| Title: Electricity Market Reform – ensuring electricity security of supply and promoting investment in low-carbon generation [update: May 2013] | Impact Assessment (IA) |
|---|---|
| **IA No: DECC0130** | **Date:** 08/05/2013 |
| **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** |
| £4.2bn to £7.6bn | - | - | 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)**

The lead policy option to deliver low-carbon investment was identified in the EMR White Paper IA[2] as a feed-in tariff Contracts for Difference (FiT CfD); a summary of the evidence informing that decision is presented in this IA. Evidence supporting the lead option to mitigate risks to electricity security of supply, using a capacity market, is presented in the Capacity Market IA, which was published alongside the Energy Bill.

As announced when the Energy Bill was published, this IA has been updated to present Cost Benefit Analysis (CBA) and price and bill impacts as a result of updated 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 and include fossil fuel price sensitivities, in addition to reflecting the recent agreement over the Levy Control Framework to 2020/21.

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.

The analysis uses DECC's in-house Dynamic Dispatch Model (DDM)[3], and rather than a point estimate, presents a range representing possible counterfactuals that meet the same decarbonisation objectives. 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.

[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/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf
[3] https://www.gov.uk/government/publications/dynamic-dispatch-model-ddm

<table>
<tr><td colspan="6">Will the policy be reviewed? It will be reviewed. If applicable, set review date: 2018</td></tr>
<tr><td colspan="3">Does implementation go beyond minimum EU requirements?</td><td colspan="3">N/A</td></tr>
<tr><td>Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.</td><td>Micro<br>No</td><td>< 20<br>No</td><td>Small<br>No</td><td>Medium<br>No</td><td>Large<br>No</td></tr>
<tr><td colspan="3">What is the CO2 equivalent change in greenhouse gas emissions?<br>(Million tonnes CO2 equivalent)</td><td colspan="2">Traded:<br>-</td><td>Non-traded:</td></tr>
</table>

***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: ........................................ Date: 08 May 2013

## Summary: Analysis & Evidence — Policy Option 1

**Description:** Contracts for Difference (FiT CfD) Feed in Tariff combined with an administrative Capacity Market.[4]

**FULL ECONOMIC ASSESSMENT**

| Price Base | PV Base | Time Period | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| **Year** 2012 | **Year** 2010 | **Years** 20 | **Low: £4.2** | **High: £7.6** | **Best Estimate: £4.2 to £7.6** |

| **COSTS (£m)** | **Total Transition** (Constant Price) | Years | **Average Annual** (excl. Transition) (Constant | **Total Cost** (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **£1,400** |
| **High** | | | | **£1,600** |
| **Best Estimate** | | | | **£1,400 to £1,600** |

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

Relative to basecases which achieve a similar decarbonisation profile to that realised under EMR using existing policy instruments, namely the RO and carbon pricing, carbon costs up to 2030 are higher under CfDs, reflecting the slightly slower decarbonisation profile followed. NPV carbon costs are £740m to £880m higher under EMR up to 2030, relative to basecase A and B.[5]

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 £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.[6] 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.[7]

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

| **BENEFITS (£m)** | **Total Transition** (Constant Price) | Years | **Average Annual** (excl. Transition) (Constant Price) | **Total Benefit** (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **£5,700** |
| **High** | | | | **£9,100** |
| **Best Estimate** | | | | **£5,700 to £9,100** |

[4] The results presented in this summary are based on a carbon emissions intensity of $100gCO_2/kWh$ 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 $50gCO_2/kWh$ and $200gCO_2/kWh$ in 2030.

[5] 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.

[6] 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.

[7] A midpoint estimate of around £700m is used in both Basecase A and B. 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 administrative costs of greater reliance on carbon pricing or the RO might be in the basecase scenarios.

| 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 revenue certainty from CfDs allows financing at a lower cost. Latest estimates, derived from the DDM model in conjunction with independent evidence on maximum possible reductions (presented in Annex A), utilise hurdle rate reductions of up to 1.2 percentage points, depending on the technology type.<br><br>Depending on the assumed level of decarbonisation in 2030, CfDs would generate an NPV of between £2.1bn and £4.1bn from lower costs of capital (up to 2030, including administrative costs), £6.6bn to £11bn up to 2040 and £12bn to £16bn up to 2049.<br><br>In addition to the technology mix impacts of CfDs being better able to target a cost-effective generation mix (in comparison to existing policy instruments) modelling also quantifies the unserved energy benefits. | |
| **Other key non-monetised benefits by 'main affected groups'**<br>For domestic consumers, EMR has the potential to reduce average annual household electricity bills, relative to a basecase which achieves the same decarbonisation level using existing policy instruments. The impact on average bills for businesses and energy-intensive industries will be similar. | |
| **Key assumptions/sensitivities/risks** **Discount rate (%)** | 3.5% |
| 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.<br><br>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. | |

**BUSINESS ASSESSMENT (Option 1)**

| Direct impact on business (Equivalent Annual) £m: [8] | | | In scope of OIOO? | Measure qualifies |
|---|---|---|---|---|
| **Costs:3,020 to 5,070** | **Benefits: 3,870 to 5,910** | **Net: 1,000** | No | N/A |

[8] 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

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## Section 1 Overview

1. This Impact Assessment is an update to the IA previously published in February 2013 (which itself updated the analysis presented in the IA alongside the Energy Bills introduction in November 2012). It reflects a small change to the overall NPV estimates, to reflect updated, and slightly higher administrative costs, as well as a number of small changes to update links and make drafting corrections.[9] No other changes have been made to the analysis or IA.

2. The EMR Impact Assessment (IA) published alongside the Energy Bill in November 2012 stated that the analysis would be updated early in 2013, to incorporate additional carbon emission intensities for the power sector in 2030 (50g$CO_2$/kWh and 200g$CO_2$/kWh), as well as a range of fossil fuel price scenarios. This would also allow for the modelling to reflect the impact of the Levy Control Framework, which was agreed in November 2012 for 2020/21.

3. During the Second Reading of the Energy Bill on 19th December 2012, Minister of State for the Department of Energy and Climate Change John Hayes committed to publishing the updated IA ahead of Committee stage for the Energy Bill (due to commence on 15th January 2013), to enable Parliament to engage in debate and scrutiny based on the latest analysis. The modelling results reported in this IA, as well as the IA accompanying the Energy Bill in November 2012, use DECC's in-house Dynamic Dispatch Model (DDM).[10]

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. The analysis also reflects the recent agreement over the Levy Control Framework to 2020/21[11].

5. In addition to analysis 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, this IA includes analysis based on average emissions levels of both 50g$CO_2$/kWh and 200g$CO_2$/kWh in 2030. There is also a range of fossil fuel price scenarios.

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[9] The presented Net Present Values (NPVs) for EMR and CfDs are between £0.2 and £0.3bn smaller than previously presented in the February 2013 IA to reflect updated administrative costs which are around £300m higher than previously assumed (NPV, 2012-2030). The increased costs reflect further clarification on the role of administrative bodies, and the costing requirements associated with those roles, as well as inclusion of administrative costs estimates associated with CfDs to energy sector businesses.

[10] 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.

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

6. The analysis shows that the design of EMR and FiT CFDs will lower the financing costs of the large investments needed in electricity infrastructure. This is the case for decarbonisation levels in the sector of 50g$CO_2$/kWh, 100g$CO_2$/kWh and 200g$CO_2$/kWh in 2030.

7. EMR IAs of December 2010[12], July 2011[13], May 2012[14] and November 2012[15] 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.[16]

    - A Capacity Market is the preferred instrument to mitigate security of supply risks compared to alternatives, including a strategic reserve and doing nothing.[17]

    - An Administrative Capacity Market is the preferred form of the capacity market compared with a reliability option.[18]

8. 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. In this analysis we have updated our assessment of the costs and benefits of the EMR package, the details of which are set out below.

9. As a result of the updated analysis, net welfare figures have changed from the estimates published alongside the Energy Bill in November 2012. However, the relative ordering of the policy choices has not changed.[19]

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[12] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf
[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf
[14] 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
[15] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66038/7105-contracts-for-difference-impacts-assessment-emr.pdf
[16] 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.
[17] 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).
[18] 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.
[19] 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 November 2012*

10. The modelling now includes a 2020 budget, as set under the recent agreement over the Levy Control Framework (LCF).[20] This has resulted in revised modelling for the DDM baseline and EMR scenarios to ensure consistency with that budget.[21] This has led to small changes in the profile and timing of new-build decisions, and hence the generation mix, in both the counterfactual and EMR scenarios.[22]

11. The key changes in the NPV estimates under the latest modelling, relative to the previous estimates published in November 2012, are not due to LCF-related issues. The value of the changes in the NPV estimates between November 2012 and this update is shown in the table below. These mainly reflect: cost of capital (financing cost) changes; improvements to modelling of the capacity market, and changes in the technology mix impact. These are discussed in more detail below.

12. In undertaking the cost-benefit analysis for EMR (i.e. CfD and a Capacity Market), the policy package is compared to two potential basecases without the EMR package. These basecases reflect the alternative ways of achieving the same decarbonisation ambition as EMR, using existing instruments (e.g. Renewables Obligation and carbon pricing). Under Basecase A, existing instruments are used to achieve the same profile in nuclear new build as under EMR; under Basecase B, these are used to achieve the same profile in nuclear and CCS new build as under EMR. Therefore, the net welfare impact of EMR is reported as a range.

**Table 1: Change in Net Welfare (NPV) – combined EMR impact (2012-2030), comparison of November 2012 and January 2013 figures[23] (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | NPV, £bn (2012-2030, real 2012 prices) | | | | | |
|---|---|---|---|---|---|---|
| | Basecase A | | | Basecase B | | |
| | Nov 2012 | April 2013 | Difference | Nov 2012 | April 2013 | Difference |
| **EMR: Total NPV** | **+7.4** | **+7.6** | **+0.2** | **+1.3** | **+4.2** | **+2.9** |
| **Contracts for Difference** | **+9.1** | **+8.2** | **-0.9** | **+3.1** | **+4.8** | **+1.7** |
| *- Financing impact* | *+1.7* | *+3.0* | *+1.3* | *+1.7* | *+3.0* | *+1.3* |
| *- Technology mix impact* | *+7.4* | *+5.1* | *-2.3* | *+1.3* | *+1.8* | *+0.5* |
| **Capacity market** | **-1.7** | **-0.6** | **+1.1** | **-1.7** | **-0.6** | **+1.1** |

[20] This sets the budget for the levels of consumer levy spend in 2020, including spend under the FIT CfD, Renewables Obligation and existing small-scale FITs mechanisms
[21] For further detail, please see Annex A
[22] 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.
[23] Inclusive of administrative costs

Source: DECC modelling

13. The first change relates to the cost of capital and is the same for both Basecase A and Basecase B. The change reflects an improved methodology for measuring cost of capital reductions from EMR. The latest analysis uses updated hurdle rate assumptions. Previously, it was assumed that only low-carbon plant with a decision year of 2016 or later would benefit from hurdle rate reductions. However, as CfDs can impact on project finance rates from when they are first issued (in 2014), this has been altered to ensure that hurdle rate reductions are also applied to low-carbon plant with a decision year before 2016. This has the effect of increasing the cost of capital benefits associated with EMR up to 2030, **from £1.7bn in November 2012 to £3.0bn in the latest analysis**.

14. The second key change relates to the impact of the Capacity Market, which is again common to both Basecase A and Basecase B. This change amounts to an overall **increase from -£1.7bn in November 2012 to -£0.6bn in the latest analysis**. This difference is due to three factors:

- The first reflects a more consistent treatment of the costs of plant built near the end of NPV assessment periods. Previously, the costs of this additional capacity were included, even though delivery did not occur until after the assessment period. The impact of this change reduces the capital costs associated with the capacity market by roughly £0.6bn.

- The second change is in the modelling of peak demand and unserved energy benefits. Since November 2012, the DDM model has been updated to include a 'hyper-peak' day, the effect of which is to reduce unserved energy benefits by approximately £0.2bn.

- Finally, there are also changes in the generation mix produced under the counterfactual scenario with no capacity market. This output from the DDM model is a direct reflection of the updated input assumptions (in Annex A). These collectively lead to a reduction in the relative difference in the carbon intensity of electricity generation between EMR and the counterfactual scenario. The combined carbon and generation costs decrease by around £0.7bn.

15. The final key change is in relation to the technology mix. The methodological approach in modelling the counterfactual scenarios is to match the EMR scenarios' generation mix as closely as possible, subject to meeting the required decarbonisation trajectory. The rationale for this is to isolate as much as possible the cost-effectiveness of EMR as a tool for decarbonising, rather than conflate this with the achievement of a particular technology mix. However, this matching is not perfect year-on-year and with the above changes to modelling methodology (as highlighted in paragraphs 13-14) and the updated assumptions in the DDM (as set out in Annex A), slight differences in tracking the EMR generation mix can affect the NPV figures for the "technology mix impact".

Relative to the November 2012 analysis, this results in a **net reduction in the NPV for EMR of £2.3bn** (in the case of Basecase A) and a **net increase in the NPV of £0.5bn** (for Basecase B).

*Overall impact of EMR*

16. In a scenario where power sector emissions are 100gCO2/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 between **£4.2bn and £7.6bn up to 2030**, with larger benefits up to 2050. Due to the methodological changes detailed above, both the upper and lower ranges of this NPV are slightly higher compared to the equivalent figures published in November 2012 (£1.3bn to £7.4bn). Further detail is given on the NPVs for each basecase in section 2.3.

**Table 2: Net Present Value (NPV) – Impact of EMR policy package relative to basecases A & B, assumed emissions intensity of 100gCO2/kWh in 2030**

| Total NPV, £bn (2012 prices) | | 2012-2030 | 2012-2040 | 2012-2049 |
|---|---|---|---|---|
| | | **+£4.2 to +£7.6** | **+£12 to +£20** | **+£15 to +£26** |
| **Contracts for Difference** | | **+£4.8 to +£8.2** | | |
| | *- Financing Impact* | *+£3.0* | | |
| | *- Technology Mix impact* | *+£1.8 to +£5.1* | | |
| **Capacity Market** | | **-£0.6** | | |

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

*Additional scenarios*

17. Further to the changes outlined above, we have included additional scenarios in this update compared to the IA published in November 2012. This IA 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). The impact on EMR of different fossil fuel price assumptions is also assessed for the 100g$CO_2$/kWh scenario. The impact of these various scenarios on the overall NPV for EMR is detailed below.

*Decarbonisation scenarios*

18. 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 – **£5.3bn for 50g**, **£4.2bn to £7.6bn for 100g** and **£1.9bn for 200g**.[24] As for

[24] Further detail on the NPV of different decarbonisation scenarios is available in section 2.3; price & bill impacts are available in section 2.4. 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.

100g, the figures for the 50g and 200g scenarios are different to those published in November 2012 (£1.2bn and -£3.6bn respectively), with the current figures both being slightly higher.

**Table 3: Change in Net Welfare (NPV) – combined EMR impact (2012-2030)[25], emission intensities of 50g, 100g and 200g$CO_2$/kWh**

| NPV, £bn (2012-2030, real 2012 prices) | Decarbonisation target in 2030 (g$CO_2$/kWh) | | |
|---|---|---|---|
| | 50 | 100 | 200 |
| **EMR: Total NPV** | **+5.3** | **+4.2 to +7.6** | **+1.9** |
| **Contracts for Difference** | **+5.2** | **+4.8 to +8.2** | **+2.4** |
| *- Financing impact* | *+4.1* | *+3.0* | *+2.1* |
| *- Technology mix impact* | *+1.0* | *+1.8 to +5.1* | *+0.3* |
| **Capacity market** | **+0.1** | **-0.6** | **-0.5** |

Source: DECC modelling

19. The key benefits of decarbonising using EMR are reducing financing costs for investors and minimising generator rents under high wholesale prices. The greater revenue certainty from CfDs allows financing at a lower cost. Latest estimates, derived from the DDM model in conjunction with independent evidence on maximum possible reductions (presented in Annex A), utilise hurdle rate reductions of up to 1.2 percentage points, depending on the technology type. 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): £2.1bn for the 200g scenario, £3.0bn for the 100g scenario and £4.1bn for the 50g scenario.

20. The overall impact of CfDs on the NPV for EMR also depends on the technology mix impacts. These do not vary in a direct linear fashion with the decarbonisation level. For example, such benefits are lower for both 50g (£1.0bn) and 200g (£0.3bn) scenarios than for 100g (£1.8bn to £5.1bn). These differences reflect the comparative difficulty of an exact matching of the EMR generation mix to reach an emissions intensity of 100g$CO_2$/kWh in 2030, relative to targeting 50g or 200g. This is also why we have modelled the 100g scenario with two basecases – Basecase A and Basecase B.

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

- For 100g, the NPV of the capacity market is -£0.6bn;

[25] Inclusive of administrative costs

- 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 overall NPV is similar (-£0.5bn);

- However, for a 50g target in 2030, the NPV of the capacity market is slightly positive (£0.1bn).[26]

22. 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 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. Under this basecase, EMR produces a net negative welfare impact of **-£4.2bn up to 2030** (up from -£6.7bn in November 2012). However, such a scenario does not decarbonise as much as EMR and does not mitigate against security of supply risks.

*Fossil fuel price sensitivities*

23. The robustness of EMR to different assumptions about fossil fuel prices has been tested using the 2012 update to DECC's annual fossil fuel price projections.[27] 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.[28]

24. Under high fossil fuel prices, EMR is a more cost-effective tool to achieve decarbonisation, generating a positive impact of **£4.6bn 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 still generates a positive impact of **£5.3bn up to 2030**.

