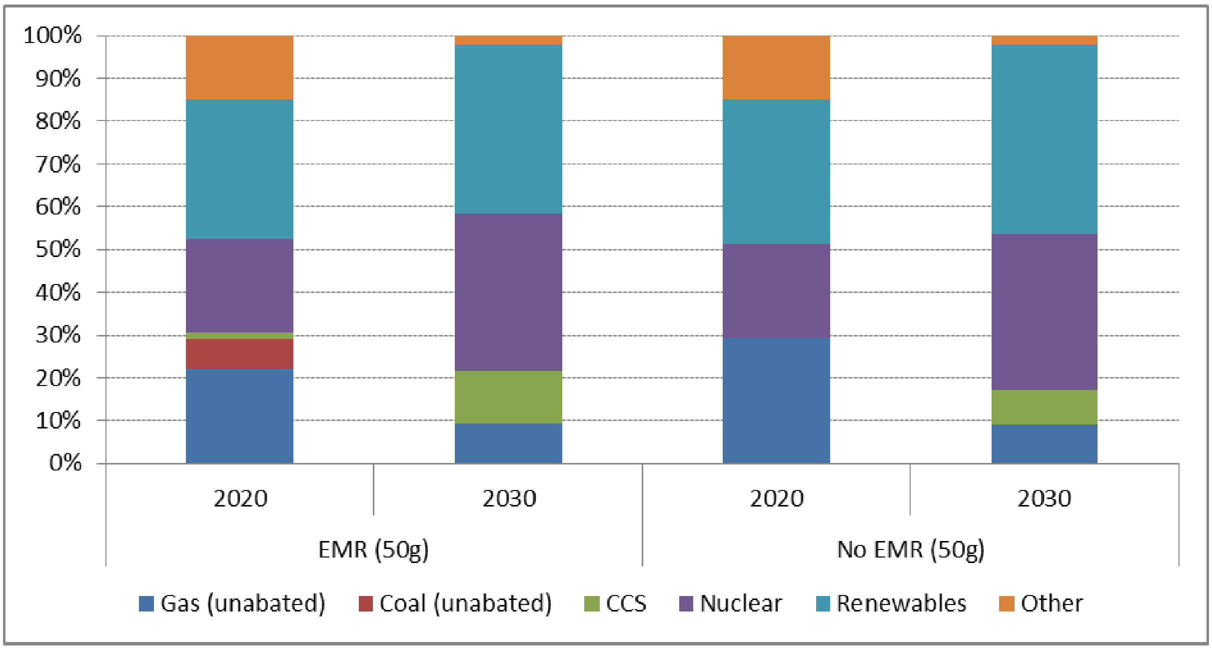

*Source: DECC modelling*
*Note: Within the modelling 'renewables' include both large scale and small-scale FITs generation but only large scale renewable generation counts towards the 2020 renewable electricity ambition.*

*Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030*

189. The generation mixes under EMR and basecase under the 50g$CO_2$/KWh scenario are broadly similar to the 100g scenario in 2020 (as are the reasons for differences). However, in 2030 the EMR and basecase scenarios achieve the decarbonisation ambition in slightly different ways. Under EMR, proportionately more CCS new build takes place, relative to the counterfactual, with the higher carbon price under the basecase resulting in a greater renewable new build, and therefore a higher renewable generation proportion in 2030.

[149] In all counterfactuals generation from biomass conversion plants are adjusted so as to match the generation profile realised under the relevant EMR scenario.

**Chart 9: Generation mix profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**



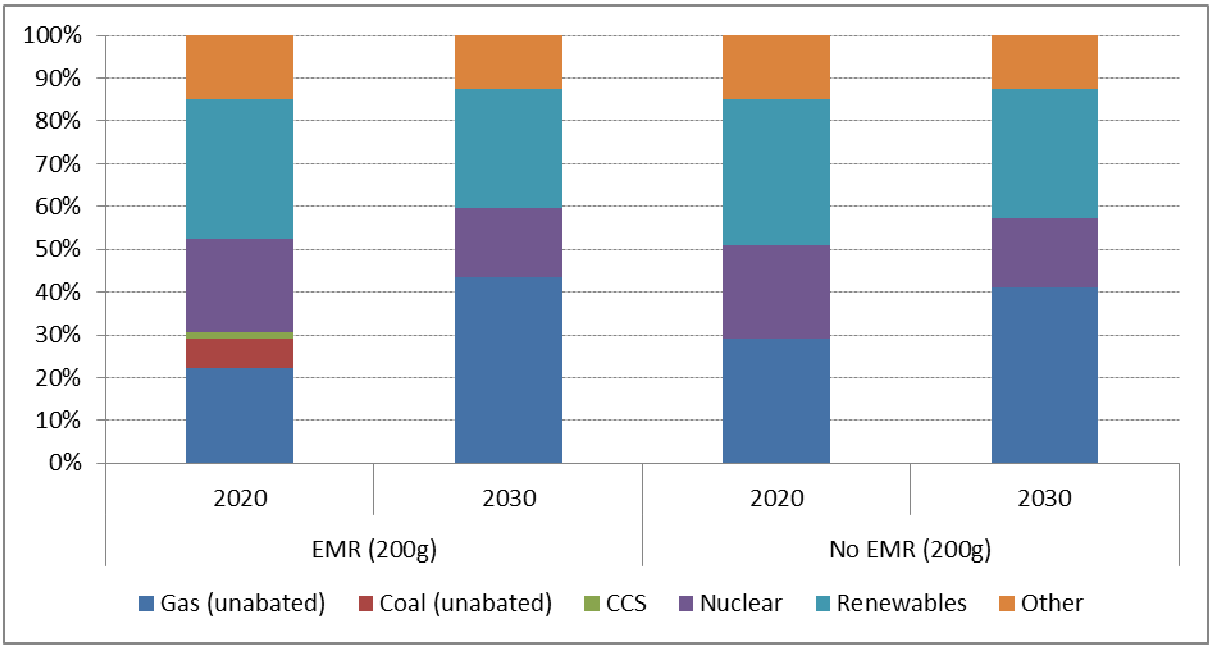

*Source: DECC modelling*
*Note: Within the modelling 'renewables' include both large scale and small-scale FITs generation but only large scale renewable generation counts towards the 2020 renewable electricity ambition.*

### *Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030*

190. Despite targeting an emissions intensity of 200g$CO_2$/kWh, there is a similar carbon price profile up to 2020 as for the 50g and 100g scenarios, leading to a similar generation mix. As a result, the generation mixes in 2030 are broadly similar for the EMR and basecase, with slightly higher renewables generation in the basecase as a result of the higher carbon price incentivising more renewable investment over the 2020s in comparison to the EMR scenario[150].

[150] Under the 200g counterfactual, within the modeling, the number of nuclear and gas CCS plants are restricted so that the build profile matches that realised under the EMR scenario. Without this restriction the carbon price in the 200g counterfactual would incentivise too much new build.

**Chart 10: Generation mix profiles – EMR and 200g basecase (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




*Source: DECC modelling*

*Note: Within the modelling 'renewables' include both large scale and small-scale FITs generation but only large scale renewable generation counts towards the 2020 renewable electricity ambition.*

## Annex D: Evolution of EMR Cost-Benefit Analysis

191. The CBA assessment of EMR has gone through a number of iterations as the policy has developed, reflecting changes in underlying assumptions (such as fossil fuel prices or levelised costs of technologies) and changes in the "status" of policies.

192. The first analysis assessing the costs and benefits of various potential EMR options was presented in the Government's December 2010 consultation on EMR.[151] The central estimate of net benefits for Package Option 2 was -**£3.9 billion** (NPV). The consultation document emphasised the modelling limitations which meant the Government would expect the NPV to be positive if the costs and benefits were assessed over a longer period.

193. In March 2011 the EMR White Paper set out an estimate of **£9.1 billion** (NPV) in net benefits for an EMR package containing a FiT CfD and a Strategic Reserve.[152] Annex E of the IA accompanying the EMR White Paper outlined the differences between the December 2010 analysis and the analysis for the EMR White Paper, and the implications of these changes.

194. In Autumn 2011 DECC published updated assumptions on fossil fuel prices, technology costs and demand. In light of these revisions the cost benefit analysis underpinning the EMR package was revised and was presented as part of the draft Energy Bill Summary IA, published in May 2012.[153] The updated CBA figures showed that compared to a basecase without EMR policies, the net welfare gain to society from the EMR package was **£0.2bn** compared to around £10bn[154] in the EMR White Paper, under central fossil fuel price assumptions.

195. This was subsequently updated in the analysis accompanying the publication of the Energy Bill, which was introduced into Parliament in November 2012.[155] This impact assessment was different to previous ones in a number of respects: firstly, it incorporated outputs from the DECC in-house Dynamic Dispatch Model (DDM, further details available in Annex A), which allows for analysis of impacts beyond 2030; secondly, it provided an assessment of costs and benefits relative to a basecase in which decarbonisation levels similar to EMR were achieved, but using existing instruments

[151] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf
[152] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf
[153] http://webarchive.nationalarchives.gov.uk/20121025080026/http://decc.gov.uk/assets/decc/11/policy-legislation/Energy%20Bill%202012/5342-summary-of-the-impact-assessment.pdf
[154] This number reflects DECC's new carbon appraisal methodology for CBA (12th August 2011) and revises the White Paper number.
[155] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66038/7105-contracts-for-difference-impacts-assessment-emr.pdf

(rather than no decarbonisation ambition at all, as previously[156]); lastly, due to the variety of ways in which existing policy instruments can be combined to achieve the same decarbonisation objective, it presented the overall net welfare impacts as a range – a positive net benefit of between **£1.3bn and £7.4bn up to 2030**, reaching between **£6.1bn to £16bn up to 2049**.

