Title: Electricity Market Reform – ensuring electricity security of supply and promoting investment in low-carbon generation [Delivery Plan update: March 2014] **IA No: DECC0143** **Lead department or agency:** DECC	**Impact Assessment (IA)** **Date: 10/03/2014** **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
£10.7bn	-	-	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 one of DECC's other key objectives of meeting the 2020 renewables target. The intended effects are that sufficient generation and demand-side resources will be available to ensure that supply and demand balance continues to be met and there will be sufficient investment in low-carbon generation to meet decarbonisation objectives.

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

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

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

Finally, to reflect the decision to take a power in the Energy Act 2013 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 100gCO_2/kWh for the power sector in 2030, consistent with previous EMR impact assessments – includes analysis based on an average emission level of both 50gCO_2/kWh and 200gCO_2/kWh in 2030. This shows that the design of EMR and specifically the FiT CfD will lower the cost of financing the large investments needed in electricity infrastructure, irrespective of the level of decarbonisation in the sector to 2030.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date: 2018**

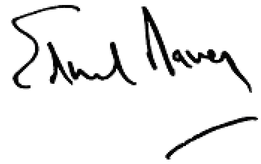
Does implementation go beyond minimum EU requirements?			**N/A**		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** **No**	**< 20** **No**	**Small** **No**	**Medium** **No**	**Large** **No**

[1] The EMR package includes a low-carbon instrument (the CfD) and a Capacity Market, combined with an Emissions Performance Standard (EPS). The impact of the Emissions Performance Standard is considered in the EPS IA, which accompanied the Energy Act 2013.

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

What is the CO2 equivalent change in greenhouse gas emissions? (Million tonnes CO2 equivalent)	**Traded:** **-**	**Non-traded:**

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

Signed by the responsible Minister:  Date: 10/03/2014

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

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

FULL ECONOMIC ASSESSMENT

Price Base Year 2012	PV Base Year 2012	Time Period Years 18	Net Benefit (Present Value (PV)) (£m)		
			Low: £	High: £	Best Estimate: £10,700

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. transition, constant prices)	Total Cost (Present Value)
Low	N/A	-	N/A	**N/A**
High	N/A		N/A	**N/A**
Best Estimate	N/A		N/A	**£2,300**

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

Under EMR, carbon costs up to 2030 are higher than the 100g basecase, which achieves a similar decarbonisation profile using existing policy instruments (RO and carbon pricing). This reflects EMR's slightly slower decarbonisation profile; in NPV terms, carbon costs up to 2030 are **£1.7bn higher under EMR**.[4]

The institutional costs of EMR consist of both National Grid delivering their EMR functions and those associated with setting up the single counterparty body. In addition, there will be associated administrative costs to energy sector businesses (the costs of which cover the whole of the UK). In total, these costs (in discounted NPV terms, over the period 2012 -2030) are estimated to range between £500m to £800m (in 2012 prices) – a mid-point estimate of **£0.6bn up to 2030** is used.[5]

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

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

[3] The results presented in this summary are based on a carbon emissions intensity of 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. Figures in this table are rounded to two significant figures and therefore totals may not sum.

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

[5] The costs largely reflect staff, IT, building costs and any external expertise which may be required – both for the institutional body and the energy businesses bidding into the Capacity Market, as well as an estimate of the administrative costs of CfDs on energy sector businesses.

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

The key benefits of decarbonising using EMR are reducing financing costs for investors and minimising generator rents under high wholesale prices. The greater price certainty from CfDs allows financing at a lower cost. The technology-specific hurdle rates used in this analysis are based on data and evidence drawn from various sources.[6] For the central assumption about 2030 carbon emission intensity (100gCO_2/kWh), these benefits are estimated to amount to **£3.8bn up to 2030** in NPV terms (including administrative costs).[7]

As in the modelling for the draft Delivery Plan in July, for this latest analysis the benefits of reductions in unserved energy are calculated using a model using data from DDM outputs. Using this model, relative to the 100g basecase, EMR reduces unserved energy costs by **around £1.7bn up to 2030** (in NPV terms).

The analysis also considers the impact of EMR on system costs, defined as the sum of the costs of building and operating the electricity system (TNUoS, BSUoS and inertia costs). These costs are calculated by National Grid models, based on DDM output. Under EMR, system costs are estimated to be **around £160m lower** than the 100g basecase, in NPV terms up to 2030.

Finally, the capacity and generation mix realised under EMR, and the 100g 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 100g basecase scenarios. In this latest modelling, the differences in technology mix attributable to CfDs under the EMR scenario and 100g basecase is estimated to lead to capital costs benefits of **£8.2bn up to 2030** (including the financing benefits discussed above), in NPV terms.[8] There is also a **£1.6bn** benefit from lower generation costs under EMR in comparison to the basecase scenario.

There is a further benefit associated with interconnectors, which results from higher wholesale prices in the 100g basecase relative to the EMR scenario as a result of the policy instrument used to decarbonise in the 100g basecase; this leads to benefits of **£1.4bn up to 2030**, in NPV terms (explained further in Annex B).

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

For domestic consumers, EMR is estimated to reduce average annual household electricity bills by 6% (£41) over the period 2014-2030, relative to a 100g basecase which achieves a similar decarbonisation level using existing policy instruments. The percentage impact on average bills for businesses and energy-intensive industries is estimated to be similar (7-8%), but slightly larger since these users typically face lower energy prices.

Estimates of EMRs impact on Fuel Poverty levels, relative to the basecase scenarios, using the new Low Income High Costs (LIHC) framework are presented in Section 3 (as well as estimates using the previous '10%' measure). The results suggest that EMR is unlikely to have a large bearing on the number of households in fuel poverty, but will affect the depth of the problem faced by the fuel poor, by reducing the fuel poverty gap in the long term.

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

Estimates of EMR institutional costs must be regarded as tentative as the component costs have not yet been fully determined, as they depend on the final agreed activities to be undertaken by the organisations.[9]

This IA presents modelling assessing the impact of reaching different carbon emission intensities for the power sector in 2030 (100gCO_2/kWh (as reported above), 50gCO_2/kWh and 200gCO_2/kWh).

Dispatch modelling is sensitive to a number of assumptions (e.g. 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.

[6] For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report: https://www.gov.uk/government/collections/energy-generation-cost-projections

[7] Depending on the assumed level of decarbonisation in 2030, these benefits would amount to an NPV of between £2.5bn and £6.0bn up to 2030 (including administrative costs). See Section 2.3.1. for further details.

[8] The capital cost benefits reflect the combined impact of two factors – the financing cost impact described above and a technology mix impact reflecting differences in the technology and generation mixes realised in the EMR and basecase scenarios. See Section 2.3.1. for further details.

[9] These costs do not consider what costs might have been in the absence of EMR. For example, they do not consider what the additional administrative costs of greater reliance on carbon pricing or the RO might be in the 100g basecase.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m: [10]			In scope of OIOO?	Measure qualifies
Costs: 5,500	**Benefits: 6,800**	**Net: 1,300**	No	N/A

[10] The Direct impact on business estimates have been updated since the December 2013 IA to make use of 2013 Updated Energy Projections (UEP). Direct costs to business are calculated using the same methodology presented in the EMR White Paper. See Annex F for further details: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48133/2180-emr-impact-assessment.pdf

Contents

Section 1 Overview

1. This Impact Assessment (IA) is a further update to the series of IAs published in support of Electricity Market Reform (EMR), the latest of which was published in December 2013[11]. This IA is a more comprehensive update to the shortened IA published alongside the EMR Delivery Plan, reflecting a range of additional analysis and further background information, although the headline results are the same as presented in December 2013.

2. The analysis contained in this IA reflects the modelling undertaken for the EMR Delivery Plan[12]. This is based on the final Contract for Difference (CfD) strike prices for renewable technologies (the full list of which were published in December 2013[13]) and the final reliability standard (set at an annual level of 3 hours expected lost load[14]).

3. The analysis shows that the design of EMR (through FiT CFDs) will lower the financing costs of the large investments needed in electricity infrastructure, regardless of the level of decarbonisation targeted in 2030 – 50gCO_2/kWh, 100gCO_2/kWh and 200gCO_2/kWh.

4. EMR and Capacity Mechanism IAs of December 2010[15], July 2011[16], May 2012[17], November 2012[18] and May 2013[19] 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.[20]

[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268202/Delivery_Plan_IA.pdf

[12] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263937/Final_Document_-_Investing_in_renewable_technologies_-_CfD_contract_terms_and_strike_prices_UPDATED_6_DEC.pdf

[14] For further details on the methodology for how the reliability standard has been set, please see Annex C of the Delivery Plan (https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan).

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

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

[17] 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

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

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

[20] 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.

- A Capacity Market is the preferred instrument to mitigate security of supply risks compared to alternatives, including a strategic reserve and the 'do nothing' case.[21]

- An Administrative Capacity Market is the preferred form of the capacity market compared with a reliability option.[22]

5. Section 2 of this IA presents updated Cost-Benefit Analysis (CBA) for the EMR lead policy package, a FiT CfD and an Administrative Capacity Market, based on the final strike prices for renewable technologies and reliability standard set out in the EMR Delivery Plan[23]. Section 3 presents updated analysis of the electricity price and bill impacts associated with this latest modelling.

Modelling changes since July 2013

6. Since the publication of the draft Delivery plan in July 2013, there have been some changes to the underlying assumptions on which EMR modelling has been based. These are set out in more detail in Annex H, which was published alongside the final EMR Delivery Plan.[24] As for the analysis undertaken for the draft Delivery Plan, the modelling is also consistent with the upper limits on spending for electricity policies agreed under the Levy Control Framework.[25]

7. Since the publication of the draft Delivery Plan, DECC has consulted on providing additional support for onshore wind projects on the Scottish islands. This consultation and the responses to it fed into decisions for the Final Delivery Plan, and culminated in a decision to provide a separate strike price for onshore wind projects on the Scottish islands.

8. In undertaking the cost-benefit analysis for EMR (based on CfDs with the final strike prices, and a Capacity Market which uses the final reliability standard), the policy package is compared to a basecase counterfactual, without the EMR package. This alternative scenario attempts to match as closely as possible the decarbonisation profile

[21] 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).

[22] 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.

[23] 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.

[24] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

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

achieved under EMR. However, given the policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown, the alternative scenario, or basecase, attempts to achieve this similar decarbonisation profile using existing policy instruments, namely the Renewables Obligation (RO) and the EU ETS and Carbon Price Floor (CPF).

9. Risks to the security of supply objective are not mitigated against in the counterfactual, investment decisions are principally made on an energy-only basis, as we do not believe it would be possible to meet the same objective without a capacity mechanism.

10. As for previous EMR IAs, this analysis assumes an illustrative carbon emissions intensity of 100gCO_2/kWh in 2030 and uses DECC's in-house Dynamic Dispatch Model (DDM).[26] It also incorporates analysis based on emission intensities of 50gCO_2/kWh and 200gCO_2/kWh, and is based on a standardised set of assumptions, including technology costs and electricity demand at the time the analysis was undertaken.

11. Whilst a range in NPV estimates is not presented, as has been the case in some previous EMR Impact Assessments, the uncertainty over how Government might decarbonise without EMR remains, hence there is still significant uncertainty around the precise welfare impact of EMR.

Summary of results

12. The value of the changes in the NPV estimates between July 2013 and this update are shown in the table below. Overall, the estimated Net Present Value for EMR (assessed up to 2030) has **increased from £9.5bn in July 2013 to £10.7bn in the latest analysis**. Within this, the net welfare benefits associated with CfDs has increased from £9.4bn to £10.2bn, while the net welfare benefit associated with the Capacity Market has also slightly increased – from a net benefit of £0.1bn to a net benefit of £0.6bn (both assessed up to 2030) [27].

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[26] 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. A description of the quality assurance work that has been undertaken on the DDM is set out in Annex G to the Delivery Plan: https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

[27] Consistent with the analysis conducted for the draft EMR Delivery Plan, the NPV estimates also include an estimate of the net impact of CfDs on Northern Ireland.