*Prices & bills impacts*

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[26] Given that the model has been set to target a non-zero level of capacity, we would expect the 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. This leads to understatement of the benefits of a Capacity Market. However, it could be imagined that a scenario in which a greater proportion of intermittent and/or inflexible low-carbon generation is required, to meet a lower decarbonisation level, might lead to more significant benefits from a capacity mechanism.

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

[28] The single basecase for different fossil fuel price scenarios reflects the constraint placed on the modelling of replicating the generation mix produced under EMR. In terms of a comparison to the basecases under the central 100g scenario, this is closest to Basecase B and therefore could be thought as providing a lower bound estimate of the benefits of EMR.

25. For domestic consumers, EMR has the potential to **reduce average annual household electricity bills by between 6% and 8% (£38 to £53) over the period 2016-2030**, relative to a basecase which achieves the same decarbonisation level of 100g$CO_2$/kWh using existing policy 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 domestic electricity bills, relative to basecases A & B (assumed emissions intensity of 100g$CO_2$/kWh in 2030)**

| Time Period | Impact of EMR on domestic electricity bills, relative to basecases A & B (real 2012 prices) |
|---|---|
| **2016-2030** | -£38 to -£53 (-6% to -8%) |

Source: DECC modelling

# Section 2 Updated Cost Benefit Analysis (CBA)

## 2.1 Rationale for intervention

### 2.1.1 Decarbonisation

26. 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.

27. 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.

28. 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.

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

30. 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.

31. 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.

32. 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.

33. 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.

34. 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.[29]

35. 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.

36. 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

37. 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 as

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

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 real-time responsive market to evolve.

38. In 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.

39. 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 and as the power system decarbonises. The market may also fail to provide incentive for capacity built 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.

40. In the Electricity Market Reform White Paper[30], we set out the potential market and regulatory failures in the current market that could prevent these signals from being realised.

41. 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.

42. 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.

43. 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

[30] 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.

44. 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 so 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.

45. This has not previously been a significant concern as prices historically have not risen above £938/MWh[31] 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.

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

## 2.2 Option under consideration

46. The modelling work for EMR 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 Green Book social discount rates.[32]

47. 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.[33]

### 2.2.1 EMR Package

48. This IA presents an updated analysis of the lead EMR package modelled against a range of basecases. The EMR package includes a low-carbon instrument (the CfD) and a Capacity Market, combined with an Emissions Performance Standard (EPS). Carbon pricing is included in the basecases against which the policy package is assessed.[34]

49. 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.

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

[33] 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

[34] 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.

50. 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.

51. The analysis shows that the design of EMR and FiT CFDs will lower the financing costs of the large investments needed in electricity infrastructure. This is the case for decarbonisation levels in the sector of 50g$CO_2$/kWh, 100g$CO_2$/kWh and 200g$CO_2$/kWh in 2030.

52. The modelling results presented show CfDs continuing to be issued post-2030.[35] 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.[36]

*Contracts for difference*

53. The Government's choice of the CfD as the preferred policy instrument was set out in full in the EMR White Paper (July 2011) and the analysis presented in this IA only updates the costs and benefits associated with CfDs. However, in summary, the White Paper assessment considered two options for driving investment in low-carbon generation:

- A Premium Feed-in Tariff (PFiT), where all low-carbon generation receives a static premium payment on top of the wholesale electricity price;
- A Feed-in Tariff with Contracts for Difference (CfD) for all low-carbon generation, guaranteeing all low-carbon generation a strike price for the electricity they produce, settled against an indicator of the wholesale electricity price.

[35] This is also true for analysis of different decarbonisation scenarios and fossil fuel price sensitivities
[36] 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 (and Capacity Market if required) 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).

54. The preference for a CfD over a PFiT was based on the CfD's ability to promote static and dynamic efficiency through allocating risk efficiently between investors and consumers. This is achieved by allocating risk to those parties best able to manage or control it. For example, the CfD insulates investors in low-carbon generation from electricity price risk, which they are unable to control.

55. The impact of this risk being transferred is that consumers are not affected by higher wholesale prices (for instance caused by higher gas prices) but equally do not benefit from lower wholesale electricity prices (for instance caused by lower gas prices). Note that this is only the case for the part of their bill related to paying for generation under the CfD.

56. As a result of lower exposure to fossil fuel price risk and the greater revenue certainty which this gives, the cost of capital for investors in low-carbon generation is lower under a CfD than under a Premium FiT. In the White Paper IA this was quantified: financing costs are expected to be lower by £2.5bn over the period to 2030 as a whole under a CfD than a Premium FiT. [37] For this latest analysis, the hurdle rates are primarily based on data from Oxera[38] (2011) and Arup[39] (2011), with initial hurdle rates for renewables drawn from the Renewables Obligation Banding Review. The hurdle rate reductions are derived from the DDM model in conjunction with Oxera's maximum possible hurdle rate reductions.[40] They are presented in Annex A and show reductions up to a maximum of 1.2 percentage points depending on the technology type.

57. It is assumed that EMR measures are generally deployed to achieve a least-cost decarbonisation pathway. However, in order to take account of uncertainty in the future costs of alternative technologies, for the purposes of modelling it has been assumed 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

[37] This figure is not directly comparable to either the £1.7bn cost of capital reduction (included in the November 2012 analysis), or the £3.0bn figure referred to above; this previous figure was generated by a different model (Redpoint), using a variety of different assumptions (e.g. costs, demand)

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

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

[40] Oxera conclude that targeted support for a technology could reduce hurdle rates for "non-risky" mature technologies, e.g. CCGTs by 0-2% and for more risky, less mature technologies e.g. offshore wind by 2-3%. To calculate the impact of the reduction in risk as a result of CfDs, a baseline was first run with current RO banding levels. This was done using the stochastic mode in DDM with each simulation including inter alia a different outturn for fossil fuel prices. This gave a distribution of returns to investment in each technology under the RO. This was then compared to a run with CfDs to get a new distribution of returns. The summary measure of risk used to compare the two distributions was the downside spread in returns, measured by the spread between 10% and the median of returns. The reduction in hurdle rate as a result of the policy is then calculated based on the proportional reduction in this risk measure from the baseline run i.e. if risk is reduced for a risky technology by half, then the effect on hurdle rates is a reduction of 2.5 (mid-point of Oxera range) multiplied by half = 1.25%.

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.

*Capacity Market*

58. 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.

59. The lead 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 in addition to energy market incentives if they fail to be available at times of scarcity and where providers are able to keep any revenues they earn in the energy market).

60. The alternative form of Capacity Market considered is a Reliability Market. Under this option providers are required to pay back the difference between a real-time reference price and the strike price. This insures consumers against the risk of price spikes and gives providers a market-based incentive to be available when needed.

61. The Administrative Capacity Market is currently the preferred form of Capacity Market for two reasons. Firstly, there is no appropriate reference price for a Reliability Market in the absence of cash out reform, as current prices do not fully reflect the value of scarcity and so would not provide sufficient incentive for providers to be available when needed. By contrast an Administrative Capacity Market reinforces market signals for plants to be available when needed as providers lose part of their capacity payment (in addition to forgoing energy market revenue) at times of system scarcity.

62. The second reason why the Administrative Capacity Market is the preferred option is that it does not create additional risk for providers wishing to sell energy forward: under a Reliability Market, by contrast, providers that sell energy forward would be exposed to significant basis risk – whereby they are paid according to the forward price but have a liability to pay the real-time price. For generators to hedge this risk they would likely either cover their position by purchasing financial options when they sell energy forward or they would sell energy into the real-time market and buy financial products to hedge price risk up to that point. However the transition to purchasing financial products is potentially costly, particularly in the implementation phase until appropriate liquid markets emerge.

63. More detail on the full options appraisal for options mitigating security of supply risks is provided in the Capacity Market impact assessment.

64. 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.

### 2.2.2 Basecase

65. In undertaking the cost-benefit analysis for EMR with the CfD and a Capacity Market, 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.[41]

*Security of supply under the basecase*

66. Modelling of the basecases 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 basecases 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 £10,000/MWh) at times of scarcity. Modelling also assumes that investors have certainty about demand when deciding whether to build capacity.

67. As a result of these assumptions, modelling is likely to overstate the costs of a Capacity Market, as it assumes an unrealistically perfect energy-only market where prices can reflect scarcity and where investors have perfect certainty of demand when choosing

[41] 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.

whether to build a new plant.[42] The Capacity Market is intended to mitigate the risk of market failure – particularly from missing money – leading to underinvestment in reliable capacity.

*Modelling assumptions on decarbonisation, security of supply and renewable objectives*

*Renewables targets under the basecase*

68. Under the basecase the EU target for 15% renewable energy consumption across the UK economy by 2020 is assumed to be met with around 30% of electricity generated coming from renewables by 2020.[43] The latest modelling is in line with stated ambitions in the RO banding review for large-scale renewable domestic deployment in 2020.[44] Renewable policy objectives after this date vary across the different basecase scenarios (discussed further below).

*Decarbonisation ambitions under the basecases*

69. 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.[45] Consistent with the November 2012 IA, we are therefore comparing the EMR package against alternatives which meet a similar decarbonisation profile as 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).

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[42] In the modelling, this means 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.

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

[44] 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.

[45] Previous analysis of EMR prior to November 2012 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).

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

71. 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; in particular, the difficulty of defining the policy environment in a counterfactual world without EMR. This was also true of earlier modelling. However, as previous modelling assessed EMR up to 2030, and modelled a basecase where decarbonisation ambitions are not met, earlier modelling focused on current Government commitments (i.e. a continuation of the RO and carbon pricing based on existing commitments).[46]

72. The policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown.[47] The basecases presented below have been designed to achieve a similar decarbonisation profile to that realised under EMR using existing policy instruments, namely the RO and carbon pricing. 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, two separate hypothetical basecases have been developed, leading to a range of NPV estimates below. The two scenarios are defined as:

- **Basecase A (nuclear only)**: Carbon prices increase pre-2030 to achieve the same profile in nuclear new build as achieved under EMR. To realise deployment of the first new nuclear plants as under EMR, the carbon price is increased to £100 per tonne in 2019. The carbon price value is held at this level until 2030, before rising linearly to 2049, to a level consistent with long-term decarbonisation ambitions. The RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies. The carbon price does not rise high enough by 2030 to make CCS economically viable.

- **Basecase B (nuclear and CCS)**: Carbon prices increase pre-2030 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 plants as under EMR, the same carbon price as in the scenario above is used. However, to generate investment in CCS technology by the end of the 2020s the carbon price must rise to around

[46] Carbon pricing is currently based on a combination of the EU-ETS and the carbon price floor (CPF). 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).

[47] As the focus of these no-EMR counterfactual basecases is EMR's relative efficiency in meeting the 2030 decarbonisation ambition, in all basecases the 2040 and 2049 emission intensity levels are met in the same way. Carbon prices increase post-2030, leading to a long-term emissions intensity in 2040 and 2049 consistent with that achieved under EMR.

£180/tonne by 2030. The carbon price value is held at this level until 2049. As for Basecase A, the RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies.

73. Table 5 provides a summary of the different outcomes and policy environments assumed under each basecase scenario.

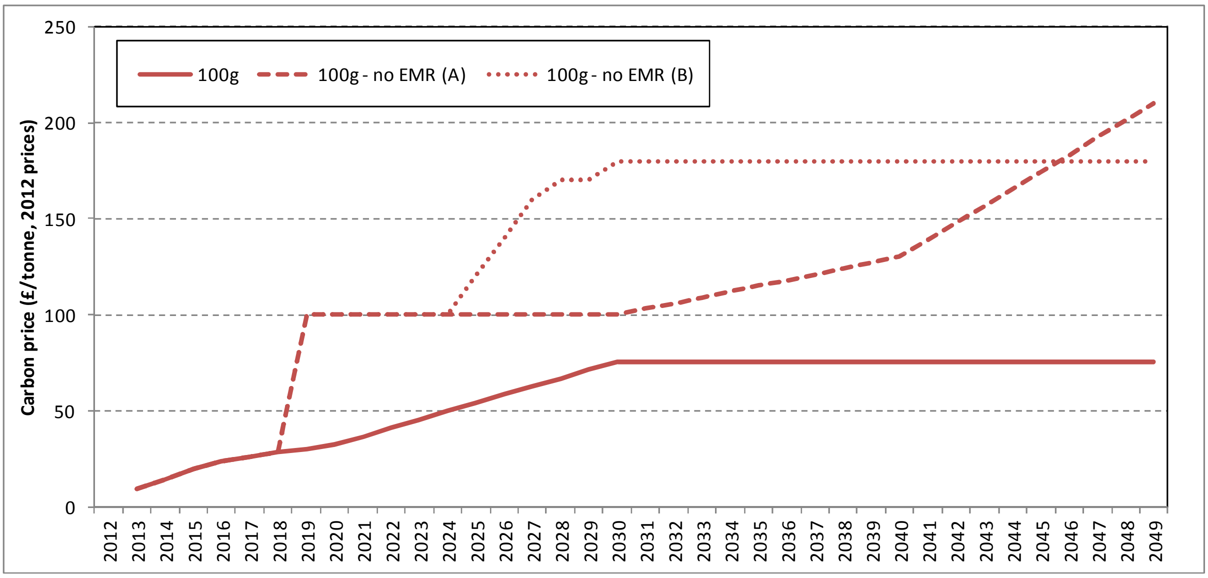
**Table 5: Summary of assumptions – Basecase A and Basecase B**

| | 2030 emissions intensity $gCO_2$/KWh | 2049 emissions intensity $gCO_2$/KWh | Carbon pricing | Renewables Obligation (RO) |
|---|---|---|---|---|
| Basecase A | 105 | 24 | Carbon prices increase to £100/tonne in 2019, remaining at that level until 2030, when carbon prices rise linearly to 2049 to a level 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.[48] |
| Basecase B | 101 | 22[49] | Carbon prices increase to £100/tonne in 2019, and rises to £180/tonne in 2030 and remains at that level until 2049 (broadly consistent with long-term decarbonisation ambitions). | |

74. Chart 1 presents the assumed profile of carbon prices. Further details of Basecase A and Basecase B (including decarbonisation profiles and generation mixes) are presented in Annex C.

[48] The total amount of renewable support under Basecase A is larger than under Basecase B, as more renewables are needed to meet the 2030 target in the absence of CCS. Annex C discusses in more detail.
[49] Although Basecase B meets the required emissions intensity target in 2049, its emission intensity in 2040 (31g) is much lower than that of either Basecase A (50g) or the EMR scenario (47g). 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.

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




Source: DECC modelling

75. 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).[50] This therefore 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.

76. 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

77. This section assesses the benefits of EMR as a whole (i.e. combined impact of CfDs and the Capacity Market), before the individual impact of CfDs and the Capacity Market are presented.

78. The tables below present the NPV results from assessing EMR (across different decarbonisation levels) relative to Basecase A and Basecase B, both of which achieve the same decarbonisation ambition using the Renewables Obligation (RO) and the carbon price, but do not mitigate against security of supply risks. The NPV range reflects the alternative ways the carbon price and RO may be combined to realise these aims, as discussed above.[51]

[50] See Annex E

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

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

79. 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 basecases, results in welfare improvements of between **£4.2bn and £7.6bn**. Assessed up to 2049, EMR results in net welfare improvements of between **£15bn and £26bn**.[52]

**Table 6: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to Basecase A[53] (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 | -880 | -340 | -1,500 |
| | Generation cost savings | 63 | -2,700 | -2,200 |
| | Capital cost savings | 8,100 | 21,000 | 27,000 |
| | Unserved energy savings | 170 | 920 | 1,300 |
| | Cost of Interconnector energy saved | 760 | 1,000 | 1,300 |
| | **Change in Net Welfare** | **8,300** | **20,000** | **26,000** |
| | **Change in Net Welfare*** | **7,600** | | |

Source: DECC modelling

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

**Table 7: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to Basecase B (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 | -740 | -3,700 | -6,000 |
| | Generation cost savings | 1,100 | 2,200 | 4,400 |
| | Capital cost savings | 3,200 | 10,000 | 13,000 |
| | Unserved energy savings | 190 | 1,000 | 1,400 |
| | Cost of Interconnector energy saved | 1,200 | 1,900 | 2,200 |
| | **Change in Net Welfare** | **4,900** | **12,000** | **15,000** |
| | **Change in Net Welfare*** | **4,200** | | |

Source: DECC modelling

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

[52] 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.

[53] In all NPVs values are discounted from 2010, in line with previous EMR IAs.

80. The overall NPV figures for both Basecase A (£7.6bn) and Basecase B (£4.2bn) are higher than those published in November 2012 (£7.4bn and £1.3bn respectively). There are three factors that explain this change:

- **Valuation of financing cost benefits**: The first of these reflects an improved methodology for measuring cost of capital reductions from EMR. The latest analysis uses updated hurdle rate assumptions. Previously, it was assumed that only low-carbon plant with a decision year of 2016 or later would benefit from hurdle rate reductions. However, as CfDs can impact on project finance rates from when they are first issued (in 2014), this has been altered to ensure that hurdle rate reductions are also applied to low-carbon plant with a decision year before 2016. This has the effect of increasing the cost of capital benefits associated with EMR up to 2030, from £1.7bn in November 2012 to £3.0bn in the latest analysis.

- **Capacity market modelling**: The second relates to the impact of the capacity market, which has increased from -£1.7bn in November 2012 to -£0.6bn in the latest analysis. This difference is due to:

    - More consistent treatment of the costs of plant built near the end of NPV assessment periods. Previously, the costs of this additional capacity were included, even though delivery did not occur until after the assessment period. The impact of this change reduces the capital costs associated with the capacity market by roughly £0.6bn.