196. Finally, in January 2013 an updated IA was released, updating the modelling to include fossil fuel price sensitivities, and to reflect the agreement over the Levy Control Framework to 2020/21. In addition, to reflect the decision to take a power in the Energy Bill to set a decarbonisation target range and show the wider range of costs and benefits of EMR, the Impact Assessment included analysis based on an average emission level of both 50g$CO_2$/kWh and 200g$CO_2$/kWh in 2030– in addition to analysis based on a carbon emissions intensity of 100g$CO_2$/kWh for the power sector in 2030, consistent with previous EMR impact assessments. This IA was updated in May 2013 to reflect a small change in administrative costs. It presented a positive net benefit of between **£4.2bn and £7.6bn up to 2030.**

197. Dispatch modelling is sensitive to a number of input and methodology assumptions which influence the capacity and generation mix realised under different scenarios. When assessing the costs and benefits of significant infrastructure investment input changes can produce changes in the estimates which appear large in absolute terms, but in the context of the total costs and benefits considered are not so significant.

198. Nevertheless, the underlying message of the analysis has remained the same: As a result of the financing and technology mix benefits CfDs create, EMR is a cost-effective instrument through which to decarbonise the electricity sector with a balanced portfolio of technologies at least cost, whilst also mitigating against risks to security of supply.

[156] This is of particular importance, as it evaluates the efficiency of EMR as a policy tool with which to decarbonise the power sector, rather than the relative efficiency of decarbonising the power sector

## Annex E: Basecase sensitivity results – no decarbonisation ambition, post-2030 carbon prices and fossil fuel price scenarios

199. This annex presents the results of assessing EMR relative to the alternative no-decarbonisation basecase discussed in the main paper (Basecase C), as well as sensitivity analysis of alternative post-2030 carbon prices and different fossil fuel price scenarios. Specifically, it presents the results of assessing EMR relative to:

- **Basecase C (no emissions intensity ambition):** No decarbonisation ambition is set under the basecase. The RO and carbon pricing continue based on existing commitments. In the case of the carbon price this is based on the published Carbon Price Floor trajectory.

- **Post-2030 carbon prices**: Previous analysis assumed that the post-2030 traded carbon market price would remain below the Carbon Price Floor, which therefore represented the carbon price faced by fossil fuel generators. The central assumption in this IA is that the traded carbon price rises above the Carbon Price Floor from 2030 onwards (under the auspices of a global deal on climate change action with a global carbon market). To reflect the uncertainty over the traded carbon market price over the next four decades, we analyse the impact of EMR relative to the basecase under the scenario where traded carbon prices stay below the Carbon Price Floor (as for previous EMR analysis).

- **Fossil fuel prices**: A range of long-term projections up to 2030 for the wholesale prices of oil, gas and coal are published annually by DECC, which are calculated for three future scenarios and provide a range for plausible future fossil fuel prices.[157]

### Basecase C

200. The table below provides a summary of the different outcomes and policy environments assumed under Basecase C.[158]

[157] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

[158] The emissions intensity under this scenario falls to around 200g$CO_2$/kWh in 2020 as a result of meeting the 2020 renewables target and the impact of the Carbon Price Floor. Post-2020, the RO is assumed to realise a broadly similar proportion of renewable generation, up to 2030, as realised in 2020. Beyond 2036, the carbon price is the only policy impacting the basecase.

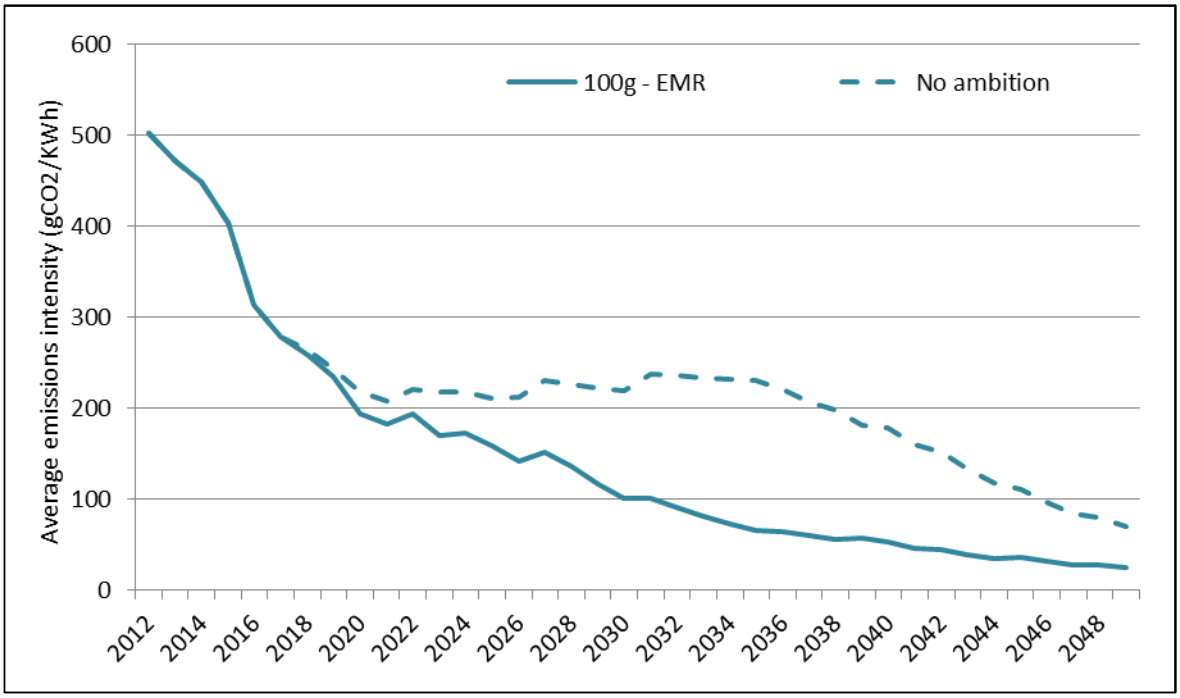
**Table 24: Summary of assumptions – Basecase C**

| | 2030 emissions intensity $gCO_2$/KWh | 2049 emissions intensity $gCO_2$/KWh | Carbon Pricing | Renewables Obligation (RO) |
|---|---|---|---|---|
| ***No Emission Intensity Ambition*** | | | | |
| Basecase C | 220 | 69 | Constant in real terms after 2030 | RO stays open to new renewable plants beyond 2017, closing in 2037. |

*Decarbonisation profiles*

201. Chart 11 presents the decarbonisation profiles under EMR, Basecase C (described above). Under Basecase C, which does not set a decarbonisation ambition for any time period, emission intensities stay broadly at the same level from 2020 to the mid 2030's.

**Chart 11: Decarbonisation Profiles – EMR and Basecase C**




*Source: DECC modelling*

202. An implicit assumption is that with less decarbonisation in the power sector (i.e. higher emissions, as shown for Basecase C above), carbon targets would be met by reductions in other sectors. These costs are not considered in EMR modelling. The HMG

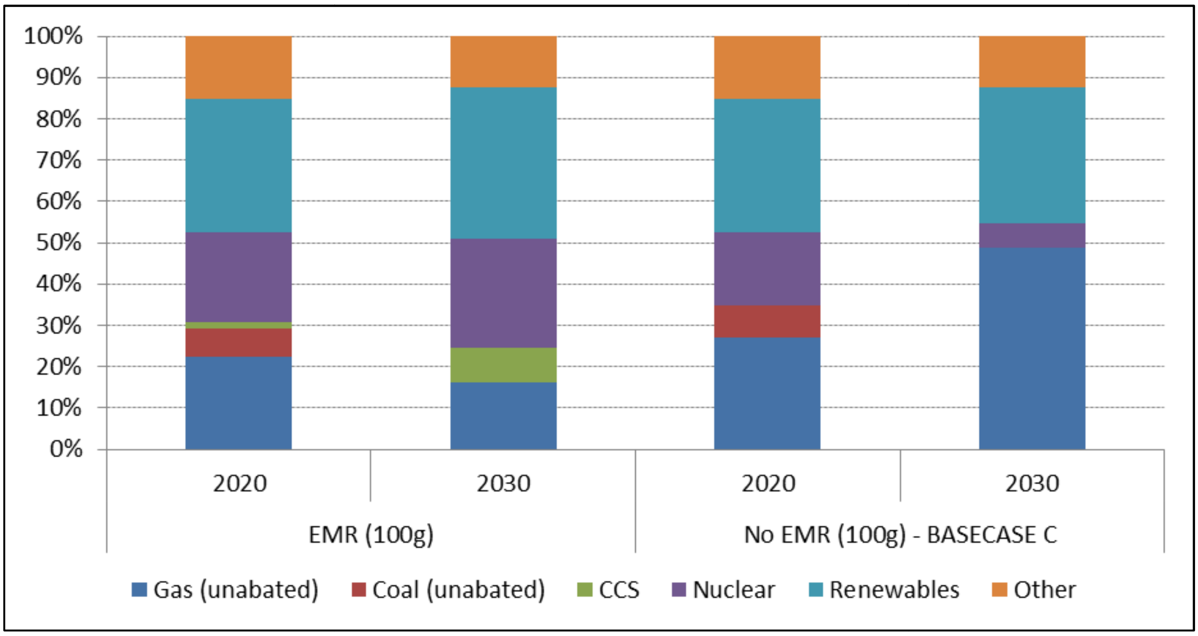
Carbon Plan, and the CCC, suggest that carbon targets can be met cost-effectively by early decarbonisation of the power sector. A basecase which assumes less decarbonisation in the power sector in 2030 will therefore underestimate the costs of meeting long-term carbon targets, by failing to consider the costs of decarbonising in more expensive sectors outside the power sector (assuming that emission reductions are met domestically, rather than through trading).

*Generation mix*

203. The chart below presents generation mix profiles for Basecase C, compared to the generation mix realised under EMR.

204. Under Basecase C, where no decarbonisation ambition is set, generation becomes increasingly gas-dependent. Without EMR, wholesale prices are insufficient to incentivise new nuclear or CCS investment and no new nuclear is built under the basecase until after 2030 (it is assumed that CCS demonstration projects do not take place without CfDs).[159] Without nuclear, coal and CCS generation, under Basecase C gas generation accounts for a much larger proportion of total generation by 2030. As a result, the emission intensity of Basecase C in 2030 is roughly double the level realised under EMR, at over 200g$CO_2$/kWh.