Table 1: Change in Net Welfare (NPV) – combined EMR impact (2012-2030), comparison of July 2013 and December 2013 figures (emissions intensity in 2030 = 100gCO_2/kWh)

	NPV, £bn (2012-2030, real 2012 prices)		
	July 2013	Dec 2013	Difference*
EMR: Total NPV	**+9.5**	**+10.7**	**+1.2**
Contracts for Difference	**+9.4**	**+10.2**	**+0.8**
- Financing impact	*+4.8*	*+3.8*	*-1.0*
- Technology mix impact	*+4.6*	*+6.4*	*+1.8*
Capacity market	**+0.1**	**+0.6**	**+0.5**

Source: DECC modelling - Figures may not sum due to rounding
Inclusive of administrative costs of approximately £0.6bn up to 2030

13. Looking at each of the key components of the NPV figures above, there are several drivers of the changes in the overall NPV for EMR.

CfDs – financing impact

14. In this latest analysis, the financing benefits associated with CfDs have **decreased by around £1bn** in NPV terms up to 2030, to £3.8bn.[28]

- Following the Hinkley Point C announcement, the commissioning date of the first new nuclear plant takes place later than assumed in the draft Delivery Plan. This results in lower nuclear financing cost benefits accruing in the period up to 2030. As a result the value of the hurdle rate reductions is lower (**-£0.4bn**).

- Hurdle rate reductions for some renewable technologies have changed from the values assumed in the draft Delivery Plan. This has resulted in some increased hurdle rate reductions relative to July (e.g. onshore wind, solar) and some decreased hurdle rate reductions (e.g. offshore wind), reflecting the analysis conducted by NERA, and published alongside the Delivery Plan[29]. Alongside changes in deployment levels, the impact of these changes is a further reduction in the financing benefit (**-£0.5bn**).

CfDs – technology mix impact

15. 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. There are differences between EMR and the 100g basecase, which arise due to imperfections in matching the decarbonisation profile and generation mix under EMR and the 100g basecase. If these differences were eliminated (i.e. the decarbonisation

[28] Component parts may not sum to total due to rounding
[29] https://www.gov.uk/government/collections/energy-generation-cost-projections

profile and generation mix were exactly the same), then this element would decrease to zero and the only source of benefits would be the pure financing benefits outlined above.

16. The technology mix impact therefore reflects the combined net impact from the portion of capital cost savings not due to financing benefits (discussed above), as well as the net impact of all the remaining categories considered as part of the Cost Benefit Analysis, as a result of differences in the capacity and generation mixes of the EMR and basecase scenarios. These include: carbon savings, generation cost savings, system cost savings, unserved energy savings and cost of interconnector energy saved[30]. As such, the technology mix impact is an attempt to aggregate the impacts resulting from differences in the generation and technology mixes in the EMR and basecase scenarios, in contrast to the financing cost benefits which are for the particular generation mix associated with implementation of EMR. The individual components of the technology mix variable are presented as part of the CBA tables below.

17. The overall technology mix component remains significant in this latest analysis, having **increased by around £1.8bn** up to 2030 in NPV terms relative to the previous IA. There are a number of explanatory factors:

- The portion of capital cost savings due to technology mix differences has **increased by £0.6bn** relative to the previous analysis. This reflects several offsetting effects: a £1.5bn increase from inclusion of the CCS demonstration projects in the no EMR scenario, a £1.1bn net decrease as a result of closer levels of renewable deployment in the basecase relative to the EMR scenario and a £200m increase as a result of larger differences between the basecase and EMR scenario for CCGT and OCGT technologies.[31]

- A **£1.2bn increase** in the net impact of the other CBA categories relative to the previous analysis, predominantly reflecting the net impact of larger generation cost savings and lower unserved energy benefits.

[30] For further detail about the definition of these categories, please see the Annex B

[31] The inclusion of costs for the CCS demonstration projects represents a change from previous EMR IAs, where CCS demonstration costs were not included in the main counterfactual scenarios for the presentation of the main NPV results. Nevertheless, the NPV of EMR including these demonstration project costs was reflected in a footnote. Given the degree of progress in these demonstration projects and the independence of their delivery relative to EMR, we believe it is more analytically consistent to include these costs in the counterfactual, as well as the EMR case. If they were not included in the counterfactual, the NPV of EMR would be £8.9bn up to 2030 (including administrative costs).

Capacity Market

18. The latest analysis shows an overall net welfare benefit of £0.6bn in NPV terms, up to 2030[32] – an **increase of £0.5bn** on the previous EMR IA in July 2013. There are two key explanations for these changes:

- Unserved energy benefits are **£1.3bn lower** than in the July analysis, reflecting changes to the assumed economic behaviour of existing plants under EMR and in scenarios without a Capacity Market.[33]

- A **£1.8bn improvement** in the NPV from the net impact of lower system cost impacts and capital cost benefits as a result of the Capacity Market[34].

19. Despite improvements in modelling capability since the draft Delivery Plan analysis in July, there are still imperfections in how we are able to represent the Capacity Market within the DDM (these are covered in more detail in Section 2). We are seeking to improve the capability of the DDM further and hope to reflect this more accurately in the future[35].

Overall impact of EMR

20. In summary, for a scenario where power sector emissions are 100gCO_2/kWh in 2030, the Cost Benefit Analysis (CBA) suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers, up to 2030 and beyond. EMR could lead to an improvement in welfare of around **£10.7bn up to 2030**, with larger benefits up to 2050. Due to the modelling changes detailed above, this NPV is slightly higher compared to the figure published in July 2013 (£9.5bn).

[32] The result that a Capacity Market has a net benefit in the modelling is driven by the assumption of missing money – i.e. that the energy-only market would fail to bring forward sufficient investment in capacity (as prices would not be able to rise to the value of lost load) and investors would fail to invest on the basis of uncertain and infrequent scarcity rents.

[33] Unserved energy is defined here as the value to customers of unmet electricity demand. It based on an estimate of the average customer value of lost load at times of peak demand £17,000/MWh. In practice, there may be some mitigating options available to National Grid which mean that unmet demand isn't just met by involuntary customer disconnections. Mitigating options include voltage reductions, instructing generators to operate at their maximum capacity and emergency assistance on our interconnectors.

[34] System cost savings partly reflect changes to the underlying modelling to incorporate a fixed cost element, based on evidence from the RIIO price control process. It should be noted that the reduction of the CM's system cost impact means that EMR as a package (i.e. including the combined impact of CfDs and CM) is now estimated to have net system cost saving (see Tables below).

[35] Analysis of the cost of the Capacity Market is sensitive to a number of assumptions made including projections of demand in capacity auctions, bidding behaviour of existing plants, and the financing and capital costs of new build. These assumptions affect the likely clearing prices to come out of the capacity auctions, as well as what parameters should be set for capacity auctions. DECC is currently consulting on the auction parameters for the first auction in 2014 - including the Cost of New Entry, price taker threshold, and auction price cap - and we will undertake further sensitivity analysis of likely clearing prices before finalising these parameters. See Section 2 for further details.

Table 2: Net Present Value (NPV) – Impact of EMR policy package relative to basecase, assumed emissions intensity of 100gCO_2/kWh in 2030

Total NPV, £bn (2012 prices)		2012-2030	2012-2040	2012-2049
		+£10.7	**+£24**	**+£31**
Contracts for Difference		**+£10.2**		
	- Financing Impact	*+£3.8*		
	- Technology Mix impact	*+£6.4*		
Capacity Market		**+£0.6**		

Source: DECC modelling- Figures may not sum due to rounding
Inclusive of administrative costs of approximately £0.6bn up to 2030

Additional scenarios

21. This IA also includes appraisals of EMR targeting a range of carbon emission intensities in 2030 (50gCO_2/kWh, 100gCO_2/kWh and 200gCO_2/kWh). The impact of these various scenarios on the overall NPV for EMR is detailed below. However, there is a more comprehensive analysis of different scenarios in the Delivery Plan (including technology costs and electricity demand).[36]

Decarbonisation ambition in 2030 – 50g, 100g & 200g

22. 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 – **£18.1bn for 50g**, **£10.7bn for 100g** and **£8.6bn for 200g**. As for 100g, the figures for the 50g and 200g scenarios are different to those published in July 2013 (£15.0bn and £4.8bn respectively), with the current figures both being higher.

[36] Particularly Annex D of final EMR Delivery Plan (National Grid EMR Analytical Report): https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

Table 3: Change in Net Welfare (NPV) – combined EMR impact (2012-2030), emission intensities of 50g, 100g and 200gCO_2/kWh

NPV, £bn (2012-2030, real 2012 prices)	Decarbonisation target in 2030 (gCO_2/kWh)		
	50	100	200
EMR: Total NPV	**+18.1**	**+10.7**	**+8.6**
Contracts for Difference	**+15.3**	**+10.2**	**+9.0**
- Financing impact	*+6.0*	*+3.8*	*+2.5*
- Technology mix impact	*+9.3*	*+6.4*	*+6.5*
Capacity market	**+2.9**	**+0.6**	**-0.4**

Source: DECC modelling- Figures may not sum due to rounding
Inclusive of administrative costs of approximately £0.6bn up to 2030

23. The key policy benefit of decarbonising using EMR are reducing financing costs for investors – the greater price certainty offered by CfDs allows investors to access financing at a lower cost. As might be expected, the financing benefits associated with CfDs increase as the 2030 decarbonisation level becomes more ambitious (hence requiring more low-carbon generation to be built): £2.5bn for the 200g scenario, £3.8bn for the 100g scenario and £6.0bn for the 50g scenario up to 2030. The larger technology mix impacts reflect a combination of the wider impacts on the power sector of using relatively inflexible existing policy tools in the basecase to decarbonise, as well as modelling limitations in the ability to match generation mixes precisely.

No-decarbonisation ambition scenario

24. The impact of EMR is also assessed against a basecase without any explicit decarbonisation ambition or tools to mitigate against security of supply risks (the 'no-decarbonisation ambition' basecase). Under this basecase the Renewables Obligation and carbon pricing continue based on existing commitments.[37] This basecase is provided purely as a point of comparison to earlier modelling results (i.e. pre-November 2012), as these were not based on achieving any particular decarbonisation ambition.

25. EMR produces a net negative welfare impact of **-£9.2bn up to 2030** (compared to -£12bn in July 2013) against a basecase with no decarbonisation ambition. However, the benefits associated with decarbonisation and from the EMR programme are seen over the longer term. In comparison to a counterfactual with no decarbonisation ambition ('no-decarbonisation ambition' basecase), the NPV for EMR is positive in the period up

[37] Under this basecase the emissions intensity falls to 2020 as a result of meeting the 2020 renewables target and the impact of the Carbon Price Floor. Post 2020 the RO is assumed to realise a broadly similar proportion of renewable generation, up to 2030, as realised in 2020. Beyond 2036 the carbon price is the only policy impacting the basecase.

to 2049 (£2.7bn).[38] In this counterfactual there is lower electricity decarbonisation, implying greater ambition needed in other sectors to meet long-term decarbonisation ambitions (discussed further in Annex E), and there is no mitigation against security of supply risks.

Table 4: Change in Net Welfare (NPV) – combined EMR impact (2012-2030), comparison to 'no-decarbonisation ambition' basecase

	NPV, £bn (2012-2030, real 2012 prices)		
	July 2013	Dec 2013	Difference
EMR: Total NPV	**-£12**	**-£9.2**	**+£2.8**

Source: DECC modelling
Inclusive of administrative costs of approximately £0.6bn up to 2030

Fossil fuel price scenarios

26. As in the draft delivery plan the robustness of EMR to different assumptions about fossil fuel prices has been tested using DECC's annual fossil fuel price projections.[39] 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 100gCO_2/kWh.

27. Under high fossil fuel prices, EMR is a cost-effective tool to achieve decarbonisation, generating a positive impact of £8.6bn 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 also generates a positive impact, of £10.6bn up to 2030.[40]

Post-2030 carbon prices

28. Within the modelling, the effective carbon price that fossil fuel generators will have to pay in the UK power market is the higher of the Carbon Price Floor and the traded carbon market price.[41] Before the draft delivery plan, EMR analysis assumed that the traded carbon market price would remain below the Carbon Price Floor, which was

[38] Principally reflecting the benefits of lower long-term Carbon and Generation Costs in the decarbonised EMR scenario, in comparison to the Carbon and Generation Costs realised in the basecase with no decarbonisation ambition (see Annex E).
[39] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013
[40] The NPV estimates for the fossil fuel price scenarios are influenced by differences in the generation mixes and decarbonisation profiles achieved in the EMR and counterfactual scenarios. In particular, the high fossil fuel price counterfactual realises a similar decarbonisation ambition to that achieved under the equivalent EMR scenario, although using relatively more renewable and less CCS generation, in comparison to the equivalent EMR high fossil fuel price scenario. This is a consequence of the policies used to decarbonise in the counterfactual scenarios and has an important impact on the NPV estimates. This is discussed further in Annex E.
[41] At the moment, the traded carbon market is the EU Emissions Trading System. In the coming decades, a more global carbon market may emerge based on the assumption of a global deal on climate change action.

assumed (in the EMR scenario) to follow its announced profile to 2030[42], and then to remain flat in real terms at the 2030 value of £76/tCO_2e (2012 prices).