    - Improved modelling of peak demand and unserved energy benefits. Since November 2012, the DDM model has been updated to include a 'hyper-peak' day, the effect of which is to reduce unserved energy benefits by approximately £0.2bn.

    - Changes in the generation mix produced under the counterfactual scenario with no capacity market. This output from the DDM model is a direct reflection of the updated input assumptions (in Annex A). These collectively lead to a reduction in the relative difference in the carbon intensity of electricity generation between EMR and the counterfactual scenario. The combined carbon and generation costs decrease by around £0.7bn.

- **Technology mix impacts**: The final relates to the technology mix. The methodological approach in modelling the counterfactual scenarios is to match the EMR scenarios' generation mix as closely as possible, subject to meeting the required decarbonisation trajectory. The rationale for this is to isolate as much as possible the cost-effectiveness of EMR as a tool for decarbonising, rather than conflate this with the achievement of a particular technology mix. However, this matching is not perfect year-on-year and with the above changes to modelling methodology (as highlighted in paragraphs 13-14) and the updated assumptions in the DDM (as set out in Annex A), slight differences in tracking the EMR generation mix can affect the NPV figures for the "technology mix impact". Relative to the November 2012 analysis, this results in a net reduction in the NPV for EMR of £2.3bn (in the case of Basecase A) and a net increase in the NPV of £0.5bn (for Basecase B).

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

81. 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[54], results in a net welfare improvement of **£5.3bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£19bn**.

**Table 8: 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 | -730 | -2,500 | -4,500 |
| | Generation cost savings | 1,300 | 2,000 | 2,600 |
| | Capital cost savings | 3,900 | 12,000 | 17,000 |
| | Unserved energy savings | 150 | 920 | 1,300 |
| | Cost of Interconnector energy saved | 1,300 | 1,900 | 2,100 |
| | **Change in Net Welfare** | **6,000** | **14,000** | **19,000** |
| | **Change in Net Welfare*** | **5,300** | | |

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*

82. 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[55], results in a net welfare improvement of **£1.9bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£5.2bn**.

[54] In contrast to a scenario in which power sector emissions in 2030 are reduced to an intensity of 100g$CO_2$/kWh, there is only a single basecase for this scenario, which is due to the comparative lack of flexibility in achieving the required reductions in carbon emissions by 2030 through the use of existing instruments (RO & carbon pricing)

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

**Table 9: 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 |
| | Value of carbon savings | -470 | 340 | -390 |
| | Generation cost savings | 1,400 | 3,800 | 8,000 |
| | Capital cost savings | 720 | -4,700 | -6,300 |
| **Net Welfare** | Unserved energy savings | 63 | 950 | 1,400 |
| | Cost of Interconnector energy saved | 810 | 1,900 | 2,500 |
| | **Change in Net Welfare** | **2,600** | **2,300** | **5,200** |
| | **Change in Net Welfare*** | **1,900** | | |

Source: DECC modelling

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

83. These results reflect the combined impact of decarbonising through CfDs and mitigating against risks to security of supply through a Capacity Market. In the following section, the impact of each of these two policy instruments is assessed in turn.[56]

### 2.3.1 Net Present Value of CfDs only

84. 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 10-13.

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

85. Relative to the basecases 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 between **£4.8bn and £8.2bn** to 2030.[57] The key benefit of CfDs is their

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

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

ability to lower the capital costs associated with decarbonisation – up to 2030, such benefits are estimated to be between **£3.3bn and £8.2bn**.[58]

86. As set out earlier, this latter benefit is higher than in figures published in November 2012 (by almost £1.5bn up to 2030, in the case of Basecase B). This is due to a revised methodology for measuring cost of capital reductions from EMR – previously, it was assumed that only low-carbon plant with a decision year of 2016 or later would benefit from hurdle rate reductions. However, as CfDs can impact on project finance rates from when they are first issued in 2014, this has been altered to ensure that hurdle rate reductions are also applied to low-carbon plant with a decision year before 2016.

**Table 10: Change in Net Welfare (NPV) – CfDs only, compared to Basecase A (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 | -820 | -220 | -260 |
| | Generation cost savings | 480 | -1,700 | -1,100 |
| | Capital cost savings | 8,200 | 22,000 | 29,000 |
| | Unserved energy savings | -21 | 43 | 20 |
| | Cost of Interconnector energy saved | 720 | 890 | 1,200 |
| | **Change in Net Welfare** | **8,600** | **21,000** | **29,000** |
| | **Change in Net Welfare*** | **8,200** | | |

Source: DECC modelling

*Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.4.1 for details)

**Table 11: Change in Net Welfare (NPV) – CfDs only, compared to Basecase B (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 | -680 | -3,500 | -4,700 |
| | Generation cost savings | 1,500 | 3,200 | 5,600 |
| | Capital cost savings | 3,300 | 11,000 | 15,000 |
| | Unserved energy savings | 4 | 130 | 120 |
| | Cost of Interconnector energy saved | 1,200 | 1,800 | 2,100 |
| | **Change in Net Welfare** | **5,300** | **13,000** | **18,000** |
| | **Change in Net Welfare*** | **4,800** | | |

Source: DECC modelling

[58] The capital cost reductions reported in these tables reflect the combined impact of two factors – a financing cost impact and atechnology mix impact. These were the splits provided for tables in Section 1 and are explained further below

* Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.4.1 for details)

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

87. 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 **£5.2bn up to 2030**.[59] 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 **£3.1bn**.

**Table 12: 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** |
| | Value of carbon savings | -490 | -2,000 | -3,400 |
| | Generation cost savings | 1,800 | 3,100 | 4,300 |
| | Capital cost savings | 3,100 | 10,000 | 15,000 |
| **Net Welfare** | Unserved energy savings | -80 | 5 | 27 |
| | Cost of Interconnector energy saved | 1,200 | 1,800 | 2,000 |
| | **Change in Net Welfare** | **5,600** | **13,000** | **18,000** |
| | **Change in Net Welfare*** | **5,200** | | |

Source: DECC modelling

*Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.4.1 for details)

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

88. 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 **£2.4bn to 2030**.[60] 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 **£740m**.

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

**Table 13: 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 | -460 | 250 | -2,100 |
| | Generation cost savings | 1,800 | 4,700 | 9,600 |
| | Capital cost savings | 740 | -3,500 | -2,700 |
| | Unserved energy savings | -58 | 3 | -19 |
| | Cost of Interconnector energy saved | 790 | 1,800 | 2,300 |
| | **Change in Net Welfare** | **2,800** | **3,200** | **7,100** |
| | **Change in Net Welfare*** | **2,400** | | |

Source: DECC modelling

*Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.4.1 for details)

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

- **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*

90. EMR reduces market risk by providing greater revenue certainty to low-carbon investors through the contract for difference (CfD) mechanism. This greater revenue 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).

91. Electricity sector modelling which provided the evidence base for the EMR White Paper suggested that the preferred EMR option of a CfD could reduce hurdle rates for low-carbon investments by up to 1.5 percentage points.[61] Independent verification of the cost of capital impacts showed broadly similar results.[62] The EMR White Paper Impact Assessment also determined what the impact of hurdle rate reductions would mean for total investment costs. It found that cost of capital under the FiT CfD proposal, in comparison to the Premium FiT option, would be £2.5bn lower over the period to 2030.

[61] Electricity sector dispatch modelling by Redpoint Energy Consultants, 2011
[62] 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

92. For this latest analysis, the hurdle rates are based on data from Oxera (2011) and Arup (2011). The hurdle rate reductions are derived from the DDM model, in conjunction with Oxera's maximum possible hurdle rate reductions. They are presented in Annex A and show reductions up to a maximum of 1.2 percentage points depending on the technology type.

93. In order to isolate the part of the capital cost savings which are due to reductions in costs of capital, capital cost estimates under 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 £2.1bn and £4.1bn from lower costs of capital (up to 2030, including administrative costs), £6.6bn to £11bn up to 2040 and £12bn to £16bn up to 2049.[63] This reflects the efficiency of delivering low-carbon investment through CfDs, relative to an alternative mechanism that would deliver the same generation mix but without financing savings.[64]

*Technology Mix Impact*

94. 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.[65]

95. Under Basecase A wholesale prices are not high enough to incentivise CCS investment by the end of the 2020s. Therefore, to realise the 2030 decarbonisation ambition under this basecase more renewable investment must take place (relative to the level undertaken under EMR), leading to greater deployment of offshore wind. As a result, part of the

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

- 100g = £3.0bn up to 2030 (including administrative costs), £8.6bn up to 2040 and £13bn up to 2049;
- 50g = £4.1bn up to 2030 (including administrative costs), £11bn up to 2040 and £16bn up to 2049, and
- 200g = £2.1bn up to 2030 (including administrative costs), £6.6bn up to 2040 and £12bn up to 2049

[64] 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.

[65] CCS demonstration projects also have an important role to play in the technology mix and NPV results. 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. The NPV results for EMR are particularly sensitive to how the CCS projects are treated in the counterfactual basecase, due to their modelled delivery date. In addition within the modeling, estimates of the costs of the demonstration projects are used as the exact costs of the demonstration projects remains unknown. If the CCS demonstration projects are included in the basecase, the EMR NPV range would increase from £4.2-£7.6bn to £5.9bn-£10.8bn (NPV, 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).

modelled £8.2bn capital cost saving under Basecase A reflects the benefits of decarbonising through CCS rather than offshore wind.[66]

96. The indicative scale of this impact can be illustrated by Basecase B, where a similar level of CCS investment takes place to that achieved under EMR. Compared to this basecase the capital cost savings fall to around £3.3bn, suggesting that once we control for differences in technology mix, the benefits of EMR from lower capital costs are smaller. These benefits therefore broadly reflect the pure cost of capital benefits associated with CfDs.

97. In contrast to the basecases which use carbon prices, CfDs allow technology-specific targeting, such 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.

98. The technology mix also drives the differences in carbon and generation costs. Against both basecases 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.[67] In addition, carbon costs under CfDs are higher in later years in comparison to Basecase B, as the lower carbon prices result in a slower decarbonisation trajectory post-2030.[68]

99. Assessed up to 2030, generation costs (defined as fixed and variable operating costs and fuel costs) are lower under CfDs in comparison to both of the basecases. Relative to Basecase A, CfDs result in lower fixed operating costs but higher variable operating and fuel costs, due to a lower proportion of renewable generation (EMR has a greater share of nuclear and CCS). In contrast, relative to Basecase B, CfDs result in lower variable costs but higher fixed costs. The low-carbon mix is broadly similar between CfDs and Basecase B, so differences largely reflect the different decarbonisation profiles.[69]

### 2.3.2 Net Present Value of the Capacity Market

100. Our analysis shows that a Capacity Market is expected to have a negative net welfare impact of **-£0.6bn**[70], relative to a scenario of an efficient energy market – i.e. where the

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[66] The higher capital expenditure of offshore wind, in comparison to CCS, reflects the fact that wind generation is de-rated more than CCS. As a result, significantly more offshore capacity needs to be built to achieve the same generation as from CCS.

[67] For more detail see Annex C

[68] Although Basecase B scenario can control for differences in CCS, it is not necessarily the preferred basecase. It cannot mirror EMR's capacity mix exactly, and it results in a decarbonisation trajectory which 'over-shoots' the 2040 target. The two basecases have both pros and cons to their respective use, hence a range is presented.

[69] For further detail, see Annex C

[70] 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 (£0.1bn) and 200g$CO_2$/kWh (-£0.5bn) are given below

energy price reflects consumer's Value Of Lost Load and where the market is able to invest on the basis of scarcity rents.

101. The improvement in this figure relative to the analysis published in November 2012 (-£1.7bn) is due to three main changes:

- The first reflects a more consistent treatment of the costs of plant built near the end of NPV assessment periods. Previously, the costs of this additional capacity were included, even though delivery did not occur until after the assessment period. The impact of this change reduces the capital costs associated with the capacity market by roughly £0.6bn.
- The second change is in the modelling of peak demand and unserved energy benefits. Since November 2012, the DDM model has been updated to include a 'hyper-peak' day, the effect of which is to reduce unserved energy benefits by approximately £0.2bn.
- Finally, there are also changes in the generation mix produced under the counterfactual scenario with no capacity market. This output from the DDM model is a direct reflection of the updated input assumptions (in Annex A). These collectively lead to a reduction in the relative difference in the carbon intensity of electricity generation between EMR and the counterfactual scenario. The combined carbon and generation costs decrease by around £0.7bn.

102. However, 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. 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.

103. Therefore, we believe that a Capacity Market could have a net benefit if the market fails to bring forward an adequate level of capacity.

### 2.3.3 Disaggregated NPV Impact

104. 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 14-16.

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

105. 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 **between £4.2bn and £7.6bn up to 2030** (under an assumed emissions intensity of 100g$CO_2$/kWh).

106. This reflects **£4.8bn to £8.2bn** worth of net benefits as a result of decarbonising through CfDs, and an offsetting net negative contribution of **-£0.6bn** from mitigating against security of supply risks through the Capacity Market. Of the £4.8bn to £8.2bn benefit from decarbonising through CfDs, around **£3.0bn** can be attributed to the benefit of lower financing costs under CfDs, with the remaining **£1.8bn to £5.1bn** of the benefits attributable to the different technology mix generated by EMR, relative to the basecases.[71]

**Table 14: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices [72] (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| **EMR (CfD + Capacity Market)** | | **Basecase A** | **Basecase B** |
|---|---|---|---|
| CfDs | | 8,200 | 4,800 |
| | *- Financing Impact* | *3,000* | |
| | *- Technology Mix Impact* | *5,100* | *1,800* |
| Capacity Market | | -600 | |
| **Net Impact** | | **7,600** | **4,200** |

Source: DECC modelling

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

107. Targeting an emissions intensity of 50g$CO_2$/kWh in 2030, EMR leads to an improvement in welfare of **£5.3bn**, up to 2030. This comprises **£5.2bn** worth of net benefits as a result of decarbonising through CfDs (of which around **£4.1bn** can be attributed to the benefit of lower financing costs under CfDs and **£1.0bn** to the different technology mix, relative to the basecase), and a further **£0.1bn** net benefit of mitigating against security of supply risks through the Capacity Market.

[71] The technology mix impact reflects the combined impact of the different technology mixes between the basecases and EMR scenarios. Under Basecase A, the majority of the technology mix benefit is the result of lower capital costs under EMR (independent of the benefit of lower financing costs). The impact on generation costs, carbon costs, unserved energy and interconnectors offset each other somewhat to produce a combined benefit of EMR from a different technology mix of around £5.1bn. Under Basecase B, the technology mix is closer to EMR and as a result the capital cost impact is smaller. The combined technology mix benefit of EMR is therefore the result of lower interconnector and generation costs, with an offsetting impact of higher carbon costs. The combined impact of all these factors results in a net benefit of EMR from a different technology mix of around £1.8bn.

[72] Inclusive of administrative costs

**Table 15: 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 | | 5,200 |
| | *- Financing Impact* | *4,100* |
| | *- Technology Mix Impact* | *1,000* |
| Capacity Market | | 100 |
| | | |
| **Net Impact** | | **5,300** |

Source: DECC modelling

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

108. Targeting an emissions intensity of 200g$CO_2$/kWh in 2030, EMR leads to an improvement in welfare of **£1.9bn up to 2030**. This comprises **£2.4bn** worth of net benefits as a result of decarbonising through CfDs (of which **£2.1bn** can be attributed to the benefit of lower financing costs under CfDs and **£0.3bn** to the different technology mix, relative to the basecase), and an offsetting net cost of -**£0.5bn** from mitigating against security of supply risks through the Capacity Market.

**Table 16: 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 | | 2,400 |
| | *- Financing Impact* | *2,100* |
| | *- Technology Mix Impact* | *300* |
| Capacity Market | | -500 |
| | | |
| **Net Impact** | | **1,900** |

Source: DECC modelling

## 2.4 Distributional Analysis

109. 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.

110. Consumer Surplus is a measure of welfare to consumers, and is a combination of the different changes in costs facing the consumer (wholesale electricity costs, low-carbon payments and capacity payments) as a result of policies for reform.

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

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

112. Consumer welfare is improved under EMR when assessed across all time periods up to 2049, relative to both basecases. The driver of this result is the reduction in wholesale prices realised under EMR in comparison to the 'no EMR' scenarios, which benefit consumers and hence increase consumer surplus. This benefit outweighs the larger low-carbon and capacity payments to suppliers, which appear as a cost to consumers and reduce consumer surplus.

113. In contrast, the effect on producers' welfare is more ambiguous under the EMR scenario, relative to both basecases. Under Basecase A, 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 turns producer surplus positive, implying that producers are better off under EMR over a longer time period, relative to Basecase A. In contrast, under Basecase B, producers are worse off under EMR, as shown by the negative change in producer surplus over all time periods. This is due to a relatively greater reduction in wholesale prices under Basecase B (which reduces producer surplus and increases consumer surplus), relative to Basecase A.

114. 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 8-12% lower under EMR when assessed up to 2030, 7-12% lower up to 2040 and 5-10% lower up to 2049, relative to the basecases.[73]

115. In contrast, returns for producers under EMR are heavily dependent on the choice of basecase. For example, under Basecase A total discounted producer surplus is 10% lower up to 2030, 4% higher up to 2040 and 29% higher under EMR. However, under Basecase B producer returns are negative across all time periods – 22% lower up to 2030, 28% lower up to 2040 and 20% lower up to 2049.[74]

116. 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 counterfactuals. Environmental taxes are a transfer from producers to the Exchequer.