**Chart 12: Generation mix profiles – EMR and Basecase C**




*Source: DECC modelling*
*Note: Within the modelling 'renewables' include both large scale and small scale FITs generation but only large scale renewable generation counts towards the 2020 renewable electricity ambition.*

[159] The assumption in the basecases is that in the absence of EMR, there would be no CfDs to fund early stage CCS projects. This is because all hypothetical modelled basecases only include existing policy instruments. However, in the absence of EMR, a likely scenario is that alternative funding would be sought for CCS consistent with the Government's commitment to help support the development of this technology.

*Cost Benefit Analysis (CBA)*

205. Table 25 presents the net welfare impact of the EMR package relative to Basecase C, for a carbon emission intensity in 2030 of 100g$CO_2$/kWh. The results suggest that the EMR package would lead to a net welfare loss of around £12bn, up to 2030.

**Table 25: Change in Net Welfare (NPV) – Combined EMR impact (CfDs with Capacity Market), compared to Basecase C (EMR emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (Real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| Net Welfare | Value of carbon savings | 7,300 | 38,000 | 60,000 |
| | Generation cost savings | 5,000 | 22,000 | 36,000 |
| | Capital cost savings | -22,000 | -68,000 | -91,000 |
| | System cost savings | -1,300 | -1,700 | -2,200 |
| | Unserved energy savings | 430 | 3,700 | 6,300 |
| | Cost of Interconnector energy saved | 92 | 460 | 830 |
| | **Change in Net Welfare** | **-11,000** | **-5,500** | **9,400** |
| | **Change in Net Welfare*** | **-12,000** | | |

*Source: DECC modelling*

**Inclusive of administrative costs of approximately £0.7bn up to 2030 (see section 2.4.1 for details)*

206. This result is driven by increased capital costs generated under EMR relative to Basecase C, as a result of the increased investment in capital-intensive low-carbon technologies, such as nuclear and renewables. Up to 2030, these costs outweigh the significant carbon and generation cost savings under EMR.

207. The greatest benefits of EMR are seen in the longer term. Therefore, considering the costs and benefits over a longer period – for example, over the complete lifetime of the low-carbon generation technologies – is likely to result in an increasingly positive NPV. Indeed, assessed up to 2040, the latest modelling suggests that EMR has a smaller positive net welfare loss of around -£5.5bn, and considered up to 2049 EMR results in a positive net welfare impact of around £9.4bn.

208. When assessing up to 2049, the generation and carbon cost savings realised under EMR more than offset the higher capital costs incurred (though this is the period for which uncertainties are greatest). Over these longer time periods, the EMR policy package also generates benefits from lower unserved energy costs, which reflect the additional capacity provided through the Capacity Market to mitigate against security of supply risks under EMR.

209. Table 26 presents the consumer and producer surplus under Basecase C. There are transfers from consumers to producers through low-carbon and capacity payments. These losses to consumer surplus are offset, to some extent, by lower wholesale prices

under EMR relative to Basecase C (which leads to transfers from producers to consumers). However, across all assessment years EMR leads to lower consumer surplus, relative to Basecase C, as low-carbon and capacity payment transfers outweigh the benefits of lower wholesale prices and less unserved energy. Conversely, producers see greater welfare under EMR, as the low-carbon and capacity payments (combined with reduced producer costs) outweigh the lower wholesale prices realised under EMR (relative to Basecase C).

210. Relative to Basecase C, EMR results in lower carbon emissions and therefore a reduction in environmental tax revenue.

**Table 26: Distributional analysis: Combined EMR impact (CfDs with Capacity Market), relative to Basecase C (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (Real 2012) | | |
|---|---|---|---|---|
| | | 2012 to 2030 | 2012 to 2040 | 2012 to 2049 |
| **Distributional analysis** | | | | |
| **Consumer Surplus** | Wholesale price | 4,000 | 25,000 | 55,000 |
| | Low carbon payments | -15,000 | -28,000 | -31,000 |
| | Capacity payments | -16,000 | -24,000 | -29,000 |
| | System cost savings | -1,300 | -1,700 | -2,200 |
| | Unserved energy | 430 | 3,700 | 6,300 |
| | **Change in Consumer Surplus** | **-28,000** | **-25,000** | **-920** |
| **Producer Surplus** | Wholesale price | -3,900 | -25,000 | -54,000 |
| | Low carbon support | 15,000 | 28,000 | 31,000 |
| | Capacity payments | 16,000 | 24,000 | 29,000 |
| | Producer costs | -8,800 | -6,800 | 5,700 |
| | **Change in Producer Surplus** | **18,000** | **20,000** | **12,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-1,200** | **-1,200** | **-1,200** |
| **Net Welfare** | **Change in Net Welfare** | **-11,000** | **-5,500** | **9,400** |

*Source: DECC modelling*

*Changes from previous analysis*

211. This latest modelling represents a significant change in the overall NPV for EMR compared to Basecase C – as set out in Table 27 below, the NPV up to 2030 has decreased by around £7bn. There are several important drivers of this change:

- **Carbon cost savings**: In the latest modelling, the carbon emissions up to 2030 are slightly lower under EMR and slightly higher under Basecase C, which results in greater carbon cost savings under EMR, improving the overall NPV slightly (from £5.1bn to £7.3bn, in NPV terms).

- **Capital cost savings**: Compared to EMR, there is less need to decarbonise; in the latest modelling, this means that there is less renewables deployment[160] (which is more capital-intensive) and delayed building of low-carbon generation (e.g. nuclear), relative to the previous analysis. Therefore, capital spending on Basecase C in the new analysis is even lower (£22bn up to 2030, in NPV terms) than in the previous analysis (£13bn up to 2030, in NPV terms).

- **Systems costs**: As for other runs, these are costs which have been newly incorporated into the modelling to reflect the costs of operating the electricity system (TNUoS and BSUoS costs). These costs (£1.3bn up to 2030, in NPV terms) are calculated by National Grid, based on DDM outputs.

212. Considering the costs and benefits of EMR over a longer period – for example, over the complete lifetime of the low-carbon generation technologies – results in an increasingly positive NPV. The latest modelling suggests that EMR has a positive net welfare impact of £9.4bn up to 2049.

213. However, this 'no decarbonisation' scenario does not mitigate against security of supply risks. In addition, it implies increased action elsewhere in the economy to meet the decarbonisation targets set out in the Climate Change Act. As set out above, these have not been costed as part of this analysis.

**Table 27: NPV Analysis – comparison to previously published CBA (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | Current NPV, £m (real 2012) 2012-2030 | Previous NPV, £m (real 2012) 2012-2030 |
|---|---|---|---|
| Net Welfare | Value of carbon savings | 7,300 | 5,100 |
| | Generation cost savings | 5,000 | 4,600 |
| | Capital cost savings | -22,000 | -13,000 |
| | System cost savings | -1,300 | - |
| | Unserved energy savings | 430 | 90 |
| | Cost of Interconnector energy saved | 92 | 46 |
| | **Change in Net Welfare** | **-11,000** | **-3,500** |

*Source: DECC modelling (not inclusive of administrative costs)*

*Price and Bills Analysis*

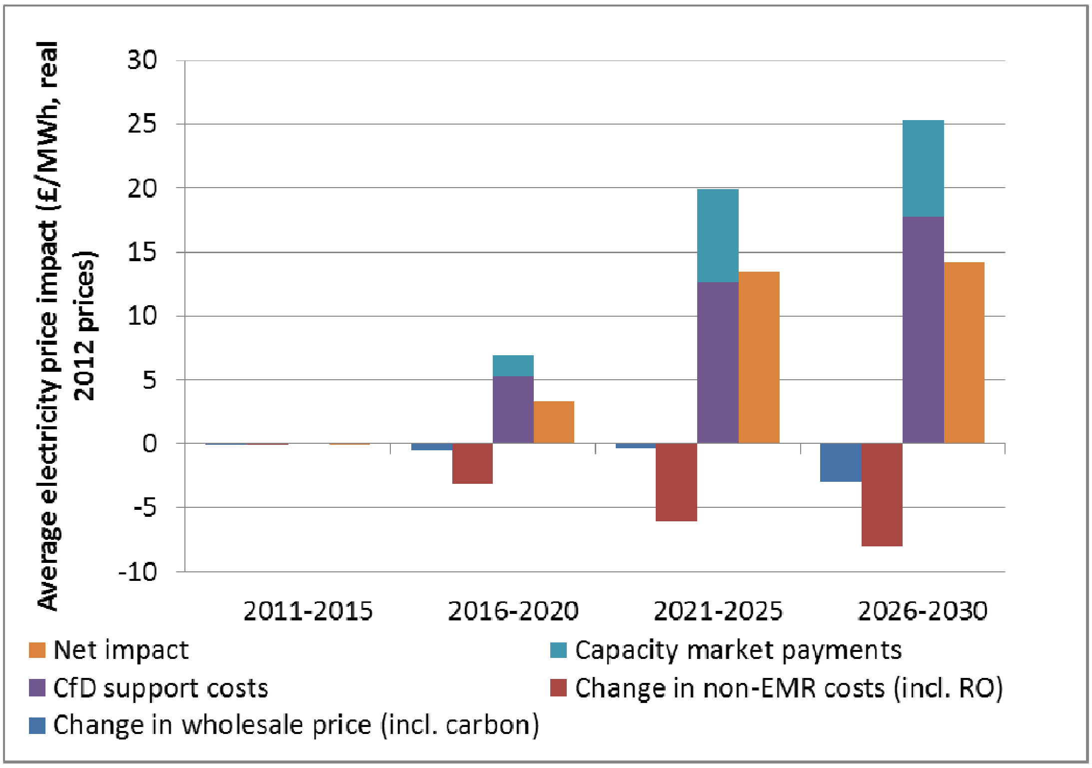
214. Chart 13 presents the net impact of EMR on prices relative to Basecase C, which does not meet the same decarbonisation ambitions and does not mitigate against security of supply risks.