29. As in the analysis of the draft delivery plan (and in this analysis), this assumption has been altered (based on the assumption of a global deal on climate change action with a global carbon market), so that the traded carbon price rises above the Carbon Price Floor from 2030 onwards. The price rises progressively as more abatement is required and the cheaper options are used up.

30. However, given the uncertainty over future carbon prices and to show results consistent with the pre-draft delivery plan analysis, sensitivity analysis has been undertaken for EMR under a scenario where traded carbon prices stay below the Carbon Price Floor (i.e. assuming that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030). Under this alternative post-2030 carbon price scenario, EMR has a slightly higher net welfare benefit in 2049: £35bn (NPV, 2012 prices), compared to £31bn under the central EMR case.

Delivery plan scenarios – reflecting uncertainty

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

32. National Grid carried out analysis for DECC to explore the implications of a number of strike price scenarios for delivery of Government policy[43]. These illustrate alternative 'views of the world', which can be used to inform and guide strike price setting. A summary of results is presented in Annex H.

Electricity Prices & bills impacts

33. For domestic consumers, EMR has the potential to **reduce average annual household electricity bills by around 6% (£41) over the period 2014-2030[44]** relative to the basecase, which achieves a similar decarbonisation level of 100gCO_2/kWh using existing policy instruments. The percentage impact on average bills for businesses and energy-intensive industries is estimated to be similar to the domestic reduction (7-8%). For further detail, see section 3.

[42] The profile for the CPF starts at £16/tCO2 (2009 prices) and takes a linear path to £30/ tCO2 (during 2013-2020) and then a linear path to £70/tCO2 (during 2020-2030).
[43] Annex D of the Delivery Plan, available at: https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan
[44] The time period has been amended to align with the start of the strike price period; the comparable figure for the 2016-2030 period is £46.

Table 5: Price and Bill impact – Impact of EMR policy package on average annual domestic electricity bills, relative to 100g basecase (assumed emissions intensity of 100gCO_2/kWh in 2030)

Time Period	Impact of EMR on average annual domestic electricity bills, relative to 100g basecase (real 2012 prices)
2014-2030	-£41 (-6%)

Source: DECC modelling

Section 2 Updated cost-benefit analysis

2.1 Rationale for intervention

2.1.1 Decarbonisation

34. 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.

35. Government clauses added to the Energy Act 2013 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.

36. 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.

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

38. 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.

39. 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.

40. 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.

41. 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.

42. 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.[45]

43. 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.

44. 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

45. 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 consumers do not respond to real time changes in the price of electricity). Smart

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

Meters, which are expected to be rolled out by 2020, should help to enable a more responsive demand side but it is anticipated that it would take time for a responsive real-time market to evolve.

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

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

47. 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. Since 2011, 8% of generating capacity has closed under the Large Combustion Plant Directive, and a further 10-12% of current power generating capacity is due to close over the coming decade. The market may also fail to provide incentives for built capacity to be sufficiently reliable, flexible and available when needed. A Capacity Market mitigates against the risk of an energy-only market failing to deliver sufficient incentives for reliable and flexible capacity.

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

49. 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.

50. 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.

51. 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 who

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

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.

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

53. This has not previously been a significant concern as prices historically have not risen above £938/MWh [47] 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 £6,000/MWh[48] (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.

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

[48] Electricity Balancing Significant Code Review – Draft Policy Decision https://www.ofgem.gov.uk/publications-and-updates/electricity-balancing-significant-code-review-draft-policy-decision-impact-assessment

2.2 Option under consideration

54. The modelling presented here has estimated the overall costs and benefits to society, or 'net welfare', of the various policy options. Net welfare is measured in terms of the net present value (NPV), which is the sum of all the social costs (-) and benefits (+) associated with the policy, with an adjustment made to reflect the time at which the different costs and benefits occur (known as discounting). This uses the social discount rates as set out in the Green Book.[49]

55. 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.[50]

2.2.1 EMR Package

56. This IA presents an updated analysis of the lead EMR package modelled against a range of basecases. This EMR package includes a low-carbon instrument (the CfD, based on delivery plan strike prices) and a Capacity Market (based on the delivery plan reliability standard), combined with an Emissions Performance Standard (EPS).[51] Carbon pricing is included in the basecases against which the policy package is assessed.[52]

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

[50] 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

[51] A separate strike price for onshore wind projects on the Scottish islands is now included within the EMR package, as set out in the Final Delivery Plan. The strike price for this Delivery Plan period is set at £115/MWh. This comes into effect from 2017/18 only, reflecting that no projects on the Scottish islands are anticipated to be able to begin generating before this date. This is to reflect conditions faced by projects on the Scottish islands that do not apply to other onshore wind projects. As with other technologies, there is a range around projected deployment and generation of onshore wind on the Scottish islands.

[52] 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.

57. The Government added clauses to the Energy Act 2013, 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.

58. 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 100gCO_2/kWh for the power sector in 2030, consistent with previous EMR impact assessments – includes analysis based on an average emissions level of 50gCO_2/kWh and 200gCO_2/kWh in 2030, as well as a range of fossil fuel price scenarios and changes to assumptions about post-2030 carbon prices. However, there is a more comprehensive analysis of different scenarios in the Delivery Plan (Including technology costs and electricity demand)[53] – these are summarised in Annex F.

59. 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 all the 2030 decarbonisation levels outlined above (50gCO_2/kWh, 100gCO_2/kWh and 200gCO_2/kWh).

60. The modelling results presented show CfDs continuing to be issued post-2030.[54] 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 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.[55]

61. The analysis in this impact assessment is based on DDM modelling runs, using the range of strike prices presented in the EMR Delivery Plan[56].

[53] Particularly Annex D of EMR Delivery Plan: https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

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

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

- a sustainably high carbon price;
- 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).

[56] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

Contracts for difference

62. The Government's choice of the CfD as the preferred policy instrument was set out in full in the EMR White Paper (July 2011). The analysis presented in this IA updates the costs and benefits associated with CfDs, based on the strike prices in the EMR Delivery Plan.[57]

63. As a result of lower exposure to risks associated with exposure to volatile wholesale market prices, achieved by the greater price certainty offered by CfDs, the cost of capital for investors in some low-carbon generation is lower under a CfD. The technology-specific hurdle rates used in this analysis are based on data and evidence drawn from various sources – Oxera[58] (2011), Arup[59] (2011), KPMG[60] (2013) and NERA[61](2013). For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report[62] and Annex H of the EMR delivery plan[63].

64. It is assumed that EMR instruments will be deployed to achieve a least-cost decarbonisation pathway, balancing least cost deployment of current technologies with support for those technologies that could make a material contribution to future decarbonisation. To take account of uncertainty in the future costs of alternative technologies, it has been assumed for modelling purposes that EMR supports a broader diversity of technologies to 2030 than would be the case based purely on current central projections for generation costs, demand and fossil fuel prices to 2030. There is uncertainty about how the electricity sector will develop over the longer term and supporting a diverse generation mix in the medium term will help manage some of the technology risks associated with achieving the sector's share of the 2050 economy-wide 80% decarbonisation target, under a range of different future scenarios. However, DECC is currently consulting on plans to move to competitive allocation of CfDs from 2014 for at least the more established renewable technologies, encouraging value for money for consumers. At this point in time, it is not possible to predict accurately what this future generation mix might be, however our ambition is for a technology mix in line with the deployment scenarios set out in the EMR Delivery Plan.

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[57] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

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

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

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

[61] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267650/NERA_Report_Assessment_of_Change_in_Hurdle_Rates_-_FINAL.pdf

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

[63] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

Capacity Market

65. 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.

66. The form of Capacity Market assessed here as part of the overall lead EMR package is an Administrative Capacity Market (where providers are subject to administrative penalties, in addition to energy market incentives, if they fail to be available at times of scarcity and providers are able to keep any revenues they earn in the energy market). More detail on the full options appraisal for mitigating security of supply risks is provided in the Capacity Market impact assessment.[64]

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

68. The reliability standard will help to inform the amount of capacity to procure in a future Capacity Market. The analysis considered in this IA is based on the reliability standard for the GB electricity market (i.e. a Loss of Load Expectation of 3 hours per year), as set out in the Delivery Plan[66]. This proposal is the result of an analytical approach to identify the optimal reliability standard for the GB market, and comparison with standards in neighbouring countries.[67] An optimal reliability standard balances the increased security of supply benefit of additional capacity (procured through the capacity market auction) with the costs of providing that capacity (new power plants that will insure consumers against blackouts).

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

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64 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/252743/Capacity_Market_Impact_Assessment_Oct_2013.pdf

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

66 Please see Chapter 4 of the EMR Delivery Plan: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268221/181213_2013_EMR_Delivery_Plan_FINAL.pdf

67 For further detail on the methodology used to calculate the reliability standard, please see Annex C of the Delivery Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267613/Annex_C_-_reliability_standard_methodology.pdf

70. 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

71. In undertaking the cost-benefit analysis for EMR (based on CfDs with delivery plan strike prices, and a Capacity Market which uses the reliability standard), the policy package is compared to a basecase counterfactual, without the EMR package. The basecase includes existing policies such as the Renewables Obligation (RO) and the EU-ETS and policies which the Government has committed itself to delivering, such as the Carbon Price Floor (CPF) policy announced in the Budget 2011.[68]

72. Since the IA published alongside the introduction of the Energy Bill to Parliament in November 2012, we compare the EMR package against an alternative scenario which tries to match as closely as possible the decarbonisation profile achieved under EMR. However, the policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown. Therefore, the basecase attempts to achieve this similar decarbonisation profile using existing policy instruments, namely the RO and carbon pricing.[69]

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

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[68] 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.

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

74. However, with updated evidence and assumptions about technology costs, since the draft Delivery plan, the approach used to replicate the EMR new build profiles in these two basecases has effectively aligned them [70]. There was no longer a clear difference between the technologies used to decarbonise the sector in Basecase A and Basecase B in the draft delivery plan modelling. The same approach is taken here.

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

76. Under this basecase, carbon prices increase pre-2030, in order to achieve the same profile in nuclear new build and a similar profile in CCS new build as under EMR. To realise deployment of the first nuclear plant (as under EMR), the carbon price is increased to around £140 per tonne in 2022; this increase is sufficient to bring on some of the early CCS plant. To generate investment in CCS technology by the end of the 2020s the carbon price rises to around £175/tonne by 2030. The carbon price value is held at this level until the traded price of carbon rises above this level (in the mid 2040's). The RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies, similar to that delivered under EMR. These assumptions are summarised in Table 6 below.

[70] In the draft Delivery Plan analysis the Carbon Price in the basecase increased in the late 2010s to replicate the nuclear new build profile under EMR. However, this increase was sufficient to incentivise some CCS build during the 2020s, making it impractical to recreate Basecase A (which replicated EMR's nuclear new build profile only).