117. The final row, 'Change in non-internalised social costs of carbon', values the wider impact on UK society of changes in greenhouse gas emissions, less the value of European Union Allowances (EUAs). The EUA value is subtracted from this item in the distributional analysis, as the value of the EUA is reflected elsewhere in the 'Change in producer surplus' line.[75]

118. The relatively small societal benefit associated with changes in these non-internalised social costs of carbon for Basecase A reflects the fact that EMR follows a similar decarbonisation trajectory, with comparable additional social costs of carbon. These trajectories are more divergent under Basecase B, leading to a greater value of these non-internalised social costs.

---

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

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

[75] See Annex B for details

**Table 17: Distributional analysis: Combined EMR impact (CfD with Capacity Market) compared to Basecase A (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 | 38,000 | 58,000 | 84,000 |
| | Low carbon payments | -1,200 | -2,800 | -25,000 |
| | Capacity payments | -8,500 | -21,000 | -30,000 |
| | Unserved energy | 170 | 920 | 1,300 |
| | **Change in Consumer Surplus** | **28,000** | **35,000** | **31,000** |
| **Producer Surplus** | Wholesale price | -37,000 | -57,000 | -83,000 |
| | Low carbon support | 1,200 | 2,800 | 25,000 |
| | Capacity payments | 8,500 | 21,000 | 30,000 |
| | Producer costs | 21,000 | 36,000 | 45,000 |
| | **Change in Producer Surplus** | **-6,600** | **2,800** | **16,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-13,000** | **-17,000** | **-20,000** |
| **Societal benefit** | **Change in non-internalised social costs of carbon** | **-450** | **23** | **-1,100** |
| **Net Welfare** | **Change in Net Welfare** | **8,300** | **20,000** | **26,000** |

Source: DECC modelling

**Table 18: Distributional analysis: Combined EMR impact (CfD with Capacity Market), compared to Basecase B (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 | 62,000 | 110,000 | 140,000 |
| | Low carbon payments | -11,000 | -25,000 | -47,000 |
| | Capacity payments | -8,500 | -21,000 | -30,000 |
| | Unserved energy | 190 | 1,000 | 1,400 |
| | **Change in Consumer Surplus** | **42,000** | **69,000** | **67,000** |
| **Producer Surplus** | Wholesale price | -60,000 | -110,000 | -140,000 |
| | Low carbon support | 11,000 | 25,000 | 47,000 |
| | Capacity payments | 8,500 | 21,000 | 30,000 |
| | Producer costs | 24,000 | 39,000 | 46,000 |
| | **Change in Producer Surplus** | **-17,000** | **-26,000** | **-18,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-20,000** | **-28,000** | **-29,000** |
| **Societal benefit** | **Change in non-internalised social costs of carbon** | **-350** | **-2,900** | **-5,100** |
| **Net Welfare** | **Change in Net Welfare** | **4,900** | **12,000** | **15,000** |

Source: DECC modelling

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

119. 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 consumer surplus. In contrast, producers are worse off under EMR up to 2040, relative to a 'no EMR' scenario (in which decarbonisation ambitions are met using existing instruments), as shown by negative changes in producer surplus. However, when analysed up to 2049, producer surplus becomes positive, implying that producers are better off under EMR.

120. This change is primarily driven by the larger component for wholesale price reductions (positive for consumers, negative for producers). This is due to the more diverse set of generation technologies (including nuclear and CCS) supported by CfD payments under EMR, relative to the renewables-only RO payments in the 'no-EMR' basecase. Construction of nuclear and CCS plant in the 'no-EMR' basecase (necessary to achieve the required reduction in emissions intensity in the power sector by 2030) is realised through artificially increasing the carbon price. This increases the wholesale price relative to EMR, yielding a large amount of consumer surplus for this component, as shown in the table below. This outweighs the increases in low-carbon payments over time, leading to an overall increase in consumer surplus.

121. This change is mirrored in the lower producer surplus up to 2040, with greater low-carbon and capacity payments to suppliers under EMR (relative to a 'no-EMR' basecase) being outweighed by lower returns from the wholesale price. However, up to 2049, the reduction in producer costs, combined with these increased payments to suppliers, outweighs the (negative) wholesale price component, resulting in a net increase in producer surplus, such that producer surplus becomes positive.

**Table 19: 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 | 66,000 | 110,000 | 130,000 |
| | Low carbon payments | -18,000 | -46,000 | -66,000 |
| | Capacity payments | -8,100 | -20,000 | -29,000 |
| | Unserved energy | 150 | 920 | 1,300 |
| | **Change in Consumer Surplus** | **40,000** | **46,000** | **41,000** |
| **Producer Surplus** | Wholesale price | -64,000 | -110,000 | -130,000 |
| | Low carbon support | 18,000 | 46,000 | 66,000 |
| | Capacity payments | 8,100 | 20,000 | 29,000 |
| | Producer costs | 22,000 | 35,000 | 43,000 |
| | **Change in Producer Surplus** | **-16,000** | **-8,400** | **5,600** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-17,000** | **-22,000** | **-24,000** |
| **Societal benefit** | **Change in non-internalised social costs of carbon** | **-340** | **-1,900** | **-3,700** |
| **Net Welfare** | **Change in Net Welfare** | **6,000** | **14,000** | **19,000** |

Source: DECC modelling

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

122. 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). In contrast, 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.

123. Again, this change is driven by a significant contribution from the wholesale price component (positive for consumers, negative for producers). Up to 2030, the impact of this effect on producer surplus between EMR and the 'no-EMR' basecase is not so significant, as it is offset to some extent by the reductions in producer costs. However, as time progresses and the wholesale price impact increases, the difference between the EMR and 'no-EMR' basecase increases. This therefore acts to increase consumer surplus, but reduce producer surplus.

**Table 20: 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 | 40,000 | 110,000 | 170,000 |
| | Low carbon payments | -8,900 | -22,000 | -56,000 |
| | Capacity payments | -8,500 | -20,000 | -29,000 |
| | Unserved energy | 63 | 950 | 1,400 |
| | **Change in Consumer Surplus** | **22,000** | **73,000** | **82,000** |
| **Producer Surplus** | Wholesale price | -39,000 | -110,000 | -160,000 |
| | Low carbon support | 8,900 | 22,000 | 56,000 |
| | Capacity payments | 8,500 | 20,000 | 29,000 |
| | Producer costs | 17,000 | 33,000 | 41,000 |
| | **Change in Producer Surplus** | **-4,300** | **-37,000** | **-37,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-15,000** | **-34,000** | **-40,000** |
| **Societal benefit** | **Change in non-internalised social costs of Carbon** | **-130** | **590** | **-79** |
| **Net Welfare** | **Change in Net Welfare** | **2,600** | **2,300** | **5,200** |

Source: DECC modelling

### 2.4.1 Institutional costs

124. 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 £1bn (2012 prices).[76] 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.[77] 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

[76] In the central case, the updated administrative costs are around £300m higher than previously assumed in January 2013. They are around £200m higher in the low case and around £330m higher in the high case (NPV, 2012-2030). The increase in costs since January 2013 reflect further clarification on the role of administrative bodies, and the costing requirements associated with those roles, as well as a inclusion of administrative costs estimates associated with CfDs to energy sector businesses.

[77] 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.

undertaken by the organisations. The table below presents EMR's NPV taking into account administrative costs.[78]

**Table 21: NPV with administrative costs (NPV 2012-2030, Real 2012, £bn)[79]**

| | NPV – Energy market only | | NPV – Energy market and administrative costs* | |
|---|---|---|---|---|
| | Basecase A | Basecase B | Basecase A | Basecase B |
| **NPV (£bn)** | 8.3 | 4.9 | **7.6** | **4.2** |
| **Of which: CfDs** | 8.6 | 5.3 | **8.2** | **4.8** |
| **Of which: CM** | -0.3 | | **-0.6** | |

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

[78] A midpoint estimate of around £700m is used in both Basecase A and B. 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.

[79] 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[80]

125. This section considers the price and bill impacts of the CfD and Capacity Market. The EMR package is assessed against the basecases described above.

126. 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.

127. 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

128. 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 Renewables Obligation cost against the basecase, because relatively fewer plant will receive RO payments.

129. 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 basecases A and B are assumed to be passed through to consumers through higher wholesale prices, resulting in higher basecase wholesale prices, and correspondingly lower prices under EMR.

130. In addition, the EMR policies could affect the capacity margin on the system. In some periods, the EMR package could deliver larger capacity margins than in the basecase, and therefore contribute to a dampening effect on wholesale prices.

131. The price and bill impact modelling assesses the net impact of these effects against the basecases described in the previous section.

---

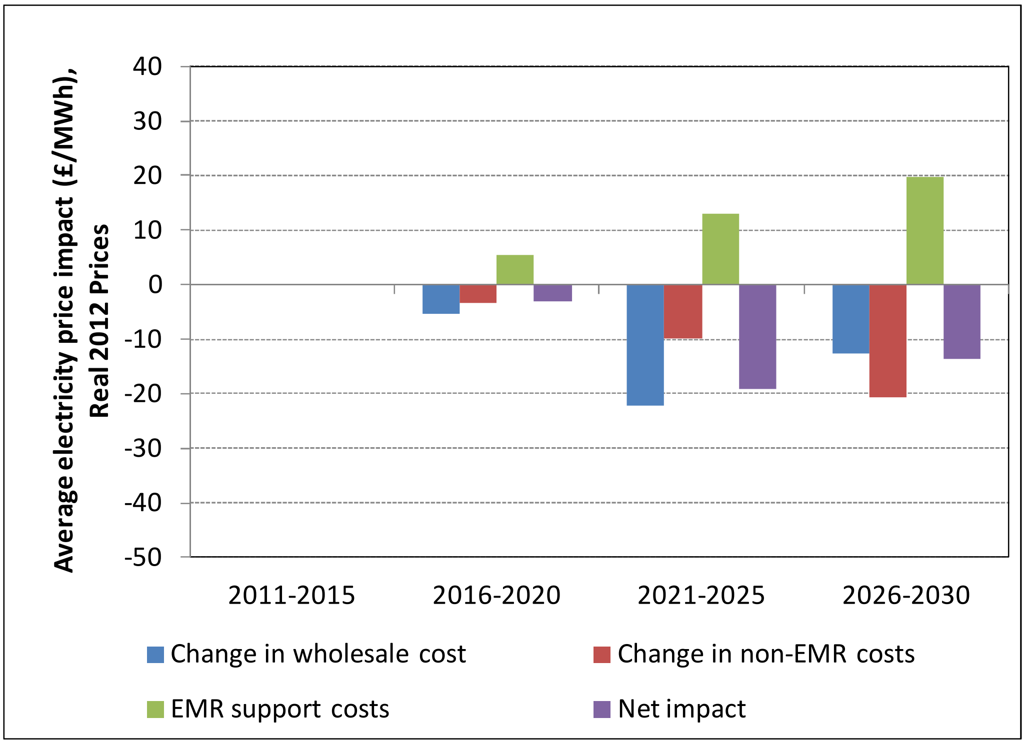
[80] The analysis presented in this IA is based on an agreed set of assumptions, including technology costs and electricity demand at the time the analysis was undertaken, which are set out in Annex A. This approach is consistent with the analysis presented in the Government's latest analysis of the 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

132. 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*

133. Relative to basecases A and B, EMR results in lower retail prices over the 2016-2030 period.[81] Over the period 2016-2030, average prices would be between 6% and 8% lower under EMR, in comparison to what they would be under the basecases. 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 basecases.[82]

**Chart 2: Net Impact of EMR on domestic electricity prices, relative to Basecase A[83] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**



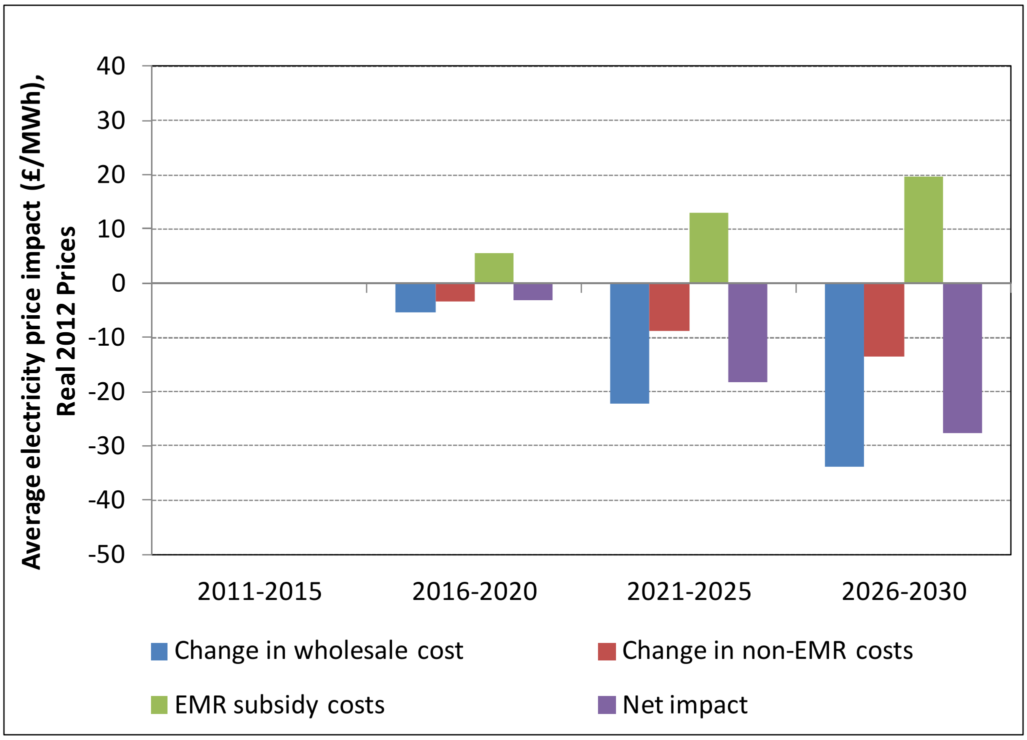

Source: DECC modelling

[81] Within the modelling EMR support costs begin in 2016, therefore the price and bill impacts are averaged over the period 2016 to 2030.

[82] 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.

[83] Non-EMR costs principally refer to lower Renewables Obligation support costs as a result of EMR.

**Chart 3: Net Impact of EMR on domestic electricity prices, relative to Basecase B (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

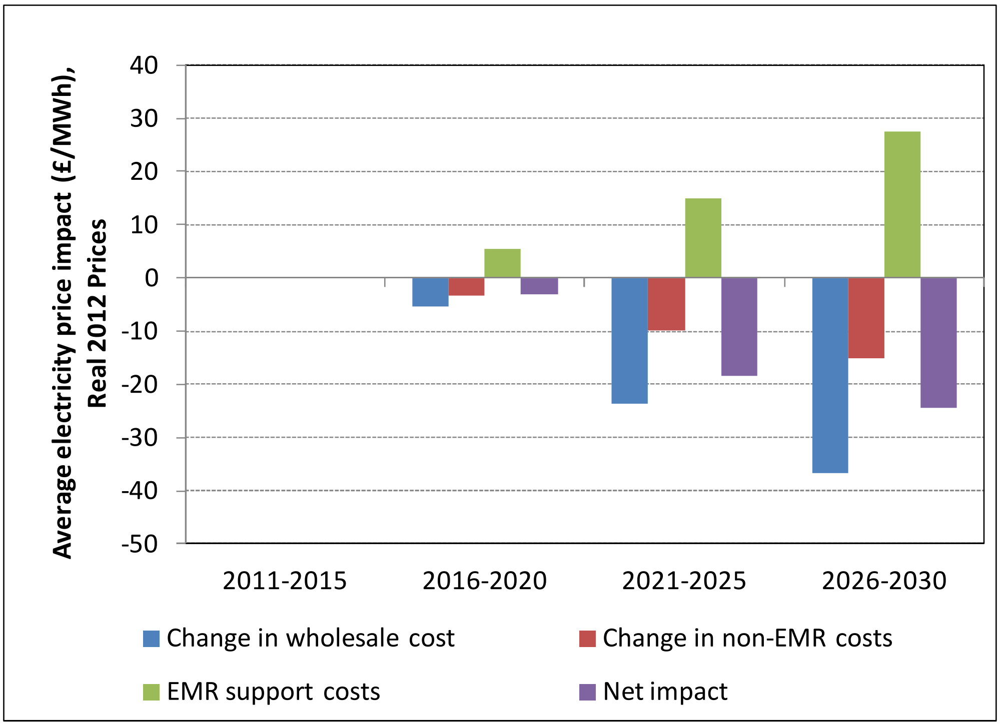



Source: DECC modelling

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

134. Relative to a basecase in which an emissions intensity of 50g$CO_2$/kWh is targeted using existing instruments, EMR still results in lower retail prices over the 2016-2030 time period – it is estimated that average domestic energy prices would be 7% 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 10% (£24/MWh) lower than the basecase.