<u>Analysis based on emissions intensity of 100g$CO_2$/kWh in 2030</u>

[160] Particularly Round 3 offshore wind

215. Assessed over the period 2016-2030, EMR increases prices relative to the basecase. Prices to 2030 are on average, around 5% higher under EMR, in comparison to what they would be under Basecase C (over the period 2016-2030). Despite the impact of EMR in marginally lowering wholesale prices and resulting in lower RO support costs relative to Basecase C over all time periods up to 2030, the size of the EMR support costs outweigh these effects, leading to an overall increase in prices (which grows over time).

**Chart 13: Net Impact of EMR on domestic electricity prices, relative to Basecase C (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




*Source: DECC modelling*

216. There are uncertainties when modelling wholesale prices into the future and therefore results are averaged over periods, rather than focusing on individual years. However, the averaging does mask trends within those periods. For example, the final years leading up to 2030 show a slight narrowing between prices under EMR and Basecase C. EMR achieves a significantly lower carbon intensity than Basecase C (as a result of investment in low-carbon generation), as well as mitigating against security of supply risks.

217. Table 31 presents the impact of EMR on consumer bills relative to Basecase C. Annual average household electricity bills under EMR are expected to be, on average, around 5% (£33) higher than they would have been under Basecase C, over the period 2016-2030. Bills for both non-domestic consumers and EIIs are expected to be between 7% and 8% higher.

**Table 28: EMR Bill Impacts relative to Basecase C (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 567 | - | 1,090 | - | 7,930 | -10 (-0.1%) |
| 2016-2020 | 589 | +10 (2%) | 1,300 | +30 (+3%) | 10,110 | +310 (+3%) |
| 2021-2025 | 591 | +41 (7%) | 1,370 | +130 (+9%) | 11,120 | +1,190 (+11%) |
| 2026-2030 | 660 | +48 (7%) | 1,450 | +130 (+9%) | 11,720 | +1,180 (+10%) |
| **2016-2030** | **613** | **+33 (5%)** | **1,370** | **+90 (+7%)** | **10,990** | **+900 (+8%)** |

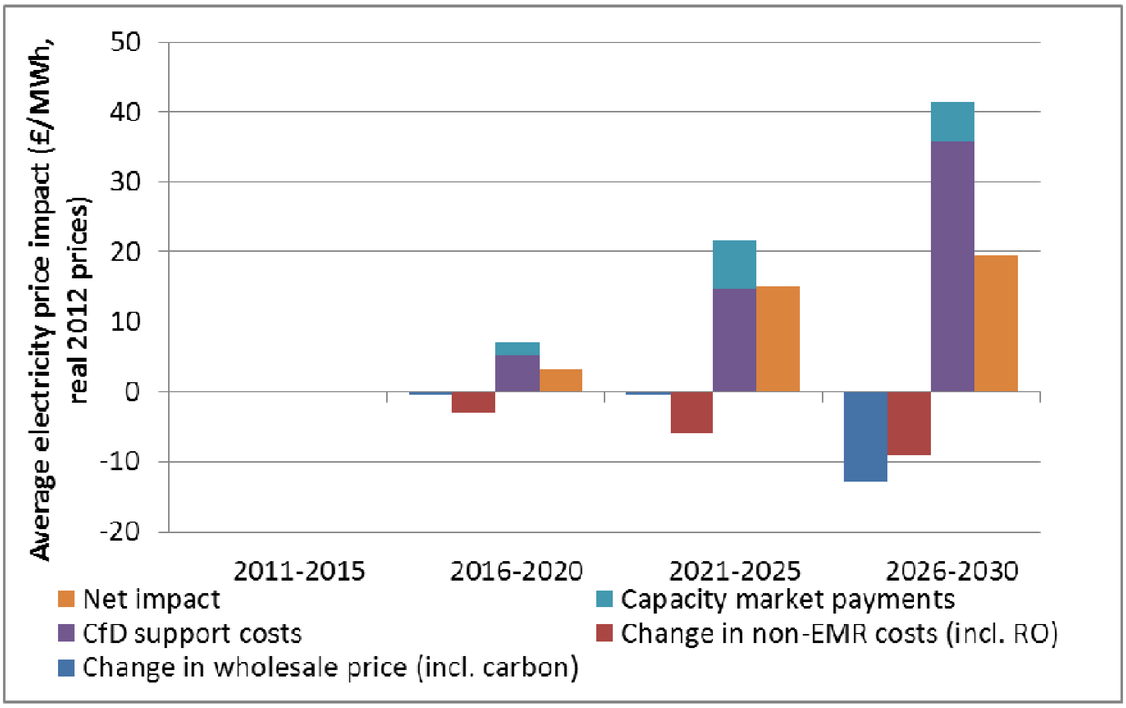
*Source: DECC modelling*

218. Between 2016 and 2020, average annual electricity bills are estimated to be marginally higher under EMR compared to Basecase C, with annual household electricity bills around £10 (2%) higher. In the early 2020s, the costs of EMR increase, with average annual domestic electricity bills £41 (7%) higher under EMR in comparison to Basecase C. The bill impact of EMR peaks in 2026, before declining towards the end of the period.

<u>Analysis based on emissions intensity of 50g$CO_2$/kWh in 2030</u>

219. Under this scenario, EMR again increases prices relative to Basecase C, with average prices to 2030 estimated to be around 7% higher under EMR, in comparison to what they would be under Basecase C (over the period 2016-2030). Similarly, despite the downward impact of EMR on bills through lower wholesale prices and lower RO support costs, EMR support costs outweigh these benefits and result in an overall increase in prices. This increase is of slightly greater magnitude than for the 100g scenario above.

**Chart 14: Net Impact of EMR on Domestic Electricity prices, relative to Basecase C (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**




*Source: DECC modelling*

220. Table 32 presents the impact of EMR on consumer bills relative to Basecase C. Annual average household electricity bills under EMR are expected to be, on average, around 7% (£41) higher than they would have been under Basecase C, over the period 2016-2030. Bills for non-domestic consumers and EIIs are also expected to be between 8% and 9% higher.

**Table 29: EMR Bill Impacts relative to Basecase C (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

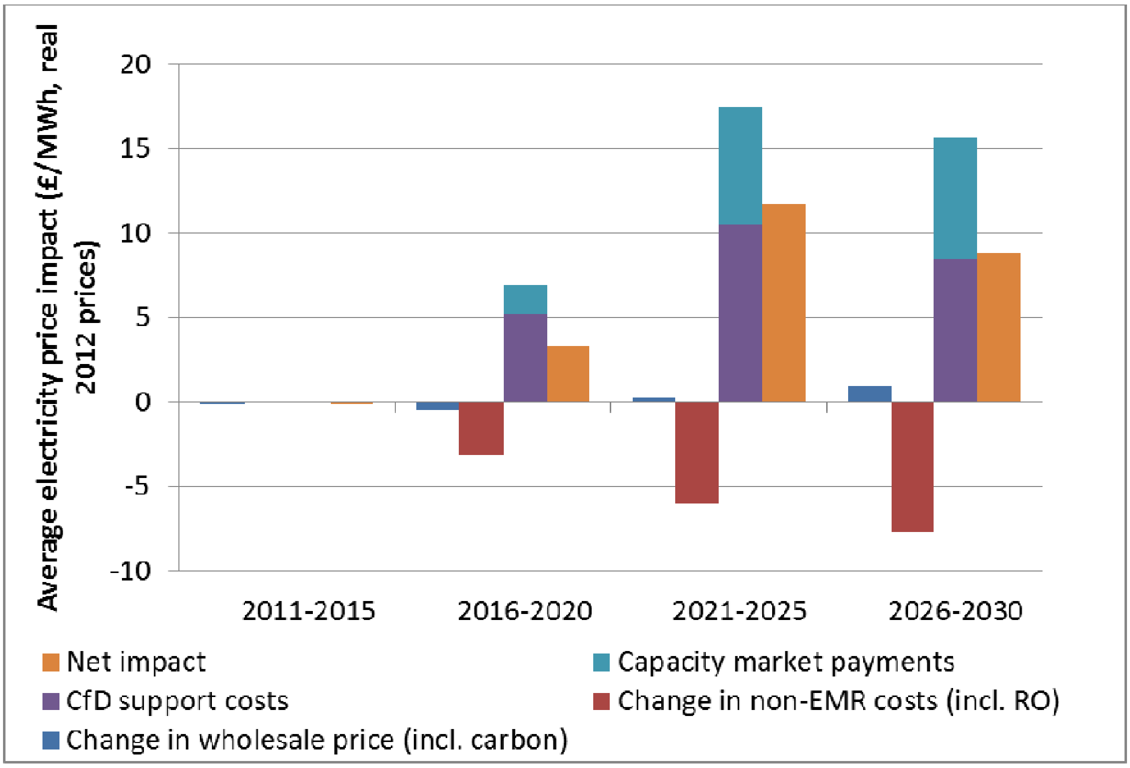
| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 567 | - | 1,090 | - | 7,930 | -10 (-0.1%) |
| 2016-2020 | 589 | +10 (2%) | 1,300 | +30 (+3%) | 10,110 | +310 (+3%) |
| 2021-2025 | 591 | +47 (8%) | 1,370 | +130 (+10%) | 11,120 | +1,280 (+11%) |
| 2026-2030 | 660 | +66 (10%) | 1,450 | +150 (+10%) | 11,720 | +1,450 (+12%) |
| **2016-2030** | **613** | **+41 (7%)** | **1,370** | **+110 (+8%)** | **10,990** | **+1,010 (+9%)** |

*Source: DECC modelling*

Analysis based on emissions intensity of 200g$CO_2$/kWh in 2030

221. Under this scenario, EMR increases prices relative to Basecase C, though by much less than before – on average, prices are estimated to be only around 4% higher under EMR, in comparison to Basecase C (over the period 2016-2030). Again, the price impact of lower wholesale prices and lower RO support costs under EMR is outweighed by EMR support costs, leading to an overall increase in prices.