Table 6: Summary of basecase assumptions

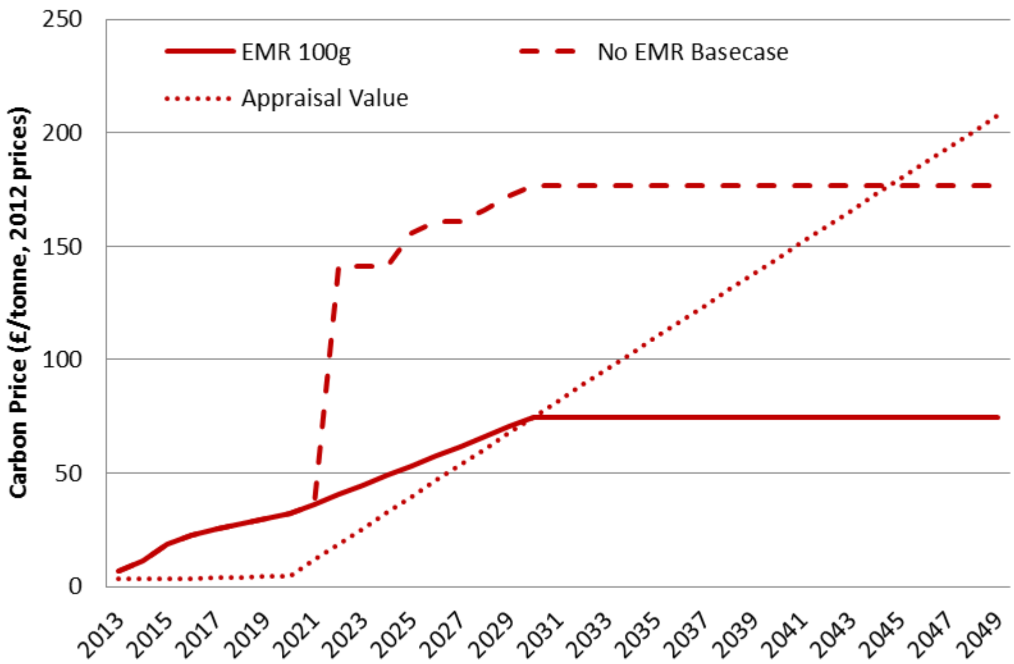
	2030 emissions intensity gCO_2/KWh	2049 emissions intensity gCO_2/KWh	Carbon pricing	Renewables Obligation (RO)
Basecase	92	23[71]	Carbon prices increase to around £140/tonne in 2022, rising to around £175/tonne in 2030 and remains at that level until traded carbon prices rise above this level (in mid 2040's).	RO support to meet 2020 renewable target and 2030 carbon emissions ambition. RO stays open to new renewable plants beyond 2017, closing in 2037.

77. Chart 1 presents the assumed profile of carbon prices under EMR and the no-EMR basecase. Further details, including decarbonisation profiles and generation mixes, are presented in Annex C[72].

[71] The basecase 'overachieves' the required emissions intensity target in 2049 and 2040, reaching 23gCO_2/KWh and 36gCO_2/KWh respectively. This is due to the increased carbon price in the late 2020s (in order to bring on CCS plant) leading to 'undershooting' – for further details, see Annex C.

[72] Within the modelling, the effective carbon price that fossil fuel generators will pay is the higher of the Carbon Price Floor and the traded carbon market price (labelled as the appraisal value in the relevant chart). In this latest analysis the traded carbon price rises above the Carbon Price Floor from 2030 onwards. From 2030, the working assumption under the EMR scenario is that there will be a functioning global carbon market with a price of £70/tCO2e in 2030, rising to £200/tCO2e in 2050 (2009 prices) – i.e. that the Carbon Price Floor is non-binding after 2030. During the adjustment phase between the EU and global carbon markets, the appraisal value is linearly interpolated between the values in 2020 and 2030.

Chart 1: Carbon price profiles – EMR and basecase (assumed emissions intensity in 2030 = 100gCO_2/kWh)



Source: DECC modelling

Security of supply under the basecase

78. Modelling of the basecase assumes that there is "missing money" and that energy prices rise to £6,000/MWh, in keeping with Ofgem's draft policy decision on cash out reform at times of scarcity[73], while the Value of Lost Load (VoLL) is estimated to be £17,000/MWh.[74] This means that an energy-only market in the basecase may fail to deliver the "economically efficient" capacity margin. A further source of "missing money" in the model is that energy investors are assumed to have perfect foresight of future energy demand up to five years ahead when deciding whether to build capacity, which means that they will not take account of "upside" risk when deciding whether to build new plant.

79. Risks to the security of supply objective are not mitigated against in the basecase, investment decisions are principally made on an energy-only basis, as we do not believe it would be possible to meet the same objective without a capacity mechanism.

Renewables targets under the basecase

80. Under the basecase, the EU target for 15% renewable energy consumption across the UK economy by 2020 is assumed to be met, with over 30% of electricity generated

[73] https://www.ofgem.gov.uk/publications-and-updates/electricity-balancing-significant-code-review-draft-policy-decision-impact-assessment
[74] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224028/value_lost_load_electricty_gb.pdf

coming from renewables by 2020.[75] The latest modelling is also consistent with the analysis supporting the EMR Delivery Plan.[76] Renewable policy objectives after this date vary across the different decarbonisation scenarios (discussed further below).

Decarbonisation ambitions under the basecase

81. 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.[77]

82. Therefore, since the IA published alongside the introduction of the Energy Bill to Parliament in November 2012, we compare the EMR package against an alternative scenario which tries to match as closely as possible the decarbonisation profile achieved under EMR. Following the approach adopted in previous EMR impact assessments, this analysis focuses on an average emissions intensity for the power sector of around 100gCO_2/kWh in 2030, 50gCO_2/kWh in 2040 and 25gCO_2/kWh in 2049. Analysis is also undertaken for two other emission intensity pathways – 50gCO_2/kWh in 2030 (leading to 50gCO_2/kWh in 2040 and 25gCO_2/kWh in 2049) and 200gCO_2/kWh in 2030 (leading to 50gCO_2/kWh in 2040 and 25gCO_2/kWh in 2049).

83. 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 No-decarbonisation ambition, set out in Annex E). This provides a point of comparison to earlier modelling results (i.e. pre-November 2012), as these were not based on achieving any particular decarbonisation target.

84. 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.

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

[76] 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.

[77] Analysis of EMR prior to November 2012 was not based on a like-for-like comparison of decarbonisation or security of supply objectives achieved under EMR and the basecase. The 'no EMR' basecase did not have the same decarbonisation trajectory or meet the same security of supply objectives as achieved under EMR. Across the relevant publications the emissions intensity achieved under the various basecases has ranged from around 165 to 200gCO_2/kWh. This compares to an indicative target of 100gCO_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).

2.3 Net Present Value of EMR

85. This section assesses the benefits of EMR as a whole (i.e. combined impact of CfDs with the final strike prices, and a Capacity Market based on the final reliability standard) in more detail.[78]

86. The tables below present the NPV results from assessing EMR (across different decarbonisation levels) relative to a basecase which achieves a similar decarbonisation ambition using the Renewables Obligation (RO) and the carbon price, but does not mitigate against security of supply risks.[79]

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

87. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 100gCO_2/kWh in 2030 through EMR compared to the basecase results in welfare improvements of around **£10.7bn**. Assessed up to 2049, EMR results in net welfare improvements of around **£31bn**.[80]

[78] The analysis presented in this IA is based on one set of assumptions, including assumed technology costs. 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.

[79] A description of the different CBA categories is provided in the Annex B.

[80] Results from energy market modelling in the following tables are rounded to two significant figures. NPV estimates adjusted for estimated administrative costs are not rounded to two significant figures to ensure consistency with disaggregated NPV estimates presented in Section 1. 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 administrative cost adjusted NPVs are not estimated beyond 2030.

Table 7: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,700	-4,500	-7,600
	Generation cost savings	1,600	4,100	5,700
	Capital cost savings	8,200	19,000	27,000
	System cost savings	160	690	1,300
	Unserved energy savings	1,700	3,300	3,300
	Cost of Interconnector energy saved	1,400	2,000	1,800
	Change in Net Welfare	**11,000**	**24,000**	**31,000**
	Change in Net Welfare*	**10,700**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.6bn up to 2030*

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

88. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 50gCO_2/kWh in 2030 through EMR compared to a basecase, results in a net welfare improvement of **£18.1bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£49bn**.

Table 8: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 50gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,600	-2,800	-7,900
	Generation cost savings	1,900	3,500	4,400
	Capital cost savings	10,000	18,000	32,000
	System cost savings	750	2,400	3,800
	Unserved energy savings	5,100	11,000	12,000
	Cost of Interconnector energy saved	2,700	4,800	5,000
	Change in Net Welfare	**19,000**	**37,000**	**49,000**
	Change in Net Welfare*	**18,100**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.6bn up to 2030*

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

89. Assessed up to 2030, decarbonising the electricity sector to an average emissions intensity of 200gCO_2/kWh in 2030 through EMR compared to a basecase, results in a net

welfare improvement of **£8.6bn**. Assessed up to 2049, EMR results in a net welfare improvement of around **£19bn**.

Table 9: Change in Net Welfare (NPV) – combined EMR impact (CfD and Capacity Market) compared to basecase (emissions intensity in 2030 = 200gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	**2012 to 2040**	**2012 to 2049**
Net Welfare	Value of carbon savings	-1,900	430	1,400
	Generation cost savings	1,200	4,200	7,400
	Capital cost savings	8,000	5,800	5,100
	System cost savings	270	680	1,200
	Unserved energy savings	370	2,200	2,200
	Cost of Interconnector energy saved	1,200	1,800	1,800
	Change in Net Welfare	**9,200**	**15,000**	**19,000**
	Change in Net Welfare*	**8,600**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.6bn up to 2030*

90. The overall NPV figures for all decarbonisation scenarios are higher than the equivalent estimates previously presented in July 2013 – £9.5bn 100g, £15.0bn for 50g and £4.8bn for 200g – all assessed up to 2030. There are two key explanatory factors:

- Changes in the generation mix profile of the EMR scenarios and the counterfactuals. In particular the inclusion of CCS demo projects in the no EMR scenarios leads to a higher EMR NPV by increasing the capital costs of the no EMR scenarios, as well as impacting relative generation costs. Offsetting this positive impact somewhat, the later deployment of new nuclear in the EMR scenarios generally leads to a closer matching of renewable deployment in the no EMR scenarios, because of greater flexibility in the use of existing policy instruments to match new build profiles.

- The increased technology mix benefits are offset somewhat by reductions in pure financing cost benefits, reflecting changes in hurdle rates and the profile of nuclear deployment.

2.3.1 Net Present Value of CfDs only

91. 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 10-12.

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

92. Relative to the basecase outlined above, the impact of CfDs alone in decarbonising the power sector to an average emissions level of 100gCO_2/kWh in 2030 would result in a positive NPV of around £**10.2bn** to 2030.[81] The key benefit of CfDs is their ability to lower the capital costs associated with decarbonisation – up to 2030 such benefits are estimated to be around **£7.7bn**.[82]

Table 10: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,300	-2,700	-4,100
	Generation cost savings	2,000	4,600	6,900
	Capital cost savings	7,700	15,000	20,000
	System cost savings	420	730	1,000
	Unserved energy savings	410	1,200	1,100
	Cost of Interconnector energy saved	1,400	2,200	2,200
	Change in Net Welfare	**11,000**	**21,000**	**27,000**
	Change in Net Welfare*	**10,200**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.5bn up to 2030*

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

93. In reaching an average emissions level of 50gCO_2/kWh for the power sector in 2030, the impact of CfDs alone results in a positive NPV of **£15.3bn up to 2030**.[83] 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 **£9.4bn**.

[81] Inclusive of CfD administrative costs up to 2030; post-2030 estimates do not include administrative costs, due to uncertainty over estimated costs.
[82] The capital cost reductions reported in these tables reflect the combined impact of two factors – a financing cost impact and a technology mix impact. These are separated and explained in more detail below.
[83] As above, this figure is inclusive of CfD administrative costs up to 2030, but not beyond.

Table 11: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 50gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,300	-2,000	-5,000
	Generation cost savings	2,100	3,400	4,700
	Capital cost savings	9,400	14,000	24,000
	System cost savings	1,000	2,300	3,300
	Unserved energy savings	1,900	5,900	6,100
	Cost of Interconnector energy saved	2,600	4,900	5,400
	Change in Net Welfare	**16,000**	**29,000**	**39,000**
	Change in Net Welfare*	**15,300**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.5bn up to 2030*

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

94. Finally, in reaching an average emissions level of 200gCO_2/kWh for the power sector in 2030, the impact of CfDs alone results in a positive NPV of **£9.0bn to 2030**.[84] The key benefit of CfDs is their ability to lower the capital costs associated with decarbonisation – up to 2030, such benefits are estimated to amount to **£8.1bn.**

Table 12: Change in Net Welfare (NPV) – CfDs only, compared to basecase (emissions intensity in 2030 = 200gCO_2/kWh)

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,800	140	3,100
	Generation cost savings	1,500	4,600	8,400
	Capital cost savings	8,100	6,600	2,900
	System cost savings	360	820	1,300
	Unserved energy savings	130	1,100	970
	Cost of Interconnector energy saved	1,200	1,800	2,000
	Change in Net Welfare	**9,500**	**15,000**	**19,000**
	Change in Net Welfare*	**9,000**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.5bn up to 2030*

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

95. 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

96. EMR reduces market risk by providing greater price certainty to low-carbon investors through the contract for difference (CfD) mechanism. This greater certainty means that, all other things being equal, financing costs are lower for some low carbon technologies.