**Chart 4: Net Impact of EMR on Domestic Electricity prices, relative to 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

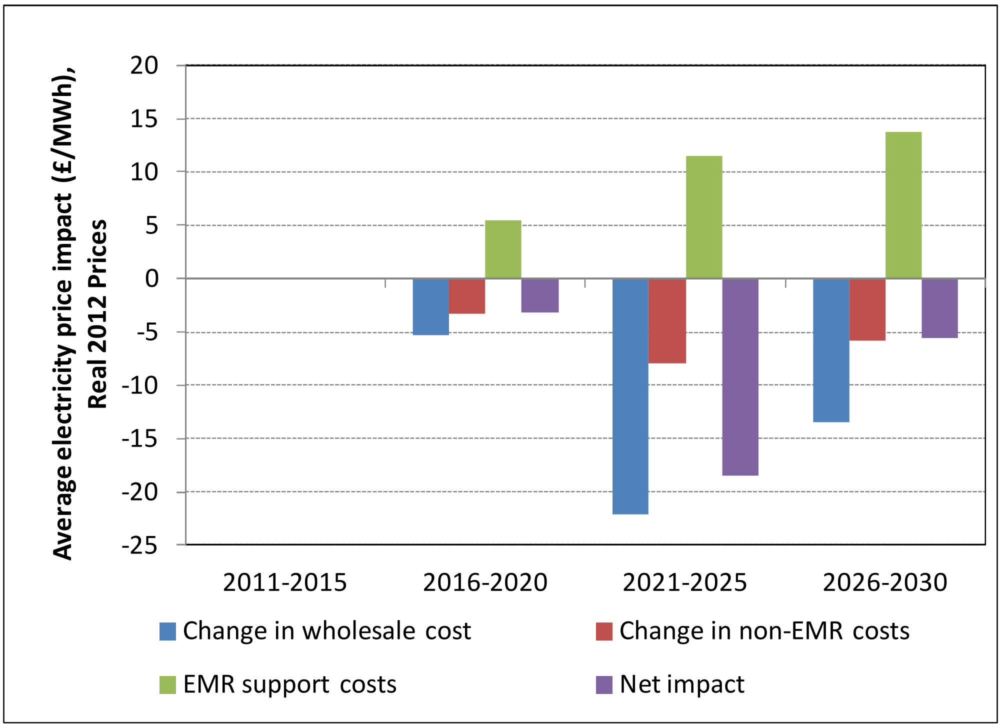



Source: DECC modelling

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

135. Relative to a basecase in which an emissions intensity of 200g$CO_2$/kWh is targeted using existing instruments, EMR still results in lower retail prices over the 2016-2030 time period – it is estimated that average domestic energy prices would be 4% 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 8% (£18/MWh) lower.

**Chart 5: Net Impact of EMR on Domestic Electricity prices, relative to 200g basecase (assumed emissions intensity in 2030 = 200gCO$_2$/kWh)**




Source: DECC modelling

### 2.5.1 Bill Impacts by consumer type

136. The impact of the EMR package on different consumer bills – distinguishing between domestic and non-domestic - are presented in Table 22 to Table 26.

*Analysis based on emissions intensity of 100gCO$_2$/kWh in 2030*

<u>Domestic customers</u>

137. For domestic consumers, EMR has the potential to reduce average annual household electricity bills by between 6% and 8% (£38 to £53) over the period 2016-2030, relative to a basecase which achieves the same decarbonisation objective using existing policy instruments. Household bills would be lower under EMR, reflecting the higher carbon prices in the basecase, and therefore the benefit to consumers of incentivising investment using CfDs.

**Table 22: Domestic Bill Impacts[84] (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 | 580 | - |
| 2016-2020 | 615 | -£9 (-1%) |
| 2021-2025 | 662 to 665 | -£56 to -£59 (-8% to -9%) |
| 2026-2030 | 731 to 780 | -£46 to -£94 (-6% to -12%) |
| **2016-2030** | **670 to 685** | **-£38 to -£53 (-6% to -8%)** |

Source: DECC modelling

Non-domestic customers

138. The table below presents the impact of EMR on non-domestic electricity bills. Average annual bills are between 7% and 10% lower under EMR for the period 2016-2030, relative to the basecases. Electricity bills are estimated to be 9% lower under EMR over the period 2021-2025 and between 5% and 14% lower for the period 2026-2030, in comparison to the basecases.

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

**Table 23: Non-domestic Bill impacts (With CRC)[85] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | Bill under basecase(s) £ | Change in bill as a result of EMR, £ (%) |
|---|---|---|
| **Non-Domestic, (£ 000's) (rounded) Real 2012 prices** | | |
| 2011-2015 | 1,150 | - |
| 2016-2020 | 1,450 | -£90 (-6%) |
| 2021-2025 | 1,600 | -£140 (-9%) |
| 2026-2030 | 1,630 to 1,810 | -£80 to -£260 (-5% to -14%) |
| **2016-2030** | **1,560 to 1,620** | **-£100 to -£160 (-7% to -10%)** |

Source: DECC modelling

Energy-intensive industry

139. 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 bills by between 7% and 11% relative to the basecases (over the period 2016-2030). Over the period 2026-2030, under EMR electricity bills could be 6% to 15% lower, in comparison to the basecases.[86]

[85] Non-Domestic users are based on the consumption of a medium-sized fuel user in industry, with an electricity usage of 11,000 MWh (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.

[86] In the Chancellor's Autumn Statement 2011 the Government announced its intention to explore ways to mitigate the impact of electricity costs arising from EMR on the most Energy Intensive Industries (EIIs), where this significantly impacts their competeviness, and subject to value for money and State Aid considerations. In order to maintain the competitiveness of the UK as a place to do business the Government intends to exempt EIIs from the cost of CfDs, and is currently minded to do so through the operation of the supplier obligation. The Department for Business Innovation and Skills will work closely with DECC to define the scope of the exemption, including who will be eligible, and the mechanics for delivering it. The work to deliver this exemption will be part of the EMR programme, delivering on the same timescale, subject to further consultation. Any exemption is also dependent on State Aid clearance. No exemption is assumed in this IA.

**Table 24: Energy Intensive Industry (EII) Bill impacts[87] (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | Bill under basecase(s) £ | Change in bill as a result of EMR, £ (%) |
|---|---|---|
| EII, (£ 000's) (rounded)Real 2012 prices | | |
| 2011-2015 | 8,360 | - |
| 2016-2020 | 11,410 | -£720 (-6%) |
| 2021-2025 | 13,210 to 13,260 | -£1,270 to -£1,320 (-10%) |
| 2026-2030 | 13,420 to 14,950 | -£750 to -£2,280 (-6% to -15%) |
| **2016-2030** | **12,680 to 13,210** | **-£920 to -£1,450 (-7% to -11%)** |

Source: DECC modelling

Security of supply impacts

140. 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 mitigating against security of supply risks though the Capacity Market (which the basecase(s) do not do). The Capacity Market is estimated to **add around £16 to average consumer bills** in years in which it is bringing on additional capacity, 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*

141. Relative to the 100g Basecase B scenario outlined above, the impact on domestic bills from using EMR to target an emissions intensity of 50g$CO_2$/kWh in 2030 is lower – i.e. EMR achieves a smaller 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 £49, compared to an upper bound reduction of £53 under the 100g scenario. This reduction is slightly less for both non-domestic customers (£150,000 compared to an upper bound of £160,000 under 100g) and energy-intensive industry (£1.29m, compared to an upper bound of £1.45m under 100g). Under such a scenario, the Capacity Market is estimated to

[87] 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.

increase average consumer bills by around £12 for years in which it is bringing on additional capacity.

**Table 25: 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 | 580 | - | 1,150 | - | 8,360 | - |
| 2016-2020 | 615 | -9 (-1%) | 1,450 | -90 (-6%) | 11,420 | -730 (-6%) |
| 2021-2025 | 667 | -56 (-8%) | 1,630 | -170 (-10%) | 13,520 | -1,500 (-11%) |
| 2026-2030 | 777 | -82 (-11%) | 1,740 | -180 (-11%) | 14,390 | -1,650 (-11%) |
| **2016-2030** | **686** | **-49 (-7%)** | **1,610** | **-150 (-9%)** | **13,110** | **-1,290 (-10%)** |

Source: DECC modelling

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

142. 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 lessened, particularly towards the end of the assessment period up to 2030. Despite this, decarbonisation through EMR still results in a reduction in bills, relative to a basecase in which decarbonisation is achieved using existing instruments. However, this reduction is not as great when compared to other decarbonisation scenarios (such as 100g and 50g).

143. Under such a scenario, the Capacity Market is estimated to add around £21 to average consumer bills in years in which it is bringing on additional capacity.

**Table 26: 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 | 580 | - | 1,150 | - | 8,360 | - |
| 2016-2020 | 615 | -9 (-2%) | 1,450 | -90 (-6%) | 11,420 | -730 (-6%) |
| 2021-2025 | 659 | -57 (-9%) | 1,580 | -130 (-9%) | 13,050 | -1,210 (-9%) |
| 2026-2030 | 687 | -19 (-3%) | 1,540 | -30 (-2%) | 12,560 | -280 (-2%) |
| **2016-2030** | **654** | **-28 (-4%)** | **1,520** | **-80 (-5%)** | **12,340** | **-740 (-6%)** |

Source: DECC modelling

Conclusion

144. 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 as projections change over time. However, the latest results suggest that average electricity bills are likely to be lower under EMR, relative to basecases A and B, which achieve the same decarbonisation ambition using existing policy instruments. The cost-effectiveness of EMR as a tool for decarbonising the power sector is reinforced by the 50g scenario, under which reductions in bills are even greater than under Basecase A. However, when targeting an emissions intensity of 200g$CO_2$/kWh, these overall reductions are lessened.

#### 2.5.2 Wider Impacts

145. 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.

146. 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 Guidance.[88] 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.

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

## Section 3 Update on CfD payment model

147. 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.

148. EMR reduces market risk by providing greater 'revenue certainty' to low carbon investors through the contract for difference (CfD) mechanism. This greater revenue certainty means that, all other things being equal, investors can borrow proportionately more money to lower the weighted average cost of capital (or equivalently that the hurdle rates for a project can be lower).

149. Electricity sector modelling[89] which provided the evidence base for the EMR White Paper suggested that the preferred EMR option of a CfD could reduce hurdle rates for low carbon investments by up to 1.5 percentage points, depending on the technology type. Independent verification of the cost of capital impacts showed broadly similar results.[90] For the latest analysis, the hurdle rates are based on data from Oxera (2011) and Arup (2011). The hurdle rate reductions are derived from the DDM model in conjunction with Oxera's maximum possible hurdle rate reductions.[91] Again the results are broadly similar to the Redpoint analysis.

150. The EMR White Paper Impact Assessment also determined what the impact of hurdle rate reductions of this size would mean for total investment costs. It found that cost of capital under the FiT CfD proposal, in comparison to the Premium FiT option, would be £2.5bn lower over the period to 2030. In the updated analysis, capital cost estimates under EMR, with and without CfD hurdle rate reductions are compared. The results suggest that CfDs would generate an NPV of around £3.0bn from lower costs of capital (up to 2030).[92]

151. Importantly, the analysis assumed that contracts would be bankable, to ensure that the necessary certainty to industry would be provided. Stakeholders raised concerns regarding the payment model that was within the draft Energy Bill that this might not be the case. This was a multiparty arrangement where effectively all suppliers were counterparty to a legislative instrument in place of a contract. Generators in particular were concerned that this was complex, about what would happen in a dispute, and

[89] Electricity sector dispatch modelling by Redpoint Energy Consultants, 2011
[90] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2180-emr-impact-assessment.pdf & http://www.decc.gov.uk/assets/decc/11/policy-legislation/emr/2174-cepa-paper.pdf
[91] The hurdle rates, and hurdle rate reductions under FiT CfDs are presented in Annex A.
[92] Inclusive of administrative costs

whether this model fused public and private law in a way that could be off-putting to investors.

152. 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 which 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. Further details are provided in the accompanying Bill documents.

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

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

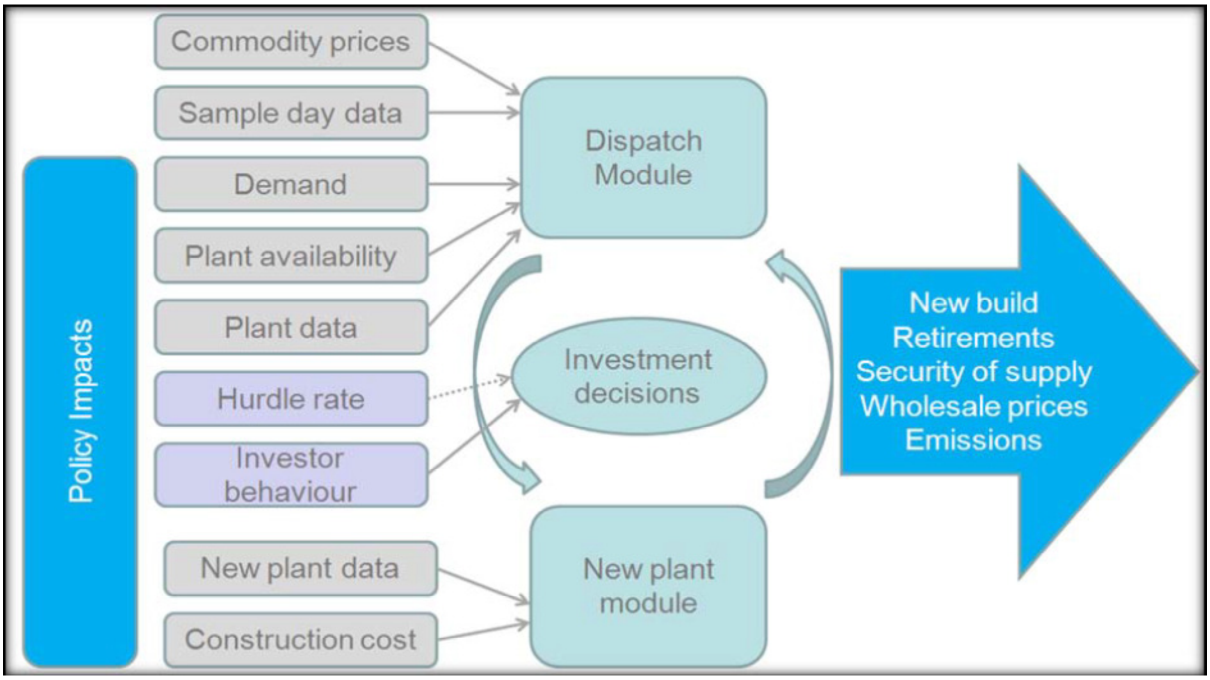
## Annex A: The Dynamic Dispatch Model (DDM)

155. 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

156. 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

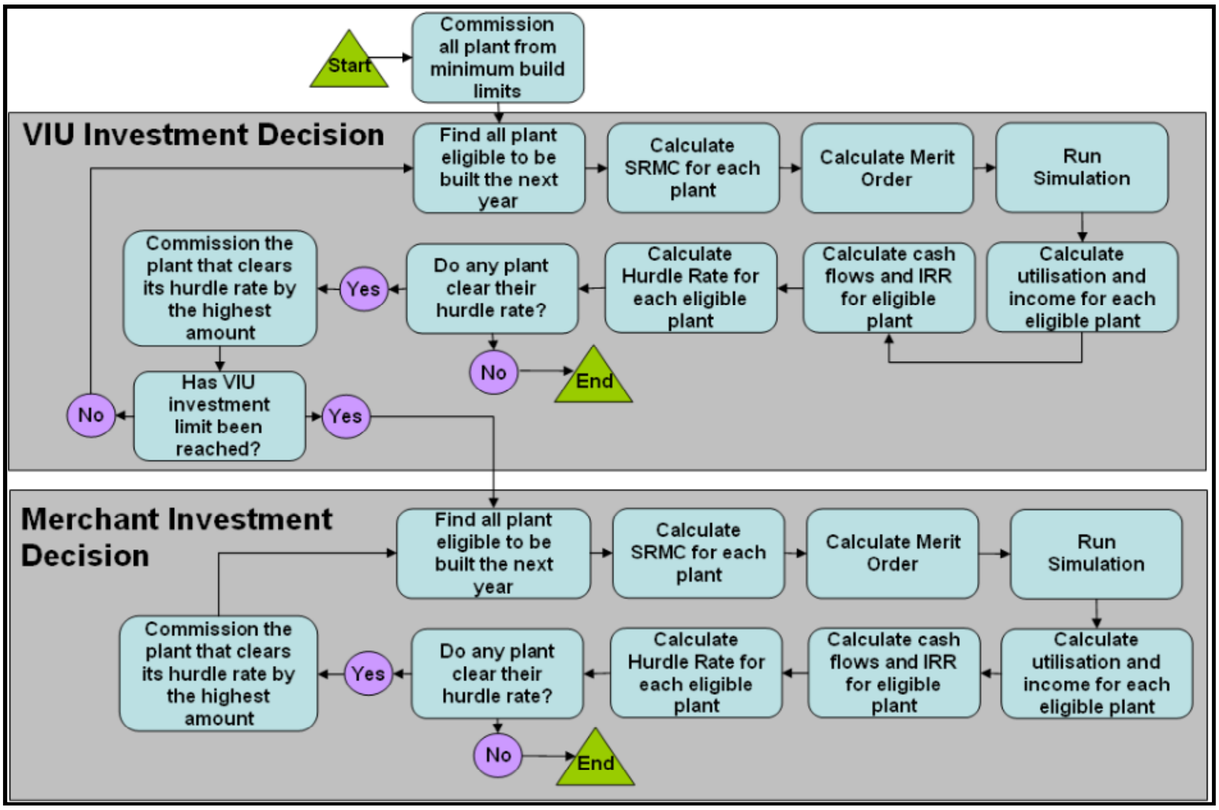
157. Economic, energy and climate policy, generation and demand assumptions are external inputs to the model. The model runs on sample days, including demand load curves for both business and non-business days, including seasonal impacts and are

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

158. 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**




159. 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**

160. 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**

161. 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.

162. 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**

163. 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**

164. On 23 November 2011, the Government agreed a Levy Control Framework (LCF) to 2020, which is set at a total of £7.6bn (in real, 2012 prices).[93] This will help diversify our energy mix by increasing the amount of electricity coming from renewables (from 11% today to around 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**

165. The baseline for DDM analysis represents a plausible outcome of Electricity Market Reforms, characterised by a diversified supply mix[94] 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.

166. 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.