**Chart 15: Net Impact of EMR on Domestic Electricity prices, relative to Basecase C (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




*Source: DECC modelling*

222. Table 30 presents the impact of EMR on consumer bills relative to Basecase C. As might be expected, the increases in annual average household electricity bills under EMR for this scenario are much smaller than for either the 50g or 100g scenario, being only 4% (£25) higher than they would have been under Basecase C, over the period 2016-2030. Bills for non-domestic consumers and EIIs are also estimated to be between 6% and 7% higher over this period.

**Table 30: EMR Bill Impacts relative to Basecase C (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**

| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 567 | - | 1,090 | - | 7,930 | -10 (-0.1%) |
| 2016-2020 | 589 | +10 (2%) | 1,300 | +30 (+3%) | 10,110 | +310 (+3%) |
| 2021-2025 | 591 | +36 (6%) | 1,370 | +110 (+8%) | 11,120 | +1,060 (+10%) |
| 2026-2030 | 660 | +30 (4%) | 1,450 | +90 (+6%) | 11,720 | +820 (+7%) |
| **2016-2030** | **613** | **+25 (4%)** | **1,370** | **+80 (+6%)** | **10,990** | **+730 (+7%)** |

*Source: DECC modelling*

**Post-2030 carbon price assumptions**

223. As for the analysis published alongside the Energy Bill, the impact of EMR has been assessed up to 2049. However, extending the analysis beyond 2030 creates a number of modelling complexities – notably uncertainty over the future traded carbon market price.

224. The effective carbon price that fossil fuel generators will have to pay in the UK power market is the higher of the Carbon Price Floor and the traded carbon market price. This is because, should the traded price be below the Carbon Price Floor, the generators have to pay a tax on the differential. At the moment, the traded carbon market is the EU Emissions Trading System. In the coming decades, a more global carbon market may emerge under the auspices of a global deal on climate change action.

225. Previous EMR analysis assumed that the traded carbon market price would remain below the Carbon Price Floor, which therefore represented the carbon price faced by fossil fuel generators. The Carbon Price Floor was assumed (in the EMR scenario) to follow its announced profile to 2030[161], and then to remain flat in real terms at the 2030 value of £76/t$CO_2$e (2012 prices).

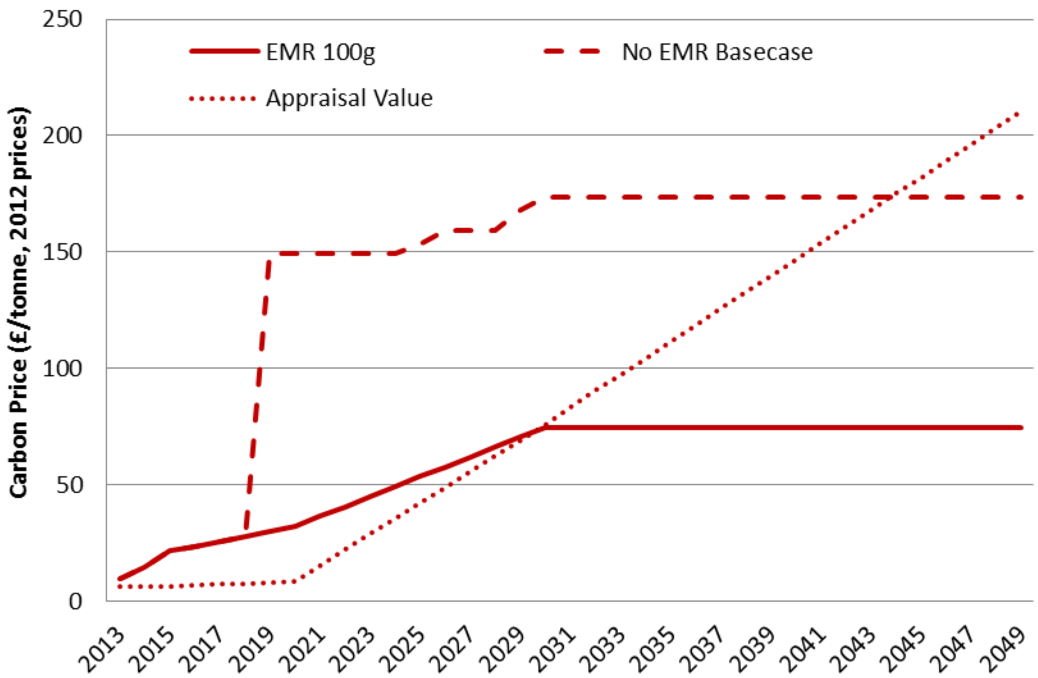
226. In this latest analysis, this assumption has been altered, so that the traded carbon price rises above the Carbon Price Floor from 2030 onwards, under the auspices of a

[161] The CPF was introduced in the Budget in March 2011 (and implemented from 1st April 2013) to provide an effective floor to carbon prices (so supplementing the EU ETS with carbon taxation on all fossil fuels used in electricity generation). The profile for carbon prices starts at £16/t$CO_2$ (2009 prices) and takes a linear path to £30/ t$CO_2$ (during 2013-2020) and then a linear path to £70/t$CO_2$ (during 2020-2030).

global deal on climate change action with a global carbon market. The price rises progressively as more abatement is required and the cheaper options are used up.[162]

227. However, given the uncertainty over future carbon prices and to show results consistent with the previous IA, here we present results showing the impact of EMR under a scenario where traded carbon prices stay below the Carbon Price Floor (i.e. assuming that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030). This alternative EMR scenario is then compared to a slightly altered basecase, as the assumed level of the CPF in the basecase goes slightly below the assumed traded carbon price in the late 2040s (as shown in Chart 16 below).

**Chart 16: Carbon price profile – CPF, 100g basecase and appraisal value**




228. Table 31 below shows that, under this alternative carbon price scenario post-2030, EMR has a slightly higher net welfare benefit in 2049: £32bn (NPV, 2012 prices), compared to £31bn under the central EMR case.

[162] The carbon price values for this scenario are sourced from modelling by DECC using the GLOCAF model. They are also used as the Government's carbon price values for policy appraisal purposes. See the appraisal guidance for further details at: https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

**Table 31: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to basecase, alternative post-2030 carbon price assumptions (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (2012-2030, real 2012) | | | |
|---|---|---|---|---|---|
| | | EMR (appraisal values) | | EMR (CPF) | |
| | | 2040 | 2049 | 2040 | 2049 |
| Net Welfare | Carbon costs | -4,100 | -7,200 | -3,800 | -5,800 |
| | Generation costs | 2,100 | 4,300 | 1,700 | 3,800 |
| | Capital costs | 17,000 | 25,000 | 17,000 | 24,000 |
| | System costs | -1,100 | -980 | -1,200 | -1,100 |
| | Unserved energy | 7,100 | 8,500 | 7,000 | 8,700 |
| | Interconnectors | 2,100 | 2,000 | 2,400 | 2,900 |
| | **Change in Net Welfare** | **23,000** | **31,000** | **23,000** | **32,000** |

*Source: DECC modelling*

**Inclusive of administrative costs of approximately £0.7bn (see section 2.4.1 for details)*

229. This change has also affected the analysis of Basecase C. Therefore, again in order to show results consistent with the previous analysis of Basecase C, here we present results showing the impact of EMR, relative to Basecase C but where traded carbon prices stay below the Carbon Price Floor (i.e. assuming that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030).

230. Table 32 below shows that, under this alternative carbon price scenario post-2030, EMR has a slightly more negative net welfare impact in 2040 (-£7.6bn, compared to -£5.5bn under the central EMR case; both in NPV terms) and a much higher positive net welfare impact in 2049 (£22bn, compared to £9.4bn under the central EMR case; again, both in NPV terms).

**Table 32: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to Basecase C, alternative post-2030 carbon price assumptions (emissions intensity in 2030 = 100gCO2/kWh)**

| | | NPV, £m (2012-2030, real 2012) | | | |
|---|---|---|---|---|---|
| | | EMR (appraisal values) | | EMR (CPF) | |
| | | 2040 | 2049 | 2040 | 2049 |
| Net Welfare | Carbon costs | 38,000 | 60,000 | 49,000 | 110,000 |
| | Generation costs | 22,000 | 36,000 | 20,000 | 33,000 |
| | Capital costs | -68,000 | -91,000 | -77,000 | -130,000 |
| | System costs | -1,700 | -2,200 | -1,900 | -2,500 |
| | Unserved energy | 3,700 | 6,300 | 2,000 | 2,600 |
| | Interconnectors | 460 | 830 | 450 | 800 |
| | **Change in Net Welfare** | **-5,500** | **9,400** | **-7,600** | **22,000** |

*Source: DECC modelling*
**Inclusive of administrative costs of approximately £0.7bn (see section 2.4.1 for details)*

### Fossil fuel price scenarios

231. The robustness of EMR to different assumptions about fossil fuel prices has been tested using the 2013 update to DECC's annual fossil fuel price projections.[163] Of the three scenarios included in each update (high/central/low fossil fuel prices), the central fossil fuel price scenario has been used for the main modelling results set out above.

232. Here, the results from the 'high' and 'low' fossil fuel price scenarios are applied to a scenario that replicates as closely as possible the generation mix produced under EMR, on the basis of targeting an average emissions intensity for the power sector in 2030 of 100g$CO_2$/kWh; it does not compare the results relative to Basecase C.[164] This therefore measures the efficiency of EMR as a tool for decarbonising the economy, rather than the relative impact of decarbonisation.