97. Initial analysis for the EMR White Paper suggested that CfDs could reduce hurdle rates for low-carbon investments by up to 1.5 percentage points.[85] As discussed above, independent verification of the cost of capital impacts showed broadly similar results.[86] The technology-specific hurdle rates used in this analysis (set out in Annex A) are based on data and evidence drawn from various sources – Oxera[87] (2011), Arup[88] (2011), KPMG[89] (2013) and NERA[90] (2013). For more information about how these have been derived, please see DECC's Electricity Generation Costs 2013 report[91] and Annex H of the EMR delivery plan[92].

98. In order to isolate the savings due to reductions in the costs of capital, modelling runs for EMR (with and without CfD hurdle rate reductions) are compared. The results suggest that, depending on the assumed level of decarbonisation in 2030, CfDs would generate an NPV of between £2.5bn and £6.0bn from lower costs of capital (up to 2030, including administrative costs), £9.8bn-£19bn up to 2040 and £15bn-£28bn up to

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85 Electricity sector dispatch modelling by Redpoint Energy Consultants, 2011
86 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
87 http://hmccc.s3.amazonaws.com/Renewables%20Review/Oxera%20low%20carbon%20discount%20rates%20180411.pdf
88 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42843/3237-cons-ro-banding-arup-report.pdf
89 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225619/July_2013_DECC_EMR_ETR_Report_for_Publication_-_FINAL.pdf
90 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267650/NERA_Report_Assessment_of_Change_in_Hurdle_Rates_-_FINAL.pdf
91 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_16_07_13_amend.pdf
92 https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

2049.[93] 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.[94]

Technology Mix Impact

99. 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.[95]

100. A critically important factor is the difference in the new build profile under EMR and the basecases. For example, the level of carbon price in the basecase in the early 2020's (necessary to replicate EMR's nuclear new build profile) generally results in higher investment in some renewable technologies during the 2020's, this is particularly true for offshore wind and solar technologies.

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

102. In contrast to the basecase (which uses carbon prices as a relatively blunt instrument for achieving decarbonisation), CfDs allow technology-specific targeting. This means that nuclear and CCS investments can be deployed without directly impacting the investment and generation decisions of alternative technologies, such as unabated coal and gas[96].

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

- 100g = £3.8bn up to 2030 (including administrative costs), £13bn up to 2040 and £20bn up to 2049;
- 50g = £6.0bn up to 2030 (including administrative costs), £19bn up to 2040 and £28bn up to 2049, and
- 200g = £2.5bn up to 2030 (including administrative costs), £9.8bn up to 2040 and £15bn up to 2049

[94] 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.

[95] CCS demonstration projects also have an important role to play in the technology mix and NPV results. The assumption in the basecase is that in the absence of EMR, the CCS demonstration projects would still take place. The inclusion of costs for the CCS demonstration projects represents a change from previous EMR IAs, where CCS demonstration costs were not included in the main counterfactual scenarios for the presentation of the main NPV results. Nevertheless, the NPV of EMR including these demonstration project costs was reflected in a footnote. Given the degree of progress in these demonstration projects and the independence of their delivery relative to EMR, we believe it is more analytically consistent to include these costs in the counterfactual, as well as the EMR case.

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

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

104. The technology mix also drives the differences in carbon and generation costs. Against the basecase carbon costs up to 2030 are generally higher under CfDs, reflecting the slightly faster decarbonisation profile followed under the No-EMR basecases as a result of the higher carbon prices in the basecase scenarios.[97]

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

2.3.2 Net Present Value of the Capacity Market

106. Our analysis shows that a Capacity Market is expected to have a marginally positive net welfare impact of **£0.6bn**[98], relative to a scenario of an efficient energy market – i.e. where the energy price can rise to £6,000/MWh and where the market is able to invest on the basis of those scarcity rents.

107. This is an **increase of £0.5bn** on the previous EMR IA in July 2013. There are two key explanations for these changes:

- Unserved energy benefits are **£1.3bn lower** than in the July analysis, reflecting changes to the assumed economic behaviour of existing plants under EMR and in scenarios without a Capacity Market.
- A **£1.8bn improvement** in the NPV from the net impact of lower system cost impacts and capital cost benefits as a result of the Capacity Market[99].

108. In addition, there have been slight increases in the Capacity Market NPVs across all three decarbonisation scenarios, relative to the July analysis.

- For 200g – where it might be expected that demand for a Capacity Market is lower than for a 100g scenario, given the less pressing need for low-carbon generation up to 2030 – the capacity market has a negative net welfare impact of £0.4bn; (-£0.8bn in the July analysis)

[97] For more detail see Annex C
[98] Value shown for a emissions intensity of 100gCO_2/kWh in 2030 (including administrative costs of around £0.1bn up to 2030).
[99] System cost savings partly reflect changes to the underlying modelling to incorporate a fixed cost element, based on evidence from the RIIO price control process. It should be noted that the reduction of the CM's system cost impact means that EMR as a package (i.e. including the combined impact of CfDs and CM) is now estimated to have net system cost saving.

- However, for a 50g target in 2030, the NPV of the Capacity Market is positive (£2.9bn, £2.7bn in the July analysis). For a scenario in which a greater proportion of intermittent and/or inflexible low-carbon generation is required in order to meet a lower decarbonisation level, it might be expected that a Capacity Market would lead to more significant benefits.

109. The result that a Capacity Market has a net benefit in the modelling is driven by the assumption of missing money – i.e. that the energy-only market would fail to bring forward sufficient investment in capacity as prices would not be able to rise to the value of lost load, and investors would fail to invest on the basis of uncertain and infrequent scarcity rents.

110. Despite improvements in modelling capability since the draft Delivery Plan analysis in July, there are still imperfections in how we are able to represent the Capacity Market within the DDM.

111. Analysis conducted by Redpoint has suggested that the modelling of the capacity market is highly dependent on assumptions around how wholesale prices in the energy market respond to scarcity[100]. Redpoint have commented that the DECC DDM results could be viewed as a conservative approach to evaluating a CM and may overstate the costs to consumers, given that the DECC DDM model has wholesale prices which were less responsive to increased scarcity than the Redpoint model. We are seeking to improve the capability of the DDM further and hope to reflect this more accurately in the future.

112. Modelling shows an average clearing price over the period 2019-2031 of £38/kW, though the price in the first auction is higher (£49/kW) as it is assumed that no large-scale OCGTs are able to participate.

113. DECC is currently consulting on the auction parameters for the first auction in 2014 - including the Cost of New Entry, price taker threshold, and auction price cap - and we will undertake further sensitivity analysis of likely clearing prices before finalising these parameters.

114. It should be noted that existing plants are assumed to bid only their losses in each year whereas in reality plants in the first auction (for the delivery year of 2018/19) may seek to recover a proportion of their losses incurred between now and the first delivery year.

115. We are seeking to improve our modelling of likely bids in the first auction to inform the parameters set for this auction. We will look to publish this analysis in the Impact

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100 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263323/Independent_CM_assessment__Redpoint.pdf

Assessment alongside the response to the consultation which will be published in June 2014.

2.3.3 Disaggregated NPV Impact

116. 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 13-15.

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

117. The CBA suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers up to 2030, leading to an improvement in welfare of **around £10.7bn up to 2030** (under an assumed emissions intensity of 100gCO_2/kWh).

Table 13: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices [101] (emissions intensity in 2030 = 100gCO_2/kWh)

EMR (CfD + Capacity Market)		
CfDs		10,200
	- Financing Impact	*3,800*
	- Technology Mix Impact	*6,400*
Capacity Market		600
Net Impact		**10,700**

Source: DECC modelling

118. This reflects **£10.2bn** worth of net benefits as a result of decarbonising through CfDs, and a small benefit **£0.6bn** from mitigating against security of supply risks through the Capacity Market. Of the £10.2bn benefit from decarbonising through CfDs, around **£3.8bn** can be attributed to the benefit of lower financing costs under CfDs, with the remaining **£6.4bn** of the benefits attributable to the different technology mix generated by EMR, relative to the basecase.[102]

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

119. Targeting an emissions intensity of 50gCO_2/kWh in 2030, EMR leads to an improvement in welfare of **£18.1bn**, up to 2030. This comprises **£15.3bn** worth of net benefits as a result of decarbonising through CfDs (of which around **£6.0bn** can be attributed to the benefit of lower financing costs under CfDs and **£9.3bn** to the different

[101] Inclusive of administrative costs

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

technology mix, relative to the basecase), and a further **£2.9bn** net benefit of mitigating against security of supply risks through the Capacity Market.

Table 14: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices (emissions intensity in 2030 = 50gCO_2/kWh)

EMR (CfD + Capacity Market)		
CfDs		15,300
	- Financing Impact	*6,000*
	- Technology Mix Impact	*9,300*
Capacity Market		2,900
Net Impact		**18,100**

Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

120. Targeting an emissions intensity of 200gCO_2/kWh in 2030, EMR leads to an improvement in welfare of **£8.6bn up to 2030**. This comprises **£9.0bn** worth of net benefits as a result of decarbonising through CfDs (of which **£2.5bn** can be attributed to the benefit of lower financing costs under CfDs and **£6.5bn** to the different technology mix, relative to the basecase), and an offsetting net cost of -**£0.4bn** from mitigating against security of supply risks through the Capacity Market.

Table 15: Disaggregated Change in Net Welfare (NPV) – CfD with Capacity Market (2012-2030), £m 2012 Prices (emissions intensity in 2030 = 200gCO_2/kWh)

EMR (CfD + Capacity Market)		
CfDs		9,000
	- Financing Impact	*2,500*
	- Technology Mix Impact	*6,500*
Capacity Market		-400
Net Impact		**8,600**

Source: DECC modelling

2.3.4 Implied investment under EMR

121. We have updated the analysis of the level of implied investment between 2013 and the end of the decade, according to the latest EMR modelling. This is unchanged from the estimate in the draft EMR Delivery Plan in July 2013 – i.e. overall investment of £100bn-110bn, of which £60bn-70bn is attributable to generation capacity and around £40bn to networks.

2.4 Distributional Analysis

122. 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.

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

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

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

125. Consumer welfare is improved under EMR when assessed across all time periods up to 2049, relative to the basecase. The driver of this result is the reduction in wholesale prices realised under EMR in comparison to the 'no EMR' scenario, which benefit consumers and hence increase consumer surplus. Compared to previous analysis, the scale of this effect has decreased across all years. Up to 2030 this reflects the later deployment on new nuclear and therefore a later (and smaller) increase in the carbon price in the 'no-EMR' basecase (relative to the basecase used in the previous analysis).

126. This benefit outweighs the greater low-carbon and capacity payments to suppliers in the EMR scenario, which appear as a cost to consumers and hence reduce consumer surplus. The impact of capacity payments has decreased slightly relative to the previous analysis, while the impact of low carbon payments is also smaller than in the previous analysis. The reduction in the difference between low carbon-payments in the basecase and EMR scenario reflects the later, and lower, increase in the carbon price to incentivise new nuclear in the basecase (meaning that low-carbon payments in the basecase are higher for a given level of decarbonisation in comparison to the previous analysis).[103]

127. In contrast, the effect on producers' welfare is more ambiguous under the EMR scenario. Relative to the basecase, producers are worse off under EMR up to 2030 (shown by a negative change in producer surplus), mainly as a result of the reduction in the wholesale price. However, up to 2049 and beyond, this is outweighed by increasing capacity payments and reductions in producer costs. This results in producer surplus

[103] The inclusion of the CCS demonstration projects also results in higher low carbon payments in the basecase narrowing the difference between the low carbon payments in this run and the EMR scenario.

becoming positive by 2049, implying that producers are better off under EMR over a longer time period, relative to the basecase. Relative to the previous analysis producer surplus up to 2049 is unchanged, whilst it is slightly less negative up to 2030 (reflecting the net impact of changes to wholesale prices, low carbon payment and producer costs).

128. The impact of EMR on consumer electricity prices and bills is presented in Section 3. 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% lower under EMR when assessed up to 2030, 7% lower up to 2040 and 4% lower up to 2049, relative to the basecase.[104]

129. In contrast, returns for producers are 11% lower up to 2030, 1% lower up to 2040 and 31% higher up to 2049.[105]

130. The negative impact of EMR on environmental tax revenue reflects the different mechanisms used to decarbonise the electricity sector. The lower carbon price under EMR will generate lower environmental tax revenues, in comparison to the reliance on a carbon price in the basecase. Given the later and smaller increase in the basecase carbon price in the new analysis environmental tax impacts are smaller than in previous analysis. Environmental taxes are a transfer from producers to the Exchequer.