167. Given the considerable uncertainty over how the electricity sector will develop to 2030, we are also developing different sets of assumptions to represent other potential future scenarios, which can then be modelled using DDM analysis. These scenarios reflect possible futures in which one low-carbon generation technology (nuclear, CCS, renewables) is deployed more heavily than the others. These recognise that there will be changes that we cannot predict in the supply chain, planning and grid constraints on deployment, technology costs and wider impacts of different technologies. Nevertheless, these scenarios include many common assumptions such as the modelling of EMR policies, fossil fuel prices, demand and the decarbonisation of the power sector to 100gCO2/kWh by 2030. These are being undertaken as part of the analysis for the draft EMR Delivery Plan, which is due to be published in July 2013.

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

[94] 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

| 2012 prices | Oil $/bbl | | | Gas p/therm | | | Coal $/tonne | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Central | High | Low | Central | High | Low | Central | High |
| 2011 | 115 | 115 | 115 | 58 | 58 | 58 | 124 | 124 | 124 |
| 2012 | 105 | 115 | 125 | 54 | 63 | 72 | 97 | 102 | 107 |
| 2013 | 103 | 116 | 128 | 51 | 70 | 87 | 94 | 110 | 121 |
| 2014 | 102 | 117 | 131 | 49 | 76 | 89 | 92 | 116 | 134 |
| **2015** | **100** | **118** | **134** | **47** | **77** | **91** | **89** | **117** | **139** |
| 2016 | 99 | 119 | 137 | 45 | 78 | 93 | 86 | 117 | 144 |
| 2017 | 97 | 120 | 140 | 43 | 75 | 95 | 84 | 118 | 149 |
| 2018 | 96 | 121 | 144 | 41 | 72 | 98 | 81 | 119 | 154 |
| 2019 | 95 | 122 | 147 | 41 | 72 | 100 | 79 | 119 | 159 |
| **2020** | **93** | **124** | **151** | **41** | **72** | **102** | **76** | **120** | **164** |
| 2021 | 92 | 125 | 154 | 41 | 72 | 103 | 76 | 120 | 167 |
| 2022 | 90 | 126 | 158 | 41 | 72 | 103 | 76 | 120 | 171 |
| 2023 | 89 | 127 | 162 | 41 | 72 | 103 | 76 | 120 | 174 |
| 2024 | 88 | 128 | 165 | 41 | 72 | 103 | 76 | 120 | 177 |
| **2025** | **86** | **129** | **169** | **41** | **72** | **103** | **76** | **120** | **181** |
| 2026 | 85 | 130 | 173 | 41 | 72 | 103 | 76 | 120 | 182 |
| 2027 | 84 | 131 | 177 | 41 | 72 | 103 | 76 | 120 | 184 |
| 2028 | 83 | 133 | 181 | 41 | 72 | 103 | 76 | 120 | 186 |
| 2029 | 81 | 134 | 186 | 41 | 72 | 103 | 76 | 120 | 187 |
| **2030** | **80** | **135** | **190** | **41** | **72** | **103** | **76** | **120** | **189** |

**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 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 |

**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 | 20 | 24 | 26 | 28 | 30 | 32 | 37 | 41 | 45 | 50 | 54 | 58 | 63 | 67 | 71 | 76 |

**Technology Assumptions**

Cost and technical data for new plant is taken from the 2012 PB Power study (for non-renewable technologies) and the Renewables Obligation Banding Review for renewable technologies. Details can be found at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65712/6884-electricity-gen-cost-model-2012-update.pdf
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42852/5936-renewables-obligation-consultation-the-government.pdf

**Hurdle Rate Reductions by Technology Type under FiT CfDs**

| | Reductions under FiT CfDs (percentage points) |
|---|---|
| **Onshore Wind** | -0.5 |
| **Offshore Wind (R1/R2)** | -1.2 |
| **Offshore Wind (R3)** | -1.1 |
| **Biomass (Large and Small)** | 0 |
| **Biomass CHP** | 0 |
| **Nuclear** | -0.8 |
| **CCS** | 0 |

The figures above are slightly different to those published in the impact assessment in November 2012 – the figure for Round 1/Round 2 offshore wind was -1.1 percentage points (and should have been -1.2 percentage points), while the figure for Round 3 was -1.2 percentage points (and should have been -1.1 percentage points). This has been corrected in the table above.

**Electricity Demand**

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

## 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.[95] 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). During the adjustment phase between the EU and global carbon markets, the TPC is linearly interpolated between the values in 2020 and 2030. Therefore after 2020 the TPC used in appraisal is above the EUA price estimates.

Non-internalised social costs of carbon represent the value of carbon costs less the EUA value. This item appears in distributional analysis because the EUA price is included in the producer costs.

### 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[96]

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

[96] 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.

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[97]. An increase in capital costs leads to a decrease in net welfare.

**Un-served energy**

Expected un-served energy is estimated using a stochastic run of the DDM. The mean un-served energy is valued at VOLL (defined by the user, normally set to £10,000/MWh). An increase in un-served 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***
  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.

- ***Un-served energy***
  This is calculated in the same was as in the net welfare calculation.

**Producer surplus**

[97] The hurdle rate reflects the minimum required rate of return which evidence suggests is necessary for a project or investment to proceed

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.

**Societal benefit**

This is the change in non-internalised social costs of carbon, or non-internalised social costs of carbon as described in the carbon costs category.

## Annex C: Basecases A and B: Decarbonisation trajectories and generation mix

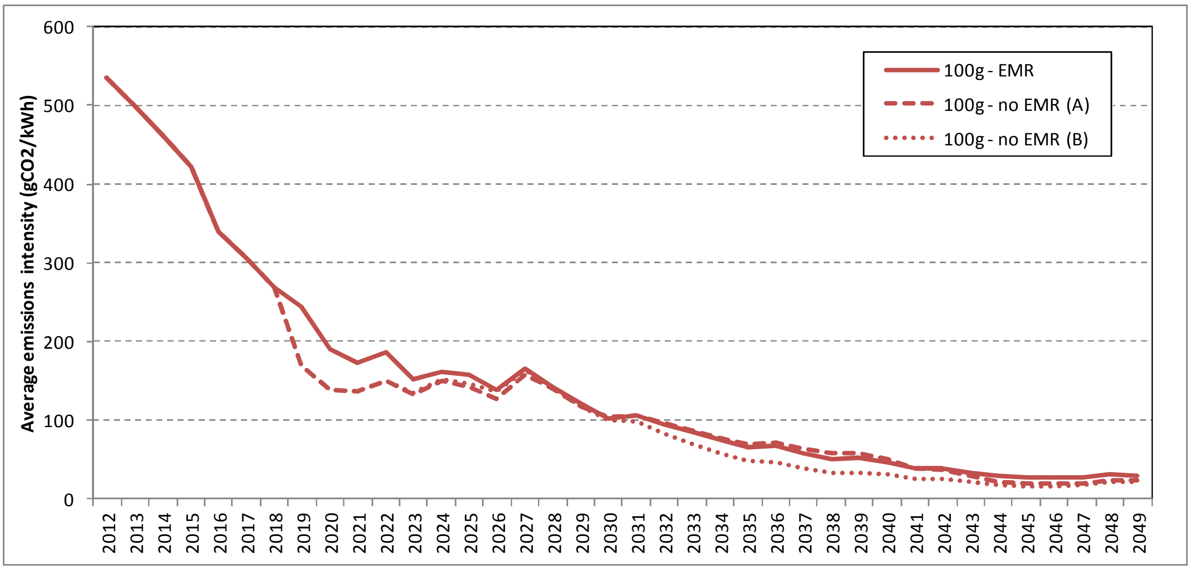
### Decarbonisation Profiles

168. Chart 6 presents the decarbonisation profiles under EMR and the two basecases (A and B) from which the range of net welfare impacts of EMR is derived. The different basecases follow a broadly similar decarbonisation trajectory, although, reflecting the different policy instruments used to decarbonise, there are some differences in the emission intensity profiles.

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

169. The introduction of a higher carbon price to incentivise nuclear investment under the basecase in both A and B 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.[98] As a consequence, the basecases have a lower emission intensity level in the early 2020s.

**Chart 6: Decarbonisation Profiles – EMR, Basecase A and Basecase B (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




Source: DECC modelling

170. This increase in the carbon price has more significant impacts on the decarbonisation trajectory during the 2030s and early 2040s. As result of the higher carbon price under Basecase B in the late 2020s (in order to bring on CCS, as well as the nuclear plants brought on under Basecase A), this produces a much lower decarbonisation profile

[98] 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.

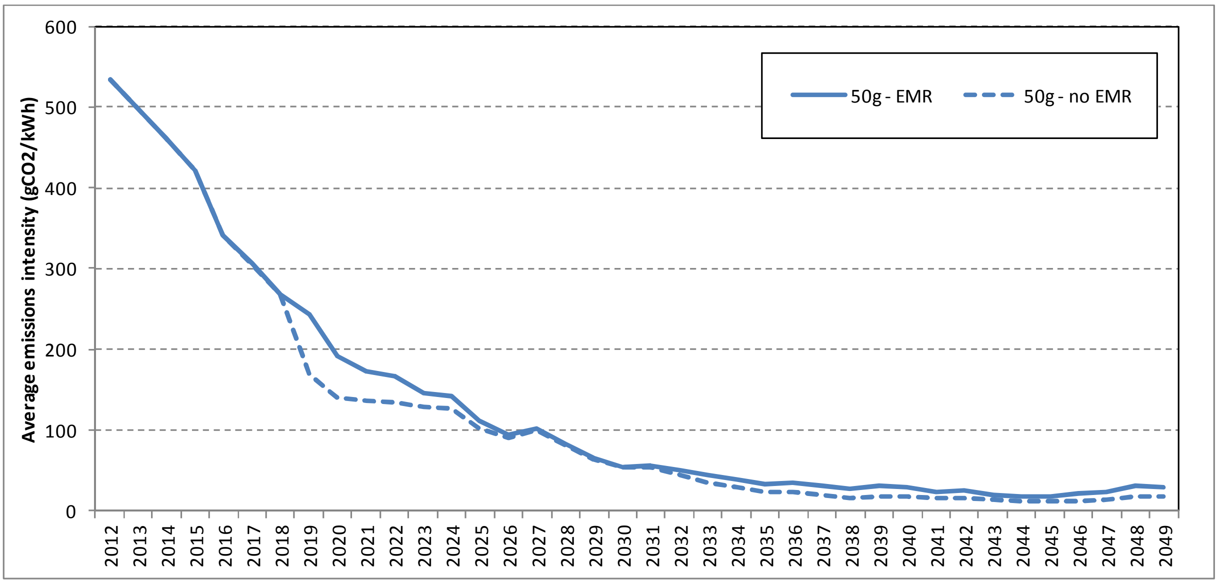
during the 2030s, such that the carbon emissions intensity in 2040 (at 31g$CO_2$/kWh) is significantly lower than either Basecase A (50g$CO_2$/kWh) or the EMR scenario (47g$CO_2$/kWh). Despite this, the differences in 2049 are much less significant.

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

171. For 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.

172. 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 7: Decarbonisation Profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

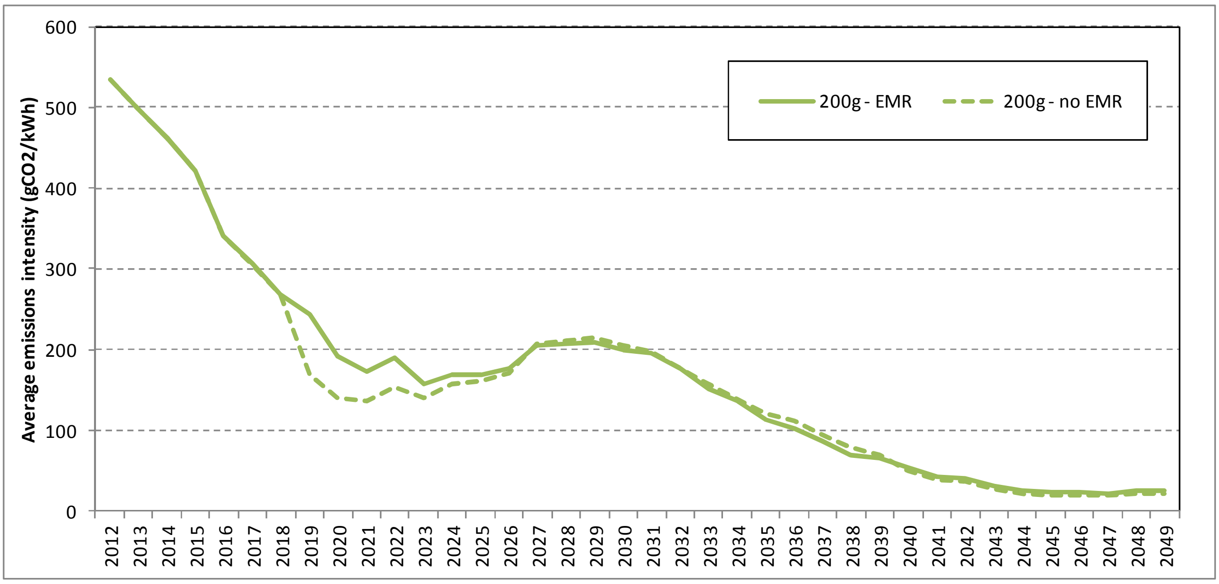



Source: DECC modelling

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

173. 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. However, from 2030 onwards the carbon price under the counterfactual rises steadily up to 2040, which produces a similar emissions profile to that achieved under EMR.

**Chart 8: Decarbonisation Profiles – EMR and 200g basecase (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




Source: DECC modelling

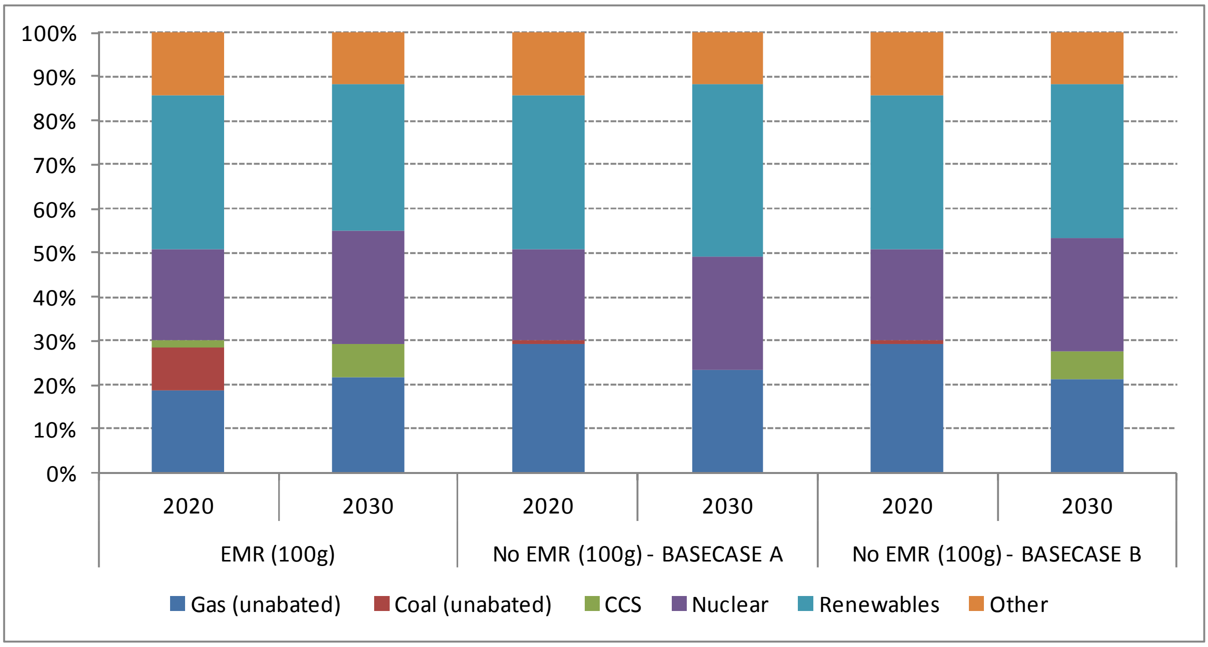
## Generation mix

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

174. Chart 9 presents generation mix profiles in 2020 and 2030 under EMR, and the basecases A and B.[99] Under Basecase A wholesale prices are not high enough to incentivise CCS investment. Therefore, in 2030, proportionately more renewable generation substitutes for the lost CCS generation in meeting the 2030 decarbonisation ambition. Under Basecase B, 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.

[99] 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).