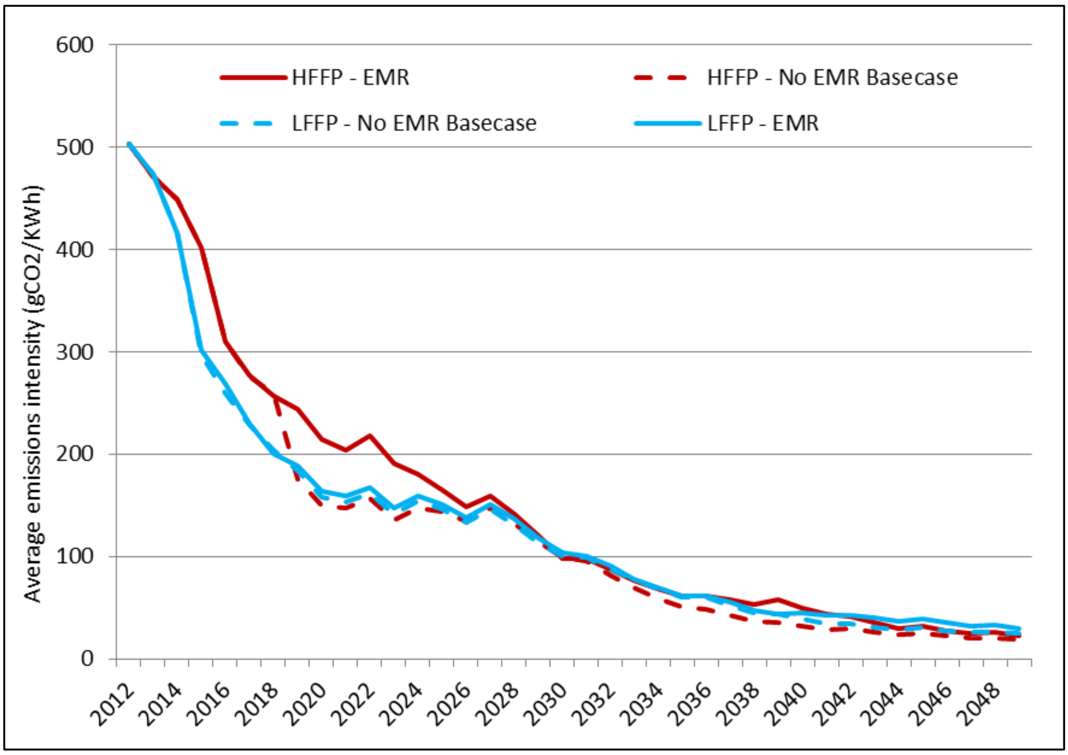
*Decarbonisation profiles*

233. Chart 17 presents the decarbonisation profiles under EMR and the high & low fossil fuel price scenarios described above. As in the central scenarios the counterfactuals follow a slightly quicker decarbonisation profile as a result of the use of carbon pricing to incentivise new nuclear. The smaller impact of carbon pricing on the low fossil fuel price sensitivity reflects the relatively low proportion of unabated coal generation in the EMR low fossil fuel price sensitivity around 2020. In contrast, the larger impact on the high

[163] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013
[164] This results in a single basecase, as different fossil fuel price assumptions limits the number of ways to achieve the same decarbonisation objectives as under EMR, using existing instruments (i.e. Renewables Obligation and carbon pricing).

fossil fuel price sensitivity reflects the relatively higher proportion of unabated coal generation in the EMR high fossil fuel price sensitivity (discussed further below).[165]

**Chart 17: Decarbonisation Profiles – EMR and high/low fossil fuel price scenarios**




*Source: DECC modelling*

*Generation mix*

234. The chart below presents generation mix profiles for high and low fossil fuel price scenarios, compared to the generation mix realised under EMR.

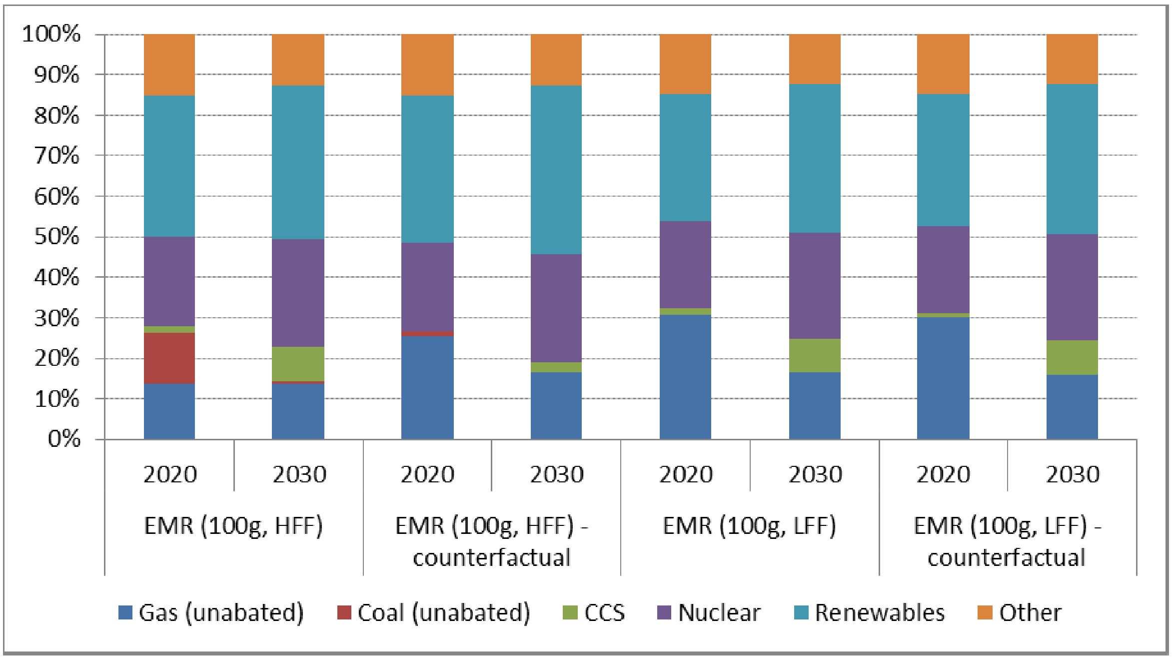
235. Under EMR with high fossil fuel prices, in 2020 unabated coal generation makes up a significant proportion of total generation. In contrast, under the counterfactual, the use of carbon pricing to incentivise new nuclear results in proportionally more gas generation. By 2030, the carbon price necessary to incentivise new CCS plants in the late 2020's results in a higher proportion of renewable generation and lower CCS generation relative to the EMR high fossil fuel price scenario[166]. In the low fossil fuel price EMR scenario, a greater proportion of generation comes from unabated gas in 2020. The carbon price used to incentivise new nuclear in the low fossil fuel price counterfactual

[165] Reflecting the impact of fossil-fuel prices on wholesale prices, the carbon price used in the fossil-fuel price sensitivity counterfactuals differs to that used in the 100g counterfactual. Under the low fossil fuel price sensitivity the carbon price used to incentivise new nuclear is higher than that used in the central 100g counterfactual. In contrast the carbon price used under the high fossil fuel price sensitivity is initially lower.

[166] The high fossil fuel price counterfactual does not increase carbon prices to deliver the same number of new build CCS plants as achieved under EMR. In meeting the 2030 decarbonisation ambition, the use of the carbon price in the counterfactual results in a higher proportion of renewable capacity and less CCS.

results in a broadly similar proportion of gas and renewable generation.[167] By 2030 the generation mix realised under the EMR low fossil fuel price scenario, and the equivalent counterfactual, are broadly similar.

**Chart 18: Generation mix profiles – EMR and high/low fossil fuel price scenarios**




*Source: DECC modelling*
*Note: Within the modelling 'renewables' include both large scale and small scale FITs generation but only large-scale renewable generation counts towards the 2020 renewable electricity ambition.*

*Cost Benefit Analysis (CBA)*

236. Table 33 presents the net welfare impact of the EMR package relative to the high and low fossil fuel price scenarios, for a carbon emission intensity in 2030 of 100g$CO_2$/kWh.

High fossil fuel prices

237. Under high fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of £10.0bn up to 2030 relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). The largest benefit of EMR comes from lower capital costs and lower unserved energy, relative to the counterfactual, although the capital cost benefit will reflect differences in the generation mix used to meet 2030 decarbonisation ambitions under EMR and the counterfactual (as discussed above).

Low fossil fuel prices

[167] Under the low fossil fuel price counterfactual the carbon price necessary to incentivise new nuclear is also sufficient to incentivise the gas CCS demonstration project.

238. Under low fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of £10.2bn up to 2030 relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). The largest benefits come from lower unserved energy and lower capital costs under EMR.

**Table 33: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to basecase, fossil fuel price scenarios (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (2012-2030, real 2012) | | |
|---|---|---|---|---|
| | | 100g basecase | High FF prices | Low FF prices |
| **Net Welfare** | Carbon costs | -1,300 | -1,800 | -510 |
| | Generation costs | -80 | 310 | -630 |
| | Capital costs | 7,700 | 7,500 | 6,900 |
| | System costs | -1,000 | -620 | -1,300 |
| | Unserved energy | 3,300 | 4,200 | 4,000 |
| | Interconnectors | 1,700 | 1,200 | 2,600 |
| | **Change in Net Welfare** | **10,000** | **11,000** | **11,000** |
| | **Change in Net Welfare*** | **9,500** | **10,000** | **10,200** |

*Source: DECC modelling*
**Inclusive of administrative costs of approximately £0.7bn (see section 2.4.1 for details)*

## Annex F: Electricity Market Reform – post-implementation review

Purpose of this consultation

The Government is seeking views on our proposals for plans to evaluate Electricity Market Reform (EMR).

This consultation is relevant to energy generators, energy suppliers, energy consumers and their representatives, network owners and operators, finance institutions and other stakeholders with an interest in the energy sector. It is also relevant to evaluation professionals, analysts and academics, particularly those with experience of evaluation of large-scale programmes. DECC invites interested parties to submit comments and evidence.

Issued*:* 30 July 2013

Respond by*:* 25 September 2013

Enquiries to:

EMR Delivery Plan Team
Department of Energy & Climate Change
3 Whitehall Place
London,
SW1A 2AW
Email: emrdeliveryplan@decc.gsi.gov.uk

Territorial extent: This consultation applies to England, Scotland, Wales and Northern Ireland.

How to respond: Your response will most useful if it is framed in direct response to the questions posed, though further relevant comments and evidence received before the closing date are also welcome. We would prefer comments to be submitted via the electronic consultation platform at https://econsultation.decc.gov.uk/. Alternatively comments can be provided by email or hard copy to the addresses below.