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

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

Table 16: Distributional analysis: Combined EMR impact (CfD with Capacity Market), compared to basecase (assumed emissions intensity in 2030 = 100gCO_2/kWh) excluding administrative costs

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	64,000	94,000	79,000
	Low carbon payments	-7,000	-21,000	-20,000
	Capacity payments	-15,000	-22,000	-26,000
	System cost savings	160	690	1,300
	Unserved energy	1,700	3,300	3,300
	Change in Consumer Surplus	**44,000**	**54,000**	**37,000**
Producer Surplus	Wholesale price	-63,000	-92,000	-77,000
	Low carbon support	7,000	21,000	20,000
	Capacity payments	15,000	22,000	26,000
	Producer costs	31,000	47,000	54,000
	Change in Producer Surplus	**-9,400**	**-1,100**	**24,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-23,000**	**-29,000**	**-30,000**
Net Welfare	**Change in Net Welfare**	**11,000**	**24,000**	**31,000**

Source: DECC modelling

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

131. In terms of achieving an emissions intensity of 50gCO_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 over all periods, relative to a ‘no EMR’ scenario (in which decarbonisation ambitions are met using existing instruments), as shown by sustained negative changes in producer surplus (as was the case in the previous analysis).

132. Compared to the draft delivery plan analysis, the consumer surplus impact is slightly reduced reflecting lower wholesale price impacts (i.e. the difference in wholesale prices under EMR and the basecase is narrower than in the previous analysis). This is due to later deployment of new nuclear in the latest analysis, and as a result later increases in carbon prices in the latest counterfactuals (in comparison to the draft delivery plan counterfactual). This reduction is offset to some extent by a smaller impact from higher low carbon payments under EMR (in comparison to the draft delivery plan analysis). Similarly to the 100g scenario above, this reflects the later increase in carbon prices in the basecase, meaning that low-carbon payments are higher for a given level of decarbonisation in the basecase.

133. These two effects also impact on producer surplus, albeit in the opposite direction to the effects on consumers outlined above – in this case, the narrower wholesale price

differential increases producer surplus and lower low carbon payments reduce producer surplus. Overall there's a net negative change in producer surplus for all time periods.

Table 17: Distributional analysis: Combined EMR impact (CfD with Capacity Market) compared to 50g basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh) excluding administrative costs

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	130,000	250,000	260,000
	Low carbon payments	-28,000	-110,000	-120,000
	Capacity payments	-15,000	-21,000	-24,000
	System cost savings	750	2,400	3,800
	Unserved energy	5,100	11,000	12,000
	Change in Consumer Surplus	**91,000**	**140,000**	**130,000**
Producer Surplus	Wholesale price	-130,000	-250,000	-260,000
	Low carbon support	28,000	110,000	120,000
	Capacity payments	15,000	21,000	24,000
	Producer costs	40,000	61,000	75,000
	Change in Producer Surplus	**-42,000**	**-60,000**	**-36,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-30,000**	**-42,000**	**-47,000**
Net Welfare	**Change in Net Welfare**	**19,000**	**37,000**	**49,000**

Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

134. Under a scenario in which EMR is used to target an emissions intensity of 200gCO_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). The change in producer surplus is negative over the periods up to 2040, implying that producers they are worse off under EMR, compared to a basecase in which an emissions intensity of 200gCO_2/kWh is achieved using existing instruments, although up to 2049 producers see a small positive producer surplus under EMR relative to the basecase.

Table 18: Distributional analysis: Combined EMR impact (CfD with Capacity Market) compared to basecase (assumed emissions intensity in 2030 = 200gCO_2/kWh) excluding administrative costs

		NPV, £m (real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	54,000	82,000	79,000
	Low carbon payments	700	-5,200	-9,300
	Capacity payments	-15,000	-23,000	-28,000
	System cost savings	270	680	1,200
	Unserved energy	370	2,200	2,200
	Change in Consumer Surplus	**41,000**	**56,000**	**45,000**
Producer Surplus	Wholesale price	-53,000	-80,000	-77,000
	Low carbon support	-700	5,200	9,300
	Capacity payments	15,000	23,000	28,000
	Producer costs	33,000	43,000	46,000
	Change in Producer Surplus	**-6,100**	**-9,100**	**6,500**
Environmental Tax	**Change in Environmental Tax Revenue**	**-25,000**	**-32,000**	**-32,000**
Net Welfare	**Change in Net Welfare**	**9,200**	**15,000**	**19,000**

Source: DECC modelling

135. Up to 2030, the change in consumer surplus under the new analysis is lower than in the draft delivery plan modelling reflecting the fact the carbon price increases later in the updated counterfactual (in comparison to the draft delivery plan). The change in the carbon price profile also influences low carbon payments. Up to 2030 low carbon payments are slightly lower under EMR (a change from the draft delivery plan).

136. These changes are mirrored in producer surplus – the change in producer surplus is less negative up to 2030, reflecting a smaller loss from wholesale prices (in comparison to the draft delivery plan). By 2049 EMR results in a positive producer surplus, reflecting the smaller negative impact from wholesale prices (in comparison to the draft delivery plan).

2.4.1 Institutional costs

137. 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 £500m to £800m (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.[106] They reflect the expected costs of both the CfD and CM instruments. The estimates must be regarded as tentative as the component costs have not yet been fully determined, as they depend on the final agreed activities to be undertaken by the organisations. The table below presents the NPV for EMR, taking into account administrative costs.[107]

Table 19: NPV with administrative costs (NPV 2012-2030, real 2012, £bn)[108]

	NPV – Energy market only	NPV – Energy market and administrative costs*
NPV (£bn)	11.4	**10.7**
Of which: CfDs	10.6	**10.2**
Of which: CM	0.7	**0.6**

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

[106] Component costs consistent with those presented in the Impact Assessment for the Supplier Obligation Secondary Legislation available here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/252273/131022_IA_-_Supplier_Obligation__final_for_publication_21_10_2013_.pdf

[107] A midpoint estimate of around £600m is used. The costs reflect a gross estimate of additional institutional costs from National Grid delivering their EMR functions and those associated with setting up a new institutional body – the single counterparty body under EMR; for example they do not consider what costs might have been in the absence of EMR. For example, they do not consider what the additional institutional costs of greater reliance on carbon pricing or the RO might be in the basecase scenarios.

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

Section 3 Updated price & bills analysis

3.1 Updated Price and Bill Impacts[109]

139. This section considers the price and bill impacts of the CfD and Capacity Market (based on the final strike prices and reliability standard set out in the Delivery Plan). This EMR package is assessed against each of the basecases described above (i.e. 50g, 100g and 200g in 2030).[110]

140. 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.

141. 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

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

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

144. In addition, EMR policies will affect the capacity margin on the system, to deliver larger capacity margins than in the basecase, and therefore contribute to a dampening effect on wholesale prices. It is likely that DECC's DDM underestimates the extent to which wholesale prices would rise in response to tight capacity margins in the absence of a capacity market – thereby underestimating the benefits that a capacity market has in dampening wholesale prices.

[109] 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.
[110] The price and bill impacts relative to the 'no-decarbonisation ambition' basecase is presented in Annex E.

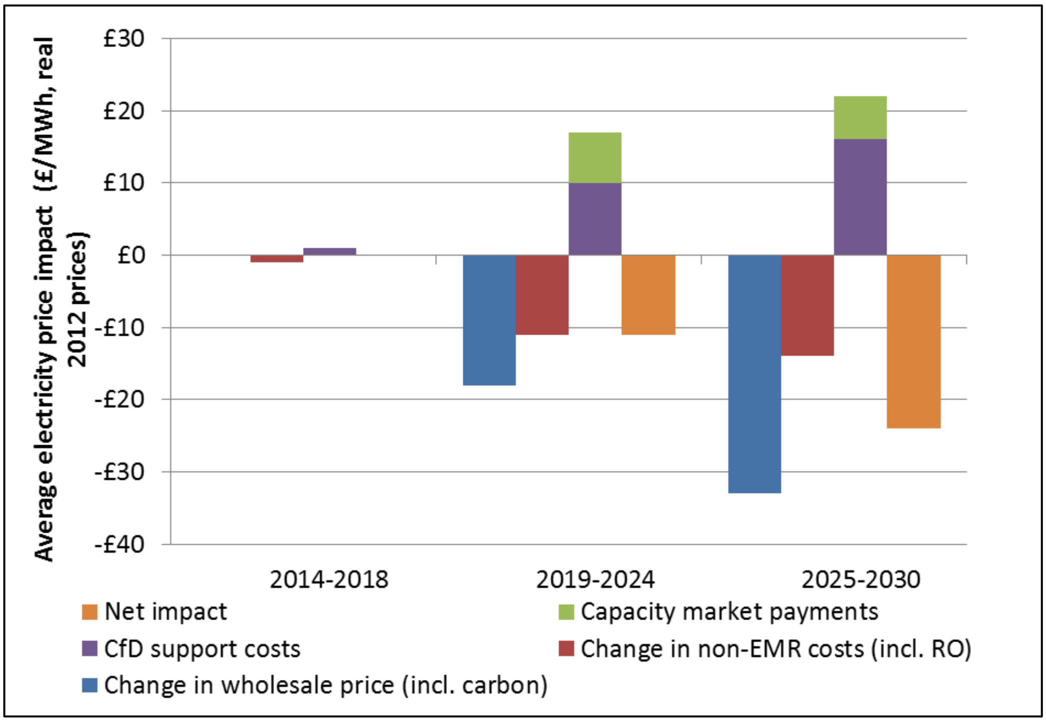
145. The charts below present the average net impact of EMR on domestic retail prices, for three different emission intensities in 2030 (100gCO_2/kWh, 50gCO_2/kWh and 200gCO_2/kWh).

146. To present results consistent with the Delivery Plan and strike price period, as well as presenting the EMR's near term impact, the period the modelling covers has been revised relative to previous Impact Assessments. For example, the modelling suggests that the EMR package may influence wholesale prices pre-2016. To present the complete impact of EMR across years we therefore now present price and bill impacts across the periods 2014-2018, 2019-2024 and 2025-2030.

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

147. Relative to the basecase, EMR results in lower average retail electricity prices over the 2014-2030 period. Over the period 2014-2030, domestic electricity prices would be around 6% lower under EMR on average, in comparison to what they would be under the basecase. Despite the increases due to EMR support payments, lower wholesale prices and smaller RO support costs offset this increase in all periods.[111]

Chart 2: Net Impact of EMR on domestic electricity prices, relative to basecase[112] (assumed emissions intensity in 2030 = 100gCO_2/kWh)



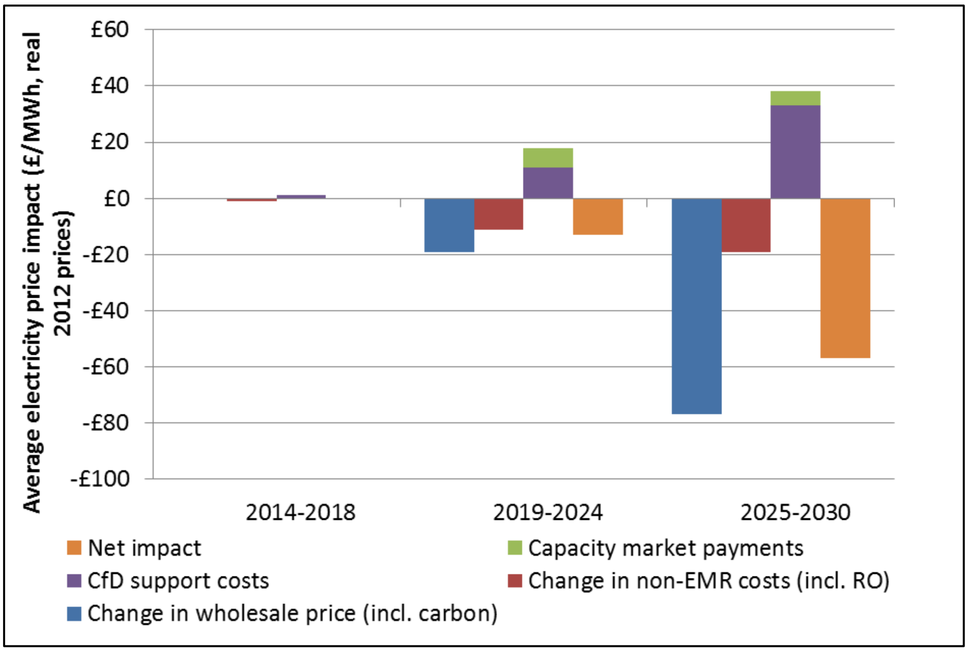
Source: DECC modelling

[111] 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.
[112] Non-EMR costs principally refer to lower Renewables Obligation support costs as a result of EMR.