**Chart 9: Generation mix profiles – EMR, Basecase A and Basecase B (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**



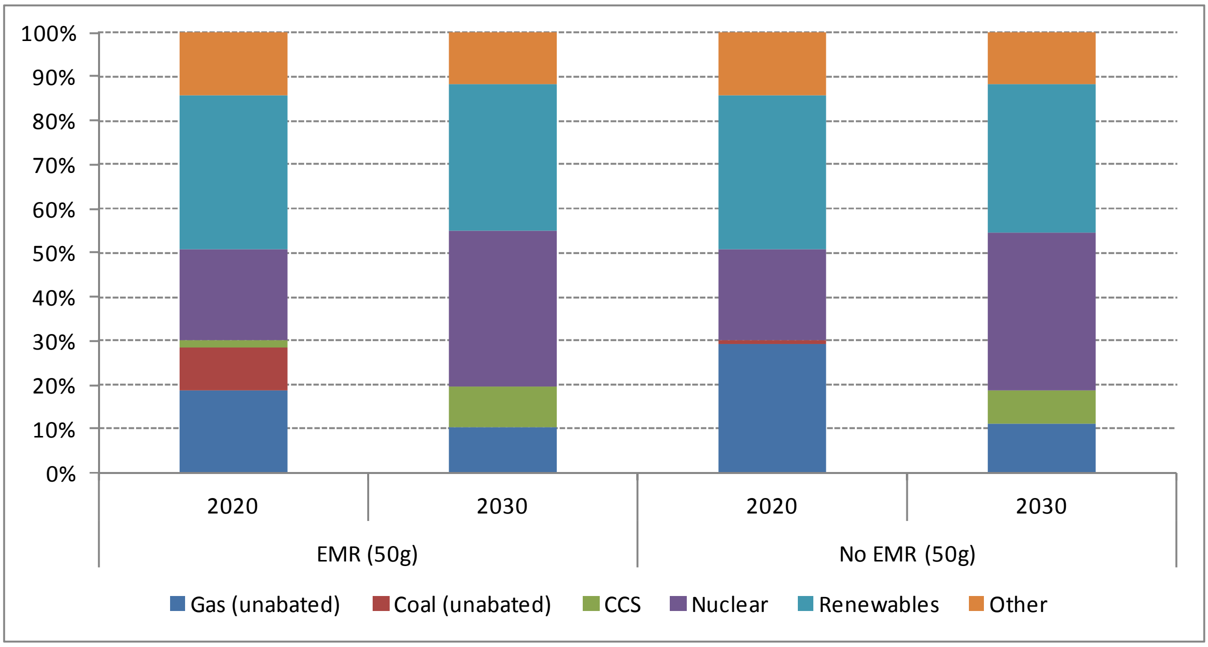

Source: DECC modelling

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*

175. In order to achieve an emissions intensity of 50gCO2/kWh in 2030, there is much less scope for variation in the potential generation mix (as shown by the similarities between the generation mix charts for both the EMR and the ‘no-EMR’ scenario in 2030 below). This is the reason for there being only a single basecase as a counterfactual in the analysis. In terms of explaining the differences in generation mix at 2020, the increased carbon price in the counterfactual in 2019 (in order to bring on nuclear plant) reduces the potential for unabated coal generation, hence why this technology does not appear in the 2020 mix for the counterfactual.

**Chart 10: Generation mix profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**



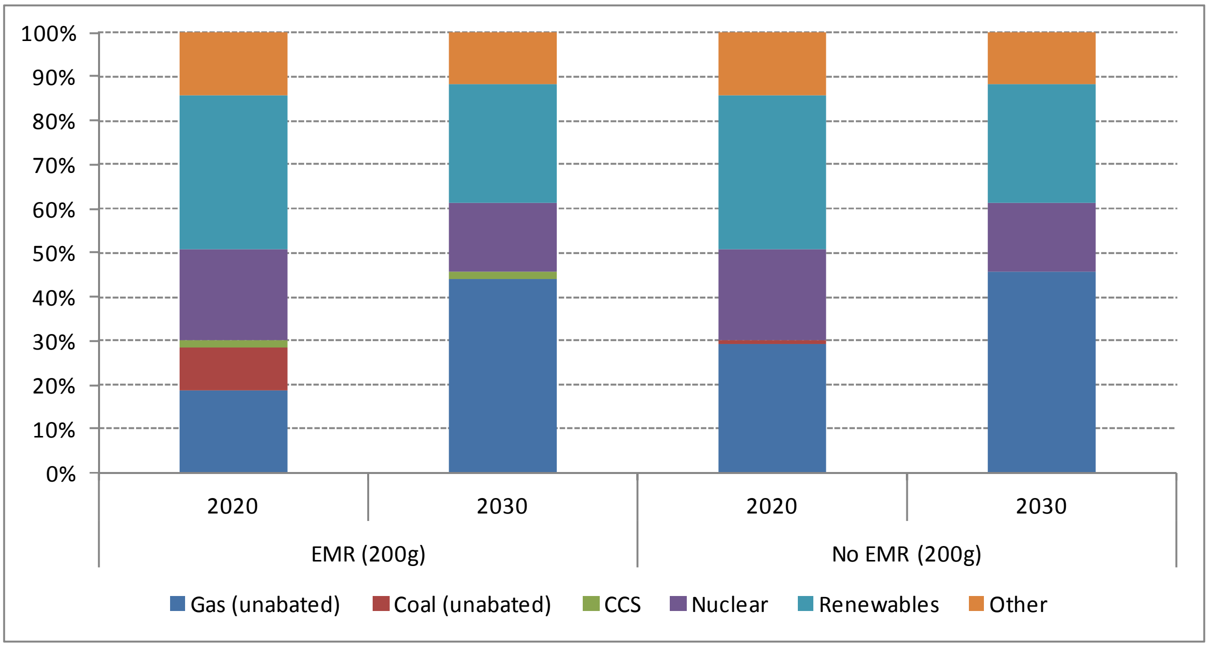

Source: DECC modelling

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*

176. Despite targeting an emissions intensity of 200g$CO_2$/kWh, there is the same carbon price profile up to 2020 as for the 50g scenario, which leads to an identical generation mix as the 50g scenario in 2020. As the carbon price in the counterfactual does not increase throughout the 2020s, the carbon price does not rise sufficiently to encourage CCS, hence there is no CCS in the 2030 generation mix for the counterfactual.

**Chart 11: 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

177. 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.

178. The first analysis assessing the costs and benefits of various potential EMR options was presented in the Government's December 2010 consultation on EMR.[100] 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.

179. 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.[101] 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.

180. 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.[102] 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[103] in the EMR White Paper, under central fossil fuel price assumptions.

181. This was subsequently updated in the analysis accompanying the publication of the Energy Bill, which was introduced into Parliament in November 2012.[104] 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

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[100] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf
[101] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf
[102] 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
[103] This number reflects DECC's new carbon appraisal methodology for CBA (12th August 2011) and revises the White Paper number.
[104] 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[105]); 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**.

182. 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.

183. 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.

[105] 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 and fossil fuel prices

184. This annex presents the results of assessing EMR relative to the alternative basecases discussed in the main paper. 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.

- **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.[106]

185. The table below provides a summary of the different outcomes and policy environments assumed under the Basecase C.

**Table 27: Summary of assumptions – Basecase C**

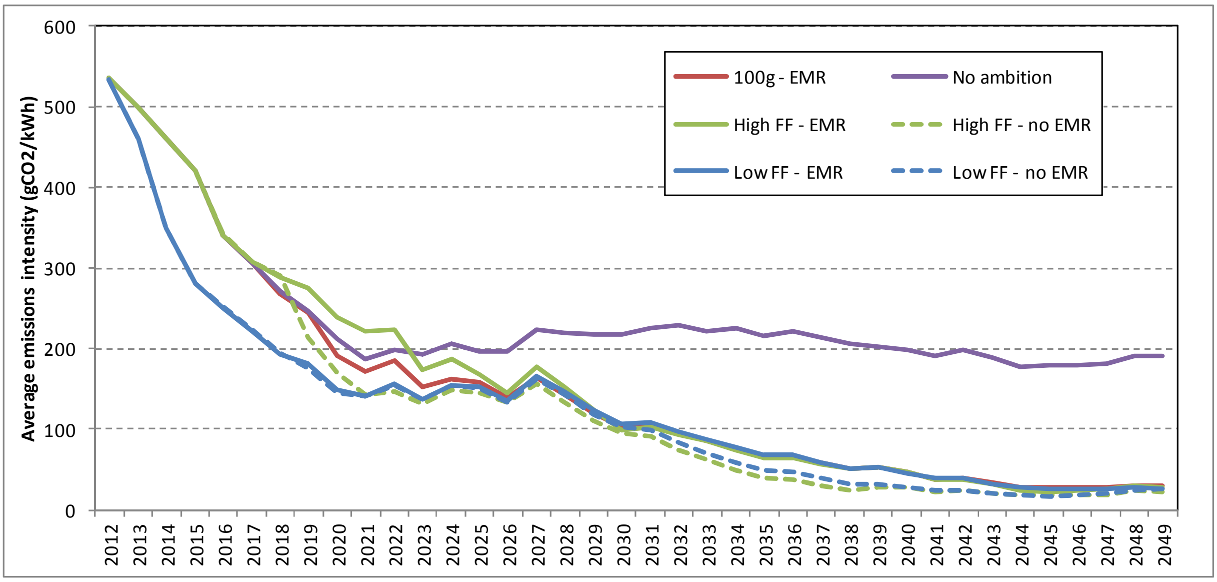
| | 2030 emissions intensity $gCO_2/KWh$ | 2049 emissions intensity $gCO_2/KWh$ | Carbon Pricing | Renewables Obligation (RO) |
|---|---|---|---|---|
| ***No Emission Intensity Ambition*** | | | | |
| Basecase C | 218 | 191 | Constant in real terms after 2030 | RO stays open to new renewable plants beyond 2017, closing in 2037. |

### Decarbonisation Profiles

186. Chart 12 presents the decarbonisation profiles under EMR, Basecase C (described above) and the different fossil fuel price scenarios. Under Basecase C, which does not set a decarbonisation ambition for any time period, emission intensities stay broadly at the same level from 2020 onwards.

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

**Chart 12: Decarbonisation Profiles – EMR, Basecase C and fossil fuel price scenarios**




Source: DECC modelling

187. Under the high fossil fuel price counterfactual, there is an increase in the carbon price towards the end of the 2020s to bring on the same nuclear build profile as under EMR. This rises steeply during the 2020s, at stepped intervals, to £200/tonne, which is necessary to achieve the required emissions intensity of 100g$CO_2$/kWh in 2030. This comparatively high carbon price is sustained under the counterfactual, which leads to a lower emissions profile relative to the EMR high fossil fuel price scenario up to 2049.

188. Under the low fossil fuel price counterfactual, a relatively steeper rise in the carbon price is required just before 2020 in order to make investment in nuclear economically viable. This carbon price is then sustained, which incentivises low-carbon generation and leads to a lower emissions profile than the equivalent EMR scenario.

## Generation mix

189. The chart below presents generation mix profiles for Basecase C and the fossil fuel price sensitivities in 2020 and 2030, compared to the generation mix realised under EMR.

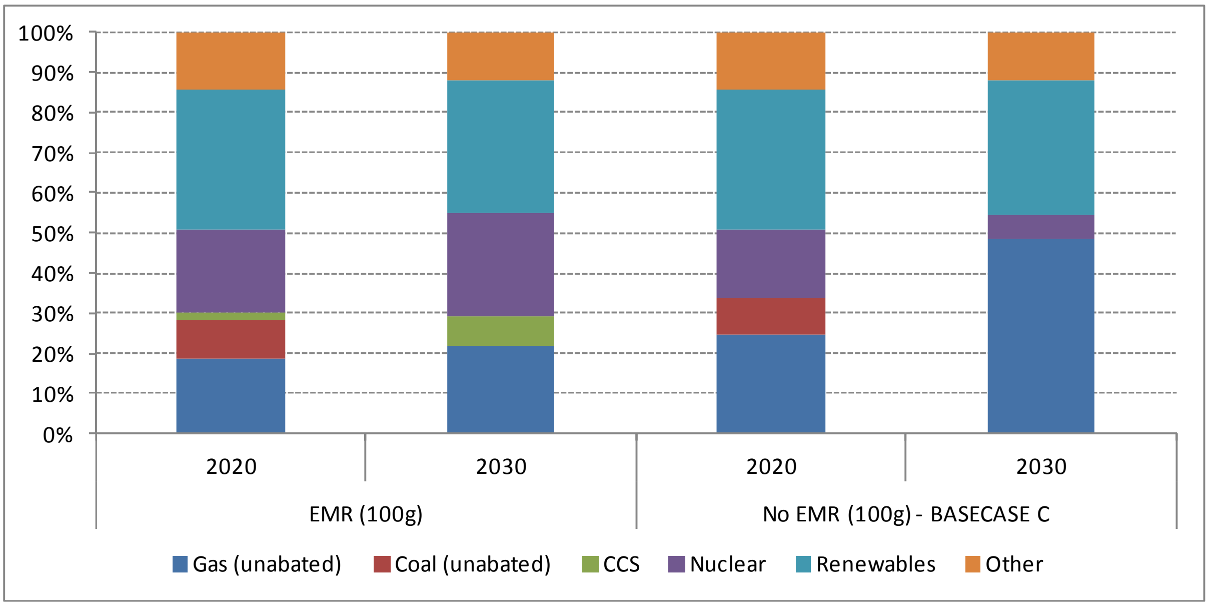
*Basecase C*

190. 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).[107] Without nuclear, coal and CCS generation, under Basecase C gas

[107] 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.

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 just over 200g$CO_2$/kWh.

**Chart 13: 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.

*Fossil fuel price scenarios*

191. Under a high fossil fuel price scenario, the relative prices of coal and gas generation change such that coal becomes comparatively more economic. Therefore, under both the EMR and 'no-EMR' scenarios, although the overall proportion of unabated generation (coal and gas combined) is the same as under a central fossil fuel price scenario, there is a relatively greater proportion of unabated coal generation in 2020.

192. In terms of differences between EMR and 'no-EMR' scenarios, the EMR scenario has a higher proportion of CCS generation in both 2020 and 2030, as this includes the CCS demonstration projects (which are not included in the basecase). The 'no-EMR' scenario also has a higher proportion of renewable generation in 2030, as the increase in the carbon price (in order to bring on nuclear build by 2020, and CCS during the 2020s) makes the building of renewable generation capacity more economic.

193. For low fossil fuel prices, the relative price of coal and gas generation changes to make gas generation relatively more attractive compared to coal. Therefore, in contrast

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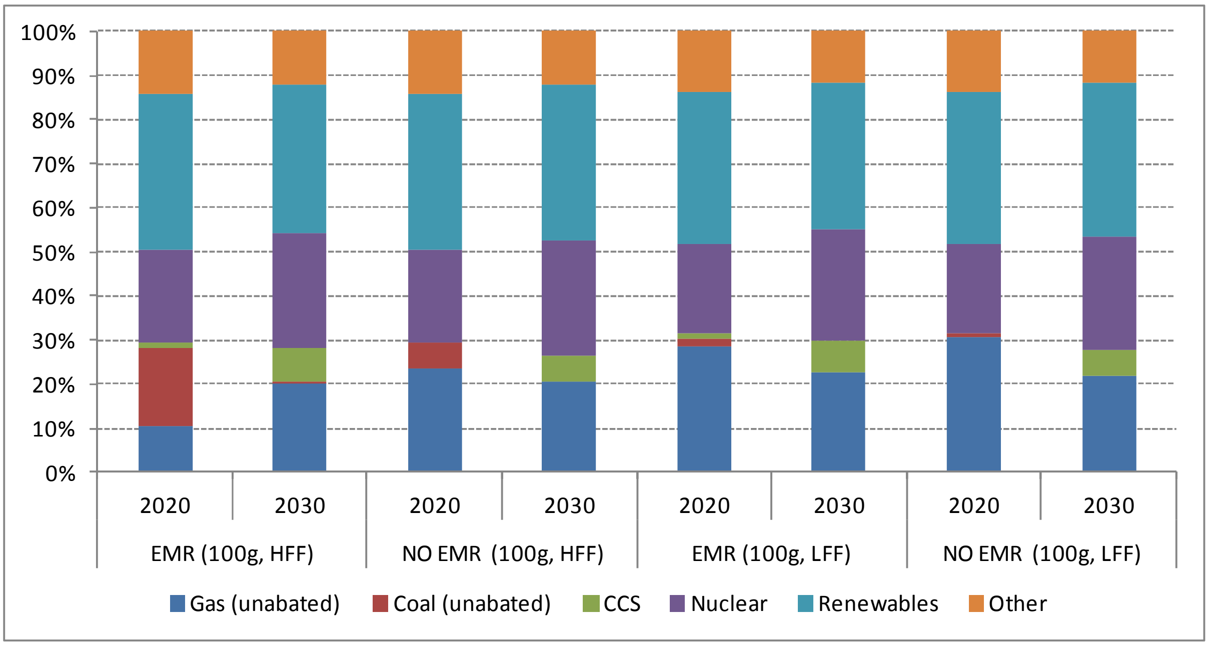
However, in the absence of EMR, a likely scenario is that alternative funding would be sought for CCS consistent with the Government's commitment to help support the development of this technology.

to the high fossil fuel price scenario, the proportion of gas generation under both the EMR and 'no-EMR' scenarios is higher in 2020 than under the central fossil fuel price scenario.

194. In terms of differences between EMR and 'no-EMR' scenarios, the EMR scenario has a higher proportion of CCS generation in 2020 due to the inclusion of the CCS demonstration projects (which are not included in the basecase). However, there are minimal differences between the EMR and 'no-EMR' scenarios by 2030.

**Chart 14: 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.

## Basecase C - no emissions intensity ambition

195. EMR is assessed against a basecase which does not meet the decarbonisation ambitions achieved under EMR.[108] This basecase provides a point of comparison to earlier EMR analysis, such as the EMR White Paper.

## Cost Benefit Analysis (CBA)

196. Table 28 presents the net welfare impact of the EMR package relative to Basecase C, for a carbon emission intensity in 2030 of $100gCO_2/kWh$. The results suggest that the EMR package would lead to a net welfare loss of around £4.2bn, up to 2030.

[108] The Emissions Intensity under this scenario falls to around $200gCO_2/kWh$ 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 floor is the only policy impacting the basecase (it remains constant in real terms post-2030).

**Table 28: Change in Net Welfare (NPV) – Combined EMR impact (CfDs with Capacity Market), compared to Basecase C (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 | 5,100 | 30,000 | 65,000 |
| | Generation cost savings | 4,600 | 13,000 | 18,000 |
| | Capital cost savings | -13,000 | -40,000 | -65,000 |
| | Unserved energy savings | 90 | 900 | 1,300 |
| | Cost of Interconnector energy saved | 46 | 300 | 610 |
| | **Change in Net Welfare** | **-3,500** | **4,300** | **20,000** |
| | **Change in Net Welfare*** | **-4,200** | | |

Source: DECC modelling

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

197. 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.