EMR Delivery Plan Team
Department of Energy & Climate Change
3 Whitehall Place
London,
SW1A 2AW
Email: emrdeliveryplan@decc.gsi.gov.uk

Additional copies: You may make copies of this document without seeking permission.

Other versions of this section in Braille, large print or audio-cassette are available on request. This includes a Welsh version. Please contact us under the above details to request alternative versions.

Confidentiality and data protection: Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

If you want information that you provide to be treated as confidential, please say so clearly in writing when you send your response to the consultation. It would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded by us as a confidentiality request.

We will summarise all responses and place this summary on our website at www.decc.gov.uk/en/content/cms/consultations/. This summary will include a list of names or organisations that responded but not people's personal names, addresses or other contact details.

Quality assurance: This consultation has been carried out in accordance with the Government's Code of Practice on consultation, which can be found here: https://www.gov.uk/government/publications/consultation-principles-guidance

If you have any complaints about the consultation process (as opposed to comments about the issues which are the subject of the consultation) please address them to:

DECC Consultation Co-ordinator
3 Whitehall Place
London
SW1A 2AW
Email: consultation.coordinator@decc.gsi.gov.uk

---

*Context*

239. The aim of the EMR programme is to undertake the necessary reform to the electricity market to ensure the UK can attract the investment in electricity generation needed to meet its renewable and carbon emission reduction targets in the most cost-effective way and to enable a secure, affordable supply of electricity towards the end of this decade and in the longer term.

240. Our long-term vision for the electricity market is for a decreasing role for the Government over time, and to transition to a market where low-carbon technologies can compete fairly on price. This competition between technologies will drive down costs and allow us to meet our objectives in the most cost-effective way.

241. Outcomes we are seeking are an electricity market that can:

- Increase the level of investment in new electricity infrastructure, sufficient to support the additional £100bn-110bn we estimate we need by 2020;

- Reduce the carbon emissions of the electricity sector to set us on a pathway consistent with our 2050 carbon emissions reduction target, and enable us to meet any future 2030 decarbonisation target for the electricity sector, as well as delivering around 30% renewable electricity generation by 2020;

- Ensure that capacity margins can be maintained at a level sufficient to avoid supply shortages, through the addition/retention of reliable capacity, from either the demand or the supply side;
- Achieve these aims at least cost to consumers.

*Scope/focus*

242. Due to the scale and duration of the EMR programme, it is unlikely to be possible to conduct a single evaluation to cover the whole spectrum of EMR workstreams. In addition, given the commonality of objectives for a number of workstreams, this will complicate the attribution of each workstream towards achieving a given high-level objective.

243. Therefore, it is proposed that a 'process' evaluation would be undertaken for each individual EMR workstream (e.g. CfD, Capacity Market, EDR, FID-enabling), which could be undertaken at a relatively earlier stage – i.e. shortly after roll-out of the policy in 2014. This could then take advantage of opportunities to shape the design of future policy (e.g. future capacity auctions, future CfDs) and obtain high-quality baseline data.

244. However, as many of the high-level common objectives for EMR have a longer time horizon, it is proposed that a single 'outcome' evaluation for all of EMR be undertaken over this longer time period, when such effects are more easily observed. Given the timing of other projects to which such an evaluation could contribute (e.g. Parliamentary reporting, second EMR Delivery Plan), it is anticipated that such an evaluation could take place in 2017-18. In addition to facilitating observation of any enduring impacts, this larger evaluation could also incorporate some of the findings from the individual process evaluations already undertaken.

245. Given the far-reaching and all-encompassing nature of EMR, it will not be possible to assign any 'treatment' and 'control' groups. This makes the construction of any counterfactual – both for the 'process' evaluations and overarching 'impact' evaluation – very difficult.

*Key evaluation questions*

246. The key evaluation questions are grouped under the following three headings, though we will welcome consultees' views on these, as they will be developed further through the process of finalising the evaluation plan over the next 6 months:

- What difference did the policy make?
- What was delivered?
- How was the policy delivered?

*What difference did the policy make?*

247. Due to the difficulties outlined above in attributing observable outcomes to EMR-specific workstreams, it is critically important to accurately specify the evaluation questions of interest at the outset. Some key evaluation questions are outlined below.

Decarbonisation

- Have cost of capital reductions for low-carbon investors been achieved?
- Have estimated cost reductions in low-carbon technologies (through learning effects associated with increased deployment) been achieved?
- Has the average emissions intensity of electricity generation been reduced?

Security of supply

- Has the incidence of supply shortages (blackouts and brownouts) been reduced?

Affordability

- What has happened to average consumer electricity bills? Have estimated reductions been achieved? What has been the impact across different types of households?

**Q1. Do you agree with the above questions on the difference that the policy made? Do you have any suggestions for additional or different questions?**

*What was delivered?*

248. In addition to looking at the outcomes that have been achieved and the extent to which these are attributable to EMR specifically, it is necessary to look at whether the processes for delivering EMR were successful and the extent to which they have been cost-effective. Some potential evaluation questions in relation to this issue are detailed below.

- Have CfD auctions taken place as planned?
- Has new entry to capacity auctions been appropriately incentivised?
- Where they have been required, have capacity auctions taken place as planned?
- Have Demand Side Response and storage providers been able to participate effectively in capacity auctions?
- Has there been an increase in investor confidence for investment, in flexible capacity and/or low-carbon generation?

**Q2. Do you agree with the above questions on what the policy delivered? Do you have any suggestions for additional or different questions?**

*How was the policy delivered?*

249. It is important to have a view on delivery of the policy, to ensure that any potential for informing future policy design are realised. Some example evaluation questions are below:

- How effective was allocation of CfD funds across different technologies at incentivising deployment?
- Was design of Capacity Market auctions effective at promoting new entry/investment, either in generation capacity or Demand Side Response/storage?
- Was sufficient capacity procured in auctions, at both four-year and year-ahead stages?
- Was split between four-year and year-ahead capacity auctions suitable/appropriate?
- What factors were important in driving take up of CfDs?

**Q3. Do you agree with the above questions on how the policy was delivered? Do you have any suggestions for additional or different questions?**

*Monitoring*

250. Data will be required throughout all stages of the programme, both on the anticipated and unanticipated impacts. This data will be collected as part of the project, economic and contract management processes and is being incorporated as part of the development of commercial case and project management environment.

251. Due to the diversity of the projects that comprise the EMR programme, there is a wide range of potential data that needs to be collected, which have been organised under the following headings:

- Monitoring and performance data
- Quantitative evaluation data
- Qualitative evaluation data
- Secondary data

<u>Monitoring and performance data</u>

- How many CfDs have been signed, and at what price;
- Capacity of agreed CfDs (split by technology)
- Capacity margin/risk of customer disconnection/number of system stress events

Quantitative evaluation data

- Average emissions intensity of power sector
- Realised reductions in hurdle rates for CfD recipients
- Amount of capacity procured through auctions

Qualitative evaluation data

- Investor attitudes to investment in low-carbon generation

Secondary data

- GVA in the energy sector
- Net additional jobs created in the energy sector
- Wholesale and retail electricity prices
- Total greenhouse gas emissions
- Investment in electricity infrastructure (generation & networks)

**Q4. Do you agree with the above list of potential monitoring & performance indicators? Do you have any suggestions for additional or different indicators?**

*Next steps/development*

252. We intend to develop this framework over the next 6 months, with a view to finalising an evaluation plan for EMR, to be published alongside the final Delivery Plan, once the Energy Bill has achieved Royal Assent (anticipated to be December 2013). We will be commissioning further analysis from external consultants to help us with this development process. Part of this work will be to engage with interested stakeholders; we will publicise plans for this once a contractor has been appointed.

List of questions

**Q1. Do you agree with the above questions on the difference that the policy made? Do you have any suggestions for additional or different questions?**

**Q2. Do you agree with the above questions on what the policy delivered? Do you have any suggestions for additional or different questions?**

**Q3. Do you agree with the above questions on how the policy was delivered? Do you have any suggestions for additional or different questions?**

**Q4. Do you agree with the above list of potential monitoring & performance indicators? Do you have any suggestions for additional or different indicators?**

## Annex G: Delivery Plan scenarios – reflecting uncertainty

253. Given the considerable uncertainty over how the electricity sector will develop to 2030, we have developed different sets of assumptions to represent other potential future scenarios, which can then be modelled using DDM analysis.

254. It is assumed that EMR measures are generally deployed to achieve a least-cost decarbonisation pathway. However, there is uncertainty about how the electricity sector will develop over the longer term. Supporting a diverse generation mix in the medium term will help manage some of the technology risks associated with achieving the sector's share of the 2050 economy-wide 80% decarbonisation target. Over time, it is expected that the benefits of competition can be realised by moving to competitive price-setting for low-carbon technologies.

**Scenarios**

255. National Grid carried out analysis for DECC to explore the implications of a number of strike price scenarios for delivery of Government policy[168]. These illustrate alternative 'views of the world', which can be used to inform and guide strike price setting, as well as sensitivity analysis to highlight the risks associated with the underlying assumptions.

256. In looking at the importance of different drivers for the setting of strike prices, we have focused on two sets of scenarios relating to technology cost assumptions and high electricity demand. This is intended to capture variations across two key input assumptions, which will impact on the outcomes we are seeking to deliver through EMR. Below we consider how changes in these variables – as set out by National Grid in the scenarios they consider in their report – impact on key aspects of the electricity market under EMR (e.g. generation mix, wholesale price).

*Technology costs*

257. Capital costs will vary across projects, which the model takes into account. However, such costs are also uncertain, especially further into the future. Therefore, to take account of this, National Grid have run two different technology cost scenarios – one with higher technology costs and one with lower technology costs.

Technology costs – low

258. This scenario tests the impact on the generation mix and support costs of lower technology costs as compared to those assumed in the core scenarios. The scenario assumes that low, central and high capital costs are 10% lower. This is to reflect a

[168] Annex E of the draft Delivery Plan, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223655/emr_consultation_annex_e.pdf

downward risk/uncertainty in capital costs. Strike prices are also set lower from 2019, to reflect the lower technology costs.