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

148. Relative to a basecase in which an emissions intensity of 50gCO_2/kWh in 2030 is targeted using existing instruments, EMR still results in lower retail prices over the 2014-2030 time period – it is estimated that domestic (i.e. household) electricity prices would, on average, be around 11% 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 2025-2030 period, when average domestic prices are 21% (£57/MWh) lower than the basecase.

Chart 3: Net Impact of EMR on Domestic Electricity prices, relative to 50g basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh)

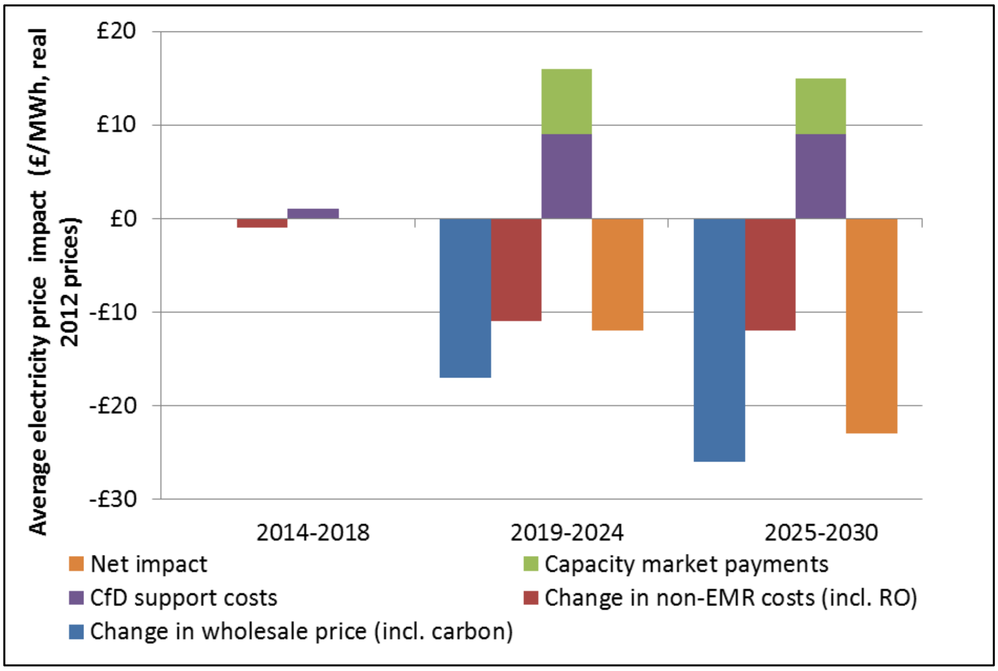


Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

149. Relative to a basecase in which an emissions intensity of 200gCO_2/kWh in 2030 is targeted using existing instruments, EMR still results in lower retail prices over the 2014-2030 time period – it is estimated that domestic electricity prices would, on average, be around 6% lower under EMR. As for other 2030 decarbonisation levels, 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.

Chart 4: Net Impact of EMR on Domestic Electricity prices, relative to 200g basecase (assumed emissions intensity in 2030 = 200gCO_2/kWh)



Source: DECC modelling

3.1.1 Bill Impacts by consumer type

150. The impacts of the EMR package on bills for different types of consumer, distinguishing between domestic, non-domestic and energy-intensive users, are presented below.

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

Domestic customers

151. For domestic consumers, EMR has the potential to reduce average annual household electricity bills by around 6% (£41) over the period 2014-2030, relative to a basecase which achieves the same decarbonisation objective using existing policy instruments.[113] Household bills would be lower under EMR, reflecting the higher carbon prices in the basecase, and therefore the benefit to consumers of incentivising low-carbon investment using CfDs.

Non-domestic customers

152. The table below presents the impact of EMR on non-domestic electricity bills. Annual bills are, on average, around 7% lower under EMR for the period 2014-2030, relative to the basecase. Electricity bills are estimated to be 6% lower on average under EMR over the period 2019-2024 and around 12% lower for the period 2025-2030, in comparison to the basecase.

[113] Based on the previous time period coverage, from 2016-2030, the equivalent figures would be 7% (£46)

Energy-intensive industry

153. 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 around 8% relative to the basecase (over the period 2014-2030). The greatest reduction is achieved over the period 2025-2030, when average annual electricity bills are estimated to be around 12% lower under EMR, in comparison to the basecase.[114]

Table 20: EMR Bill Impacts relative to 100g basecase (assumed emissions intensity in 2030 = 100gCO2/kWh)[115]

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 (%)
2014-2018	587	-	1,240	-	9,390	-10 (-0%)
2019-2024	659	-35 (-5%)	1,570	-90 (-6%)	12,810	-810 (-6%)
2025-2030	788	-81 (-10%)	1,800	-210 (-12%)	14,910	-1,860 (-12%)
2014-2030	**684**	**-41 (-6%)**	**1,550**	**-110 (-7%)**	**12,540**	**-940 (-8%)**

Source: DECC modelling

Security of supply impacts

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

155. The Capacity Market is estimated to **add around £15 to average annual household bills over the period 2014 to 2030**[116]. However, in practice the costs of a Capacity

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

[115] Results for the household sector are based on a representative average annual electricity demand level for households, derived from historical total domestic consumption, and is set at 4.5MWh of electricity per year (before policies). Non-domestic users are based on the consumption of a medium-sized fuel user in industry, with an electricity usage of 11,000 MWh per year (before policies), and includes the effects of the CRC. Bills and impacts will vary with electricity consumption. Similar impacts will occur for non-CRC non-domestic users. 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.

[116] This is assessed on a 'net' basis (i.e. inclusive of impacts on wholesale prices). However, this includes 5 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

Market could be lower, as it should help reduce financing costs for investment in new capacity. DECC's modelling may also underestimate the extent to which wholesale prices would rise in response to very tight capacity margins in the absence of a Capacity Market. This would mean the impact on consumer bills would be less than estimated.

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

156. Relative to the 100g basecase scenario outlined above, the impact on domestic bills from using EMR to target an emissions intensity of 50gCO_2/kWh in 2030 is higher – i.e. EMR achieves a larger reduction in bills, when compared to a basecase of achieving the same emissions intensity using existing instruments. For example, the average reduction over the period 2014-2030 for domestic customers is around £81. Under such a scenario, the Capacity Market is estimated to increase average annual household bills by around £10 over the period 2014 to 2030[117].

Table 21: 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 (%)
2014-2018	587	-	1,240	-	9,390	-10 (-0%)
2019-2024	665	-39 (-6%)	1,580	-110 (-7%)	12,950	-960 (-7%)
2025-2030	909	-190 (-21%)	2,090	-490 (-24%)	17,520	-4,370(-25%)
2014-2030	**728**	**-81 (-11%)**	**1,660**	**-210 (-13%)**	**13,520**	**-1,880 (-14%)**

Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

157. Relative to the 100g scenario outlined above, the impact on domestic bills from using EMR to target an emissions intensity of 200gCO_2/kWh in 2030 is similar. Decarbonisation through EMR still results in a reduction in bills – a 6% reduction in average annual domestic bills over the period 2014 to 2030, relative to a basecase in which decarbonisation is achieved using existing instruments.

158. Under such a scenario, the Capacity Market is estimated to add around £15 to average annual household bills over the period 2014 to 2030[118].

[117] This is assessed on a 'net' basis (i.e. inclusive of impacts on wholesale prices). As for the 100g analysis, this includes 5 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

[118] This is assessed on a 'net' basis (i.e. inclusive of impacts on wholesale prices). As for the 100g (and 50g) analysis, this includes 5 years where the capacity procured through the 2014 auction is not contributing to security of supply, as support costs start to impact on consumer bills in 2019

Table 22: 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 (%)
2014-2018	587	-	1,240	-	9,390	-10 (-0%)
2019-2024	659	-36 (-5%)	1,560	-90 (-6%)	12,780	-840 (-7%)
2025-2030	762	-78 (-10%)	1,740	-210 (-12%)	14,390	-1,860 (-13%)
2014-2030	**674**	**-40 (-6%)**	**1,530**	**-110 (-7%)**	**12,350**	**-950 (-8%)**

Source: DECC modelling

Conclusion

159. Energy prices are volatile, and there are significant uncertainties around estimates, in particular, of wholesale electricity prices for the next 20 years. Therefore these estimates are likely to change further, as projections change over time. However, the latest results suggest that, on average, electricity bills are likely to be lower under EMR, relative to a basecase that achieves the same decarbonisation ambition using existing policy instruments, across a range of potential decarbonisation ambitions (50g, 100g and 200gCO_2/kWh in 2030) – this reinforces the cost-effectiveness of EMR as a tool for decarbonising the power sector.

Fuel Poverty

160. In 2013 the Government announced its intention to adopt a new measure of fuel poverty in England, based on the Low Income High Costs (LIHC) framework outlined by Professor John Hills in his independent review of fuel poverty[119]. Revised estimates of fuel poverty in England using this new approach were published on 8th August 2013.[120]

161. Estimates of the impact of EMR on Fuel Poverty using both the previous '10%' measure and the new LIHC definition are presented below for England. While no quantified estimates for the rest of Great Britain are presented here, it is likely that similar broad conclusions could be drawn for the impact of EMR on the fuel poor in Scotland and Wales.

[119] https://www.gov.uk/government/publications/fuel-poverty-a-framework-for-future-action
[120] https://www.gov.uk/government/collections/fuel-poverty-statistics

Table 23: EMR Fuel Poverty impact in 2030 in England (difference in fuel poor households and fuel poverty gap under EMR and basecase scenarios)[121]

Average emissions intensity in 2030 (gCO_2/kWh)	Number of households (1,000s) Previous definition (10% measure)		Number of households (1,000s) New definition (LIHC measure)		Aggregate Fuel Poverty Gap (£m) (LIHC Measure)	
	Low	High	Low	High	Low	High
50g	-1,055	-800	-100	-50	-265	-195
100g	-460	-325	-20	-20	-95	-70
200g	-545	-355	-30	-30	-120	-90

162. In the years modelled, the fuel poverty results mirror the net impact of EMR on domestic electricity prices, relative to the basecase(s). Therefore the modelling suggests that EMR would result in fewer households in fuel poverty in 2030 across all decarbonisation scenarios.

163. Under the previous, 10% definition, the magnitude of the impact is generally larger in comparison to the impact under the new LIHC definition. The 10% measure is unduly sensitive to changes in fuel prices, compared to other drivers of fuel poverty. This was one of the key reasons the Hills Review recommended moving away from the 10% indicator.

164. Under the LIHC indicator EMR is unlikely to have a large bearing on the number of households in fuel poverty, but it may have an impact on those remaining in fuel poverty. For example, under the LIHC measure, compared to the basecase, EMR will in the long run lead to a small reduction in the overall number of households in fuel poverty, and the depth of the problem faced by those remaining in fuel poverty (expressed in terms of the fuel poverty gap) is notably reduced.

165. These projections should be treated with caution, as they only reflect projected changes in fuel prices and incomes between 2011 and 2030. They do not take into account changes to the housing stock i.e. new builds or demolitions, nor do they take into account measures to improve the energy efficiency of properties, such as cavity wall

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[121] The projection model is based on data from the 2011 English Housing Survey. The changes in energy prices use DECC's most recent price projections for gas and other non-electric fuels, released in September 2013. Price projections for electricity under different decarbonisation scenarios were taken from Delivery plan consistent modeling. Projecting disposable income involves combining information on the different types of household income, such as earnings, benefits and savings, and applying the relevant rates of change (OBR projections or assuming growth in line with inflation). The fuel poverty aggregate gap is expressed in real terms, using 2011 prices. In the high scenario, fuel prices are 10% higher than projected and incomes are 10% lower, whereas in the low scenario the converse is true. Figures are rounded to the nearest 5,000 households and 5 million pounds.

insulation and loft insulation. However, it is likely that the housing stock will improve considerably in this time period. This effect will impact household consumption levels and fuel bills, which will in turn influence measures of fuel poverty.