198. EMR is a policy with upfront costs and long-term benefits. 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 positive net welfare impact of £4.3bn, rising to around £20bn up to 2049.

199. When assessing up to 2040, the generation and carbon cost savings realised under EMR more than offset the higher capital costs incurred, a feature that is reinforced when EMR is assessed up to 2049 (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.

200. Table 29 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 consumers enjoy from lower wholesale prices and less unserved energy. Conversely, producers enjoy improved 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).

201. Relative to Basecase C, EMR results in lower carbon emissions and therefore a reduction in environmental tax revenue. The final row reflects the benefit to society from carbon abatement. The large social benefit from non-internalised social costs of carbon reflects the benefit of decarbonising and the avoided social costs of carbon up to 2049.

**Table 29: 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 | 2,300 | 19,000 | 42,000 |
| | Low carbon payments | -3,800 | -15,000 | -38,000 |
| | Capacity payments | -8,500 | -21,000 | -30,000 |
| | Unserved energy | 90 | 900 | 1,300 |
| | **Change in Consumer Surplus** | **-10,000** | **-16,000** | **-24,000** |
| **Producer Surplus** | Wholesale price | -2,200 | -18,000 | -41,000 |
| | Low carbon support | 3,800 | 15,000 | 38,000 |
| | Capacity payments | 8,500 | 21,000 | 30,000 |
| | Producer costs | -2,900 | -4,900 | -10,000 |
| | **Change in Producer Surplus** | **7,300** | **13,000** | **16,000** |
| **Environmental Tax** | **Change in Environmental Tax Revenue** | **-4,800** | **-18,000** | **-30,000** |
| **Societal benefit** | **Change in non-internalised Social Costs of Carbon** | **4,000** | **26,000** | **58,000** |
| **Net Welfare** | **Change in Net Welfare** | **-3,500** | **4,300** | **20,000** |

Source: DECC modelling

*Changes from previous analysis*

202. In the IA accompanying the Energy Bill, published in November 2012, the overall NPV for EMR relative to Basecase C was presented as -£6.7bn (real 2012 prices). Therefore, the latest modelling updates outlined above have resulted in a significant improvement in EMR's overall NPV.

203. Generation cost savings are slightly lower (by £0.6bn) under the latest analysis, in comparison to the modelling published in November 2012 (2012 prices). The most significant proportion of the increase in the NPV can be explained by the capital costs

under EMR being around £4bn lower in the latest modelling.[109] Finally, in the latest modelling there is a slight decrease in the value of unserved energy savings under EMR, relative to the basecase, of around £100m.

**Table 30: 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 | 5,100 | 4,500 |
| | Generation cost savings | 4,600 | 5,200 |
| | Capital cost savings | -13,000 | -17,000 |
| | Unserved energy savings | 90 | 190 |
| | Cost of Interconnector energy saved | 46 | 46 |
| | **Change in Net Welfare** | **-3,500** | **-6,700** |

Source: DECC modelling

**Price and Bills Analysis**

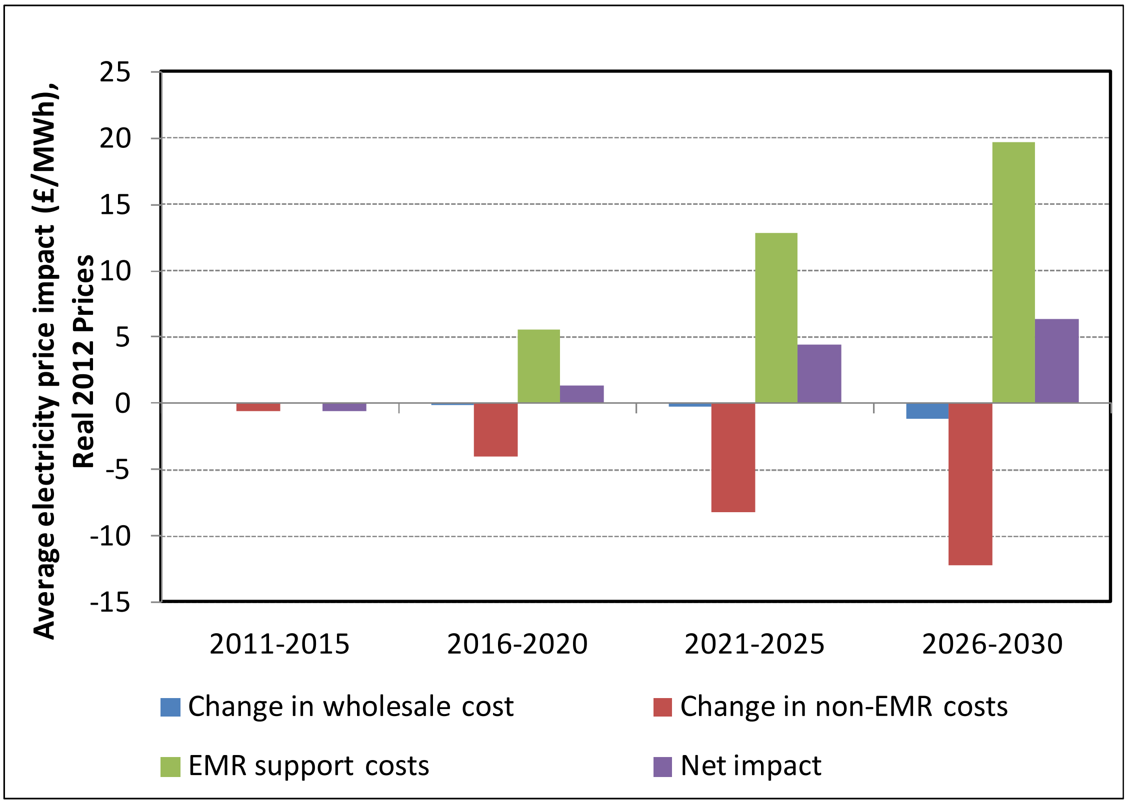
204. Chart 15 presents the net impact of EMR on prices relative to Basecase C, which does not meet the same decarbonisation ambitions and does not mitigate against security of supply risks.

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

205. Assessed over the period 2016-2030, EMR increases prices relative to the basecase. Prices to 2030 are on average, around 2% 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).

[109] The updated results have been rounded to two significant figures in the table. The reported differences from the previous NPV reflect the differences in the modelled figures, and therefore may not match with the tables results due to the rounding.

**Chart 15: Net Impact of EMR on domestic electricity prices, relative to Basecase C (assumed emissions intensity in 2030 = 100g$CO_2$/kWh)**




Source: DECC modelling

206. 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, such that prices in 2029 are only 2% higher under EMR. However, despite these effects, EMR will have achieved 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.

207. 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 2% (£14) 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 around 3% higher.

**Table 31: 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 | 580 | - | 1,150 | - | 8,360 | - |
| 2016-2020 | 601 | +5 (1%) | 1,350 | +10 (1%) | 10,580 | +110 (1%) |
| 2021-2025 | 592 | +14 (2%) | 1,410 | +50 (3%) | 11,490 | +450 (4%) |
| 2026-2030 | 663 | +22 (3%) | 1,500 | +50 (3%) | 12,190 | +480 (4%) |
| **2016-2030** | **619** | **+14 (2%)** | **1,420** | **+40 (3%)** | **11,420** | **+340 (3%)** |

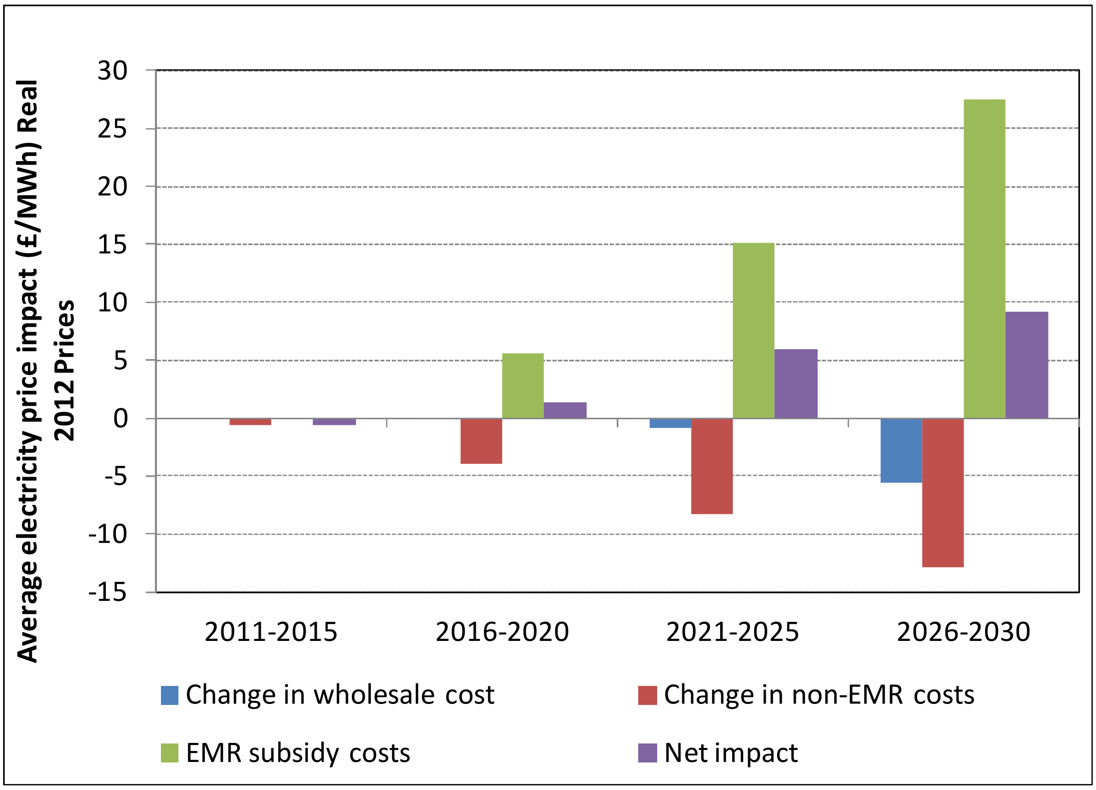
Source: DECC modelling

208. 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 £5 (1%) higher. In the early 2020s, the costs of EMR increase, with average annual domestic electricity bills £14 (2%) higher under EMR in comparison to Basecase C. The bill impact of EMR peaks in 2026, before declining towards the end of the period. In 2029, the modelling suggests annual domestic electricity bills could be £12 (2%) higher under EMR in comparison to what they would have been under Basecase C.

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

209. Under this scenario, EMR again increases prices relative to Basecase C, with average prices to 2030 estimated to be around 3% 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, being just over £9/MWh higher for the period 2026-2030.

**Chart 16: Net Impact of EMR on Domestic Electricity prices, relative to basecase C (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**




Source: DECC modelling

210. 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 3% (£18) 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 around 3% higher.

**Table 32: EMR Bill Impacts relative to Basecase C (assumed emissions intensity in 2030 = 50g$CO_2$/kWh)**

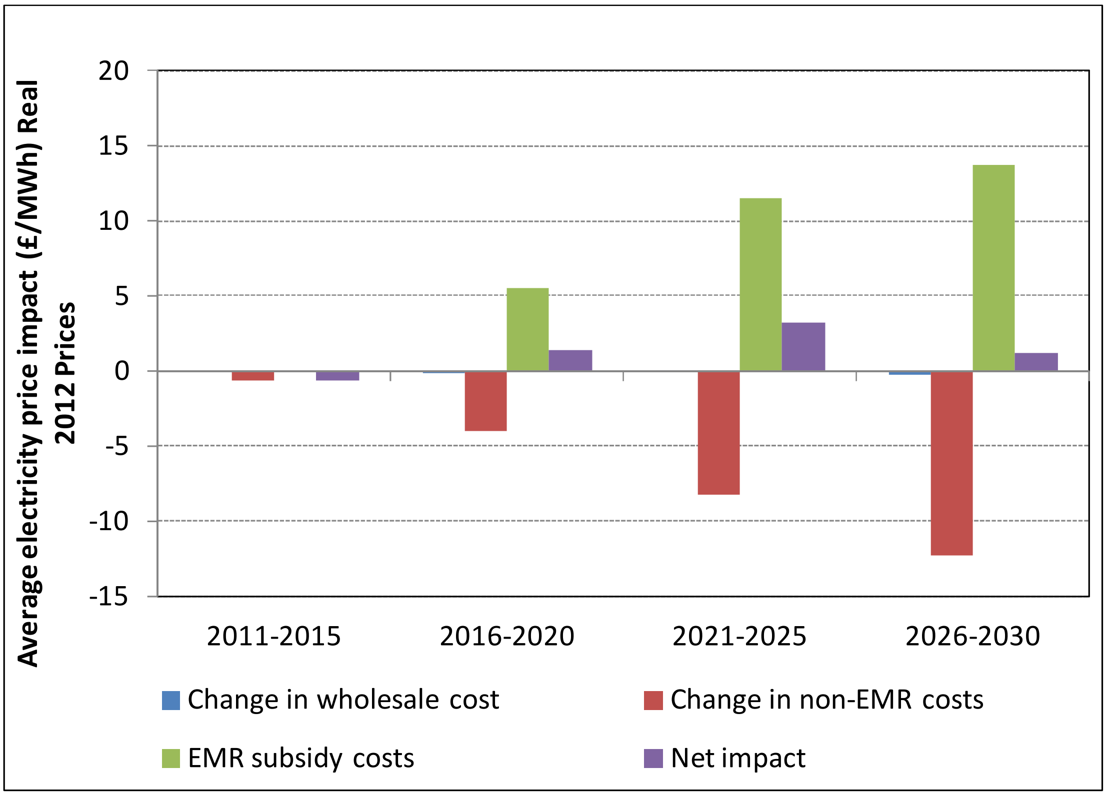
| Real 2012 prices | Domestic (£) | | Non-Domestic (with CRC) (£'000s) | | Energy Intensive Industry (£'000s) | |
|---|---|---|---|---|---|---|
| | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) | Bill under basecase | Change in bill due to EMR (%) |
| 2011-2015 | 580 | - | 1,150 | - | 8,360 | - |
| 2016-2020 | 601 | +5 (1%) | 1,350 | +10 (1%) | 10,580 | +110 (1%) |
| 2021-2025 | 592 | +19 (3%) | 1,410 | +50 (4%) | 11,490 | +530 (5%) |
| 2026-2030 | 663 | +31 (5%) | 1,500 | +60 (4%) | 12,190 | +550 (5%) |
| **2016-2030** | **619** | **+18 (3%)** | **1,420** | **+40 (3%)** | **11,420** | **+400 (3%)** |

Source: DECC modelling

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

211. 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 1% 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 17: Net Impact of EMR on Domestic Electricity prices, relative to basecase C (assumed emissions intensity in 2030 = 200g$CO_2$/kWh)**




Source: DECC modelling

212. Table 33 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 1% (£7) 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 1% and 2% higher over this period.

**Table 33: 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 | 580 | - | 1,150 | - | 8,360 | - |
| 2016-2020 | 601 | +5 (1%) | 1,350 | +10 (1%) | 10,580 | +110 (1%) |
| 2021-2025 | 592 | +11 (2%) | 1,410 | +40 (3%) | 11,490 | +350 (3%) |
| 2026-2030 | 663 | +5 (1%) | 1,500 | +10 (1%) | 12,190 | +90 (1%) |
| **2016-2030** | **619** | **+7 (1%)** | **1,420** | **+20 (1%)** | **11,420** | **+180 (2%)** |

Source: DECC modelling

**Fossil fuel price scenarios**

213. The robustness of EMR to different assumptions about fossil fuel prices has been tested using the 2012 update to DECC's annual fossil fuel price projections. 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.

214. 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.[110] This therefore measures the efficiency of EMR as a tool for decarbonising the economy, rather than the benefits of decarbonisation.

*High fossil fuel prices*

215. Under high fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of **£4.6bn up to 2030** relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). This result is driven by significant generation cost savings (by approximately £3bn relative to Basecase B, to which this scenario is most similar), though this is offset to some degree by higher carbon costs under EMR, relative to the counterfactual.

[110] 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). In terms of a comparison to the basecases under the central 100g scenario, this is closest to Basecase B and therefore could be thought as providing a lower bound estimate of the benefits of EMR.

*Low fossil fuel prices*

216. Under low fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of **£5.3bn up to 2030** relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). In this case, the result is primarily driven by a combination of significant capital cost savings and generation cost impact (in fact, generation costs are slightly higher under EMR, as shown by the negative figure), relative to the counterfactual.

**Table 34: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to Basecases A and B, fossil fuel price scenarios (emissions intensity in 2030 = 100g$CO_2$/kWh)**

| | | NPV, £m (2012-2030, real 2012) | | | |
|---|---|---|---|---|---|
| | | Basecase A | Basecase B | High FF prices | Low FF prices |
| Net Welfare | Value of carbon savings | -880 | -740 | -1,900 | -220 |
| | Generation cost savings | 63 | 1,100 | 4,200 | -900 |
| | Capital cost savings | 8,100 | 3,200 | 1,400 | 5,300 |
| | Unserved energy savings | 170 | 190 | 410 | 65 |
| | Cost of Interconnector energy saved | 760 | 1,200 | 1,200 | 1,700 |
| | **Change in Net Welfare** | **8,300** | **4,900** | **5,300** | **6,000** |
| | **Change in Net Welfare*** | **7,600** | **4,200** | **4,600** | **5,300** |

Source: DECC modelling

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