259. Under the low-technology cost scenario, the level of draft CfD strike prices (set according to the central technology cost assumptions) means that returns to investors are greater than under the central EMR scenario. This incentivises greater deployment of renewable technologies – onshore and offshore wind, as well as other renewables. As a result, a higher proportion of generation in 2020 comes from renewable sources, relative to the central EMR scenario (as shown in Chart 19 below)[169].

260. This higher proportion of renewable generation results in slightly lower wholesale prices up to 2020, relative to the central EMR scenario (see Chart 20 below). Lower wholesale prices and higher deployment result in higher CfD costs up to 2020, especially for wind (despite the strike prices being adjusted downwards). Although nuclear policy costs are lower, reflecting the lower strike price, higher CfD support costs mean that the LCF profile is exceeded from 2017/18.

Technology costs – high

261. This scenario tests the impact on the generation mix and support costs should technology costs turn out to be higher than those assumed in the core scenarios. The scenario assumes that low, central and high capital costs are 10% higher. This is to reflect an upward risk/uncertainty in capital costs. Strike prices are set higher than the core scenarios from 2018, to reflect the higher technology costs. This scenario also assumes low biomass conversions.

262. Under the assumption of high technology costs, fewer investors are incentivised to enter into CfDs relative to the central EMR scenario, as the return relative to the draft strike price is lower. Nevertheless, a similar generation mix is achieved as under the central EMR scenario. Up to 2020 there is less investment in biomass, but total offshore wind capacity is higher in 2020 (reflecting the higher strike price in 2019 and 2020 relative to the central EMR scenario), leaving the proportion of renewables generation only slightly lower than under the central EMR scenario. Despite the higher strike prices from 2018 onwards, up to 2020 the lower levels deployment for most renewables technologies means that the LCF envelope is met.

263. Wholesale prices are marginally lower than the central EMR scenario in 2020, reflecting the slight differences in the mix of renewables generation. Up to 2030, the difference in wholesale price from the central EMR scenario becomes progressively larger, reaching just over £2/MWh in comparison to the reference case by 2030.

[169] For further detail on capacity data associated with these scenarios, please see p.40-41 of Annex E of the draft EMR Delivery Plan

*High demand*

264. This scenario tests the impact on the generation mix and support costs of demand being higher than anticipated. It uses DECC's high demand projections[170]. This higher level of demand requires more generation capacity, including greater deployment of renewables, to maintain a proportion of renewable generation sufficient to meet the 2020 renewables target. Relative to the central EMR scenario, strike prices for most renewable technologies are higher from 2019.

265. In terms of the generation mix up to 2020, there are only minor differences relative to the central EMR scenario. The additional renewables deployment necessary to meet the renewables target is met by slightly greater generation from both onshore and offshore wind.

266. Higher demand (with minimal capacity differences up to 2020) results in higher wholesale prices, relative to the central EMR scenario. The higher strike prices from 2019 results in greater new build of renewables generation, which is needed to meet the 2030 decarbonisation ambition of 100g$CO_2$/kWh. This creates counteracting effects on wholesale prices – higher generation requirements puts upward pressure on wholesale prices, while a greater proportion of renewable capacity exerts a downward pressure. The net impact is that wholesale prices in 2030 are higher in the high-demand scenario than in the central EMR scenario.

267. Until 2018, total CfD support costs are slightly lower than the central EMR scenario (the combination of unchanged strike prices and higher wholesale prices). However, due to greater deployment of renewables technology towards the end of the decade, CfD support costs are higher in 2020, in comparison to the central EMR scenario.

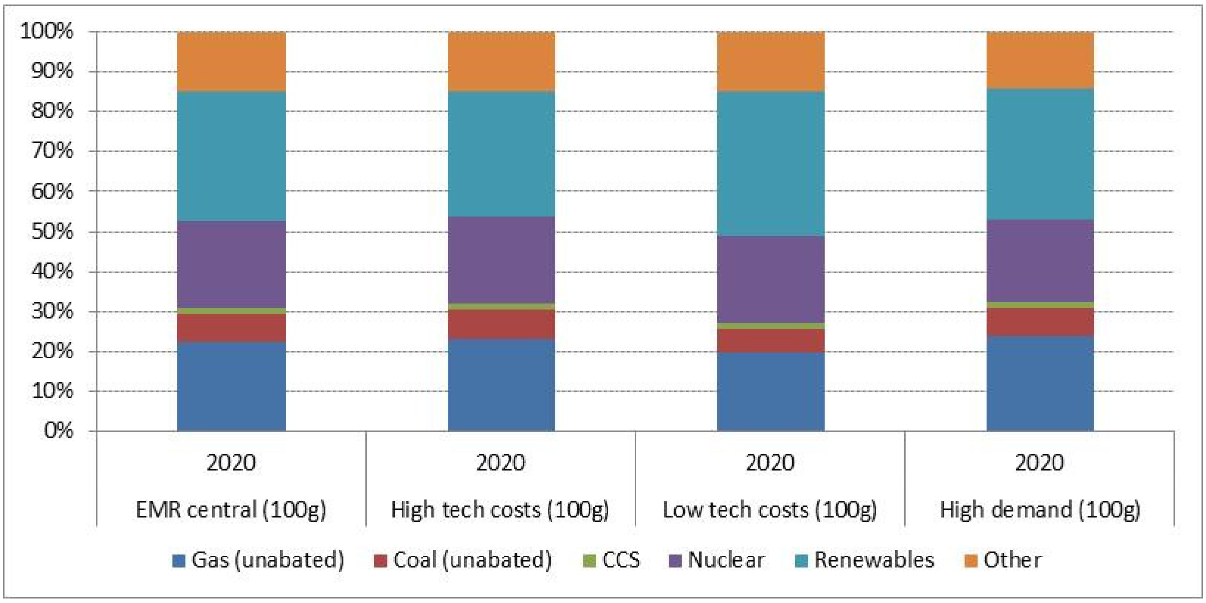
**Conclusions**

268. As shown in this section, there is still considerable uncertainty over how the electricity sector will develop to 2030 and beyond. Dispatch modelling is sensitive to a number of such assumptions (e.g. around inputs, methodology), which influence the capacity and generation mix realised under different scenarios.

269. The outcomes outlined in the main body of this impact assessment therefore represent a specific state of the world based on central assumptions. However, we have undertaken sensitivity analysis around a range of potential alternative scenarios (2030 decarbonisation levels, fossil fuel prices, post-2030 carbon prices), as well as different counterfactuals (including one without any decarbonisation ambition).

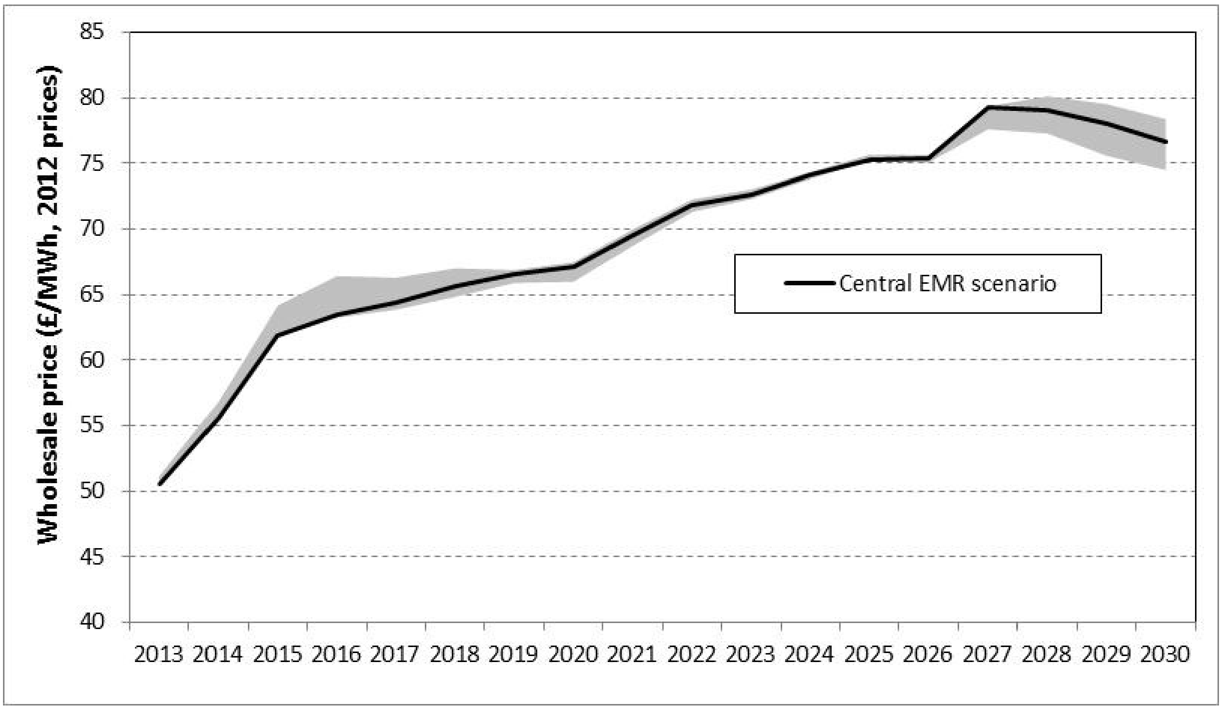
[170] For the high demand projections, the values are the higher of: the upper quartile of the distribution around Updated Energy Projection (UEP) annual demand, or National Grid's 2013 Gone Green scenario annual demand (http://www.nationalgrid.com/corporate/About+Us/futureofenergy/), adjusted to the same definition as UEP.

**Chart 19: Generation mix profiles (2020) – EMR, high/low technology cost and high demand scenarios**




*Source: DECC modelling*

**Chart 20: Variation in wholesale prices (2013-2030) – EMR, compared to high/low technology cost and high demand scenarios**




*Source: DECC modelling*