3.1.2 Wider Impacts

166. 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.

167. 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.[122] 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.

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

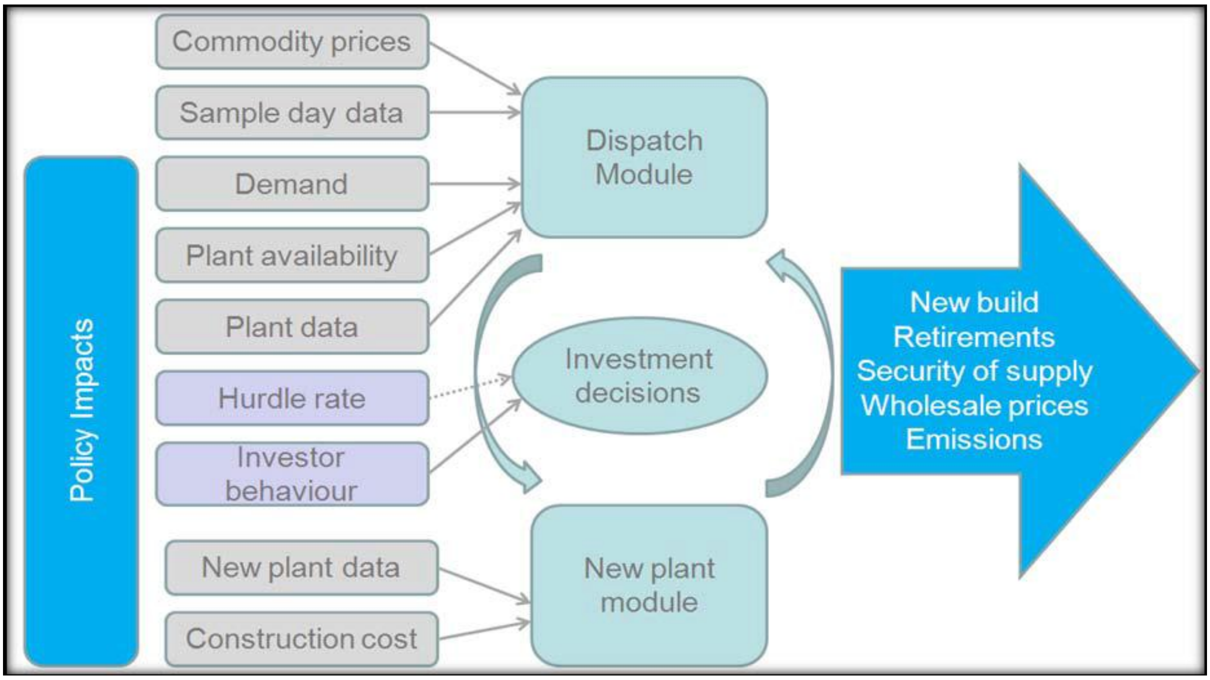
Annex A: The Dynamic Dispatch Model (DDM)

168. 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

169. 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

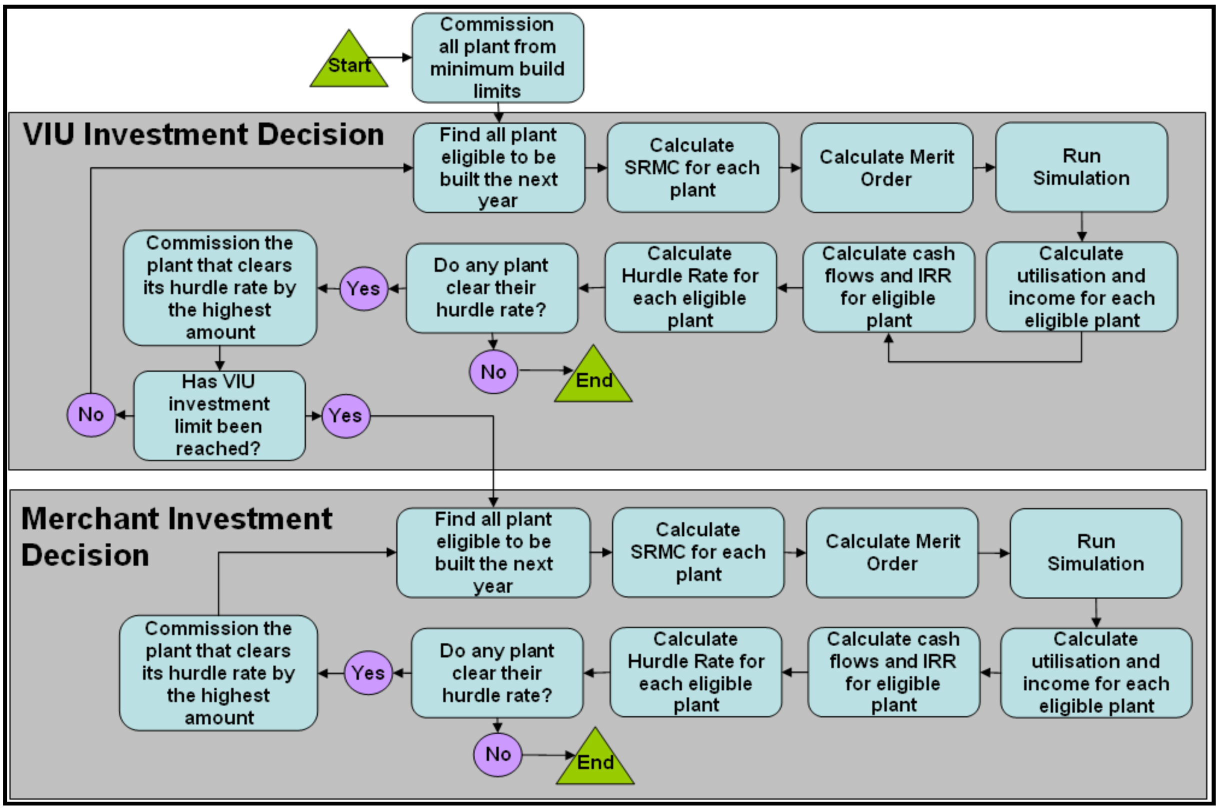
170. Economic, energy and climate policy, generation and demand assumptions are external inputs to the model. The model runs on sample days, including demand load curves for both business and non-business days. The generation data includes plant availabilities (incorporating planned and unplanned outage rates), efficiencies and

emissions. The modelling of energy unserved also considers the probabilities around demand, generation and loss of load expectations.

171. The Short Run Marginal Cost (SRMC) for each plant is calculated and determines a generation merit order taking into account support payments. Demand for each sample day is then calculated taking interconnector flows, pumped storage, autogeneration and wind generation into account. Once the level of demand and system reserve has been determined, the system SRMC is calculated by matching the demand and reserve against the generation merit order and taking the SRMC of the marginal plant which meets this. The wholesale price is equal to this marginal price plus a mark-up. The mark-up is derived from historic data and reflects the increase of system price above marginal costs at times of tight 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



172. The model requires input assumptions of the costs and characteristics of all generation types and has the capability to consider a large 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 internal rate of return (IRR). This is then compared to a 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

173. 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

174. 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.

175. 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

176. 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

177. On 23 November 2012, the Government agreed a Levy Control Framework (LCF) to 2020/21, which is set at a total of £7.6bn (in real, 2011/2012 prices).[123] This will help

[123] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268221/181213_2013_EMR_Delivery_Plan_FINAL.pdf

diversify our energy mix by increasing the amount of electricity coming from renewables (from 11% today to over 30% by 2020), as well as supporting 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

178. The baseline for DDM analysis represents a plausible outcome of Electricity Market Reforms, characterised by a diversified supply mix[124] and an assumed carbon emissions intensity of 100gCO_2/kWh in 2030 (with 50g & 200g scenarios also presented in this IA), which is an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments.

179. Dispatch modelling is sensitive to a number of assumptions (e.g. around inputs, methodology), which influence the capacity and generation mix realised under different scenarios (as discussed further in Annex F). 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.

Quality Assurance

180. At the time of the Macpherson review of quality assurance of government models,[125] the DDM was internally assessed as having undergone developer testing, internal peer review, external peer review and periodic review and being subject to version control, governance and transparency through regularly published results. It was noted that the DDM was being brought into line with DECC's (then) new quality assurance guidelines. The DDM had not at that stage undergone either internal or external audit. Recently, key sections of the DDM code have been reviewed by PwC. This review concentrated on the investment decision modelling within the DDM, and found no issues that affected the outputs of the model. Following this initial review, DECC has commissioned PwC to extend their work to cover all of the model code. This work is underway and is expected to be completed shortly. Further details on the Quality Assurance procedures are presented in Annex G of the Delivery Plan.[126]

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[124] 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

[125] https://www.gov.uk/government/publications/review-of-quality-assurance-of-government-models

[126] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/267616/Annex_G_-_Modelling_Quality_Assurance.pdf

Input assumptions
Fossil fuel price assumptions

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

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

Carbon Prices

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

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

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Central	6	3	4	4	4	4	4	4	5	12	19	26	33	40	47	54	61	68	75

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	3	4	4	4	4	4	4	5	12	19	26	33	40	47	54	61	68	75

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:
https://www.gov.uk/government/consultations/carbon-price-floor-support-and-certainty-for-low-carbon-investment

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
7	12	19	23	25	28	30	32	36	41	45	49	53	58	62	66	70	75

Technology Assumptions

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

https://www.gov.uk/government/collections/energy-generation-cost-projections

Hurdle Rate Reductions by technology type under FiT CfDs

Technology type	Reductions under FiT CfDs* (percentage points)	Reductions under previous analysis (percentage points)
ACT advanced	-0.5	-0.6
ACT CHP	0.1	-0.4
ACT standard	-0.5	-0.4
AD >5MW	-0.5	-0.6
AD CHP	0.1	-0.7
Biomass Conversion	-0.7	-0.7
Coal CCS	-1.0	-1.0
Biomass CHP	0.1	-0.8
EfW CHP	-1.1	-0.7
Gas CCS	-0.7	-0.7
Geothermal	-0.5	-1.4
Geothermal CHP	0.3	-1.5
Hydro	-1.3	-0.3
Landfill gas	-2.8	-0.4
Large Solar	-1.0	-0.4
Nuclear	-1.5	-1.5
Offshore Wind R3**	-0.4	-0.6
Offshore Wind**	-0.5	-0.6
Onshore Wind	-1.2	-0.4
Sewage Gas	-1.9	-0.4
Tidal stream	0.3	-0.7
Wave	0.3	-0.6

*As per the draft Delivery Plan analysis in July, these are adjusted for the Effective Tax Rate work which is explained in DECC's Electricity Generation Costs December 2013 report: https://www.gov.uk/government/publications/electricity-generation-costs

Rounded to one decimal place from non-rounded estimates

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

Electricity Demand

The DDM uses Electricity Demand from the 2013 Updated Emissions Projection (UEP). These can be found in Annex C of the following link:

https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2013

Note: The UEP numbers are then adjusted downwards by 2.7% before use in the DDM model as they include Northern Ireland, while the DDM models Great Britain alone. Northern Ireland is reflected in the modelling through the analysis conducted by National Grid and the System Operator Northern Ireland (SONI), as presented in the Delivery Plan[127].

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

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

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

£m, 2011/12 prices	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
LCF cap	3.30	4.30	4.90	5.60	6.45	7.00	7.60

[127] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan

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 uses carbon values that are based on estimates of the price of EU allowances. Policies that change emissions in sectors covered by the EU Emissions Trading System (ETS), and in the future other trading schemes, are appraised using the "traded price of carbon (TPC)". This is based on estimates of the future price of EU emissions Allowances (EUAs) and, in the longer term, estimates of future global carbon market prices. Up to 2020, the TPC is the estimated price of EUAs.

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

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[128]

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

System costs

[128] 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.

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

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

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

Unserved energy

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

Interconnectors

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

Consumer surplus

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

- ***Wholesale price***

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

- ***Low-carbon payments***

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

  Low carbon payments are a transfer between consumers and producers.

- ***Capacity payments***

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

  Capacity payments are a transfer between consumers and producers.

- ***Unserved energy***

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

Producer surplus

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

- ***Wholesale price***

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

- ***Low carbon support price***

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

- ***Capacity payments***

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

- ***Producer costs***

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

Environmental tax

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

Environmental tax is a transfer between producers and the Exchequer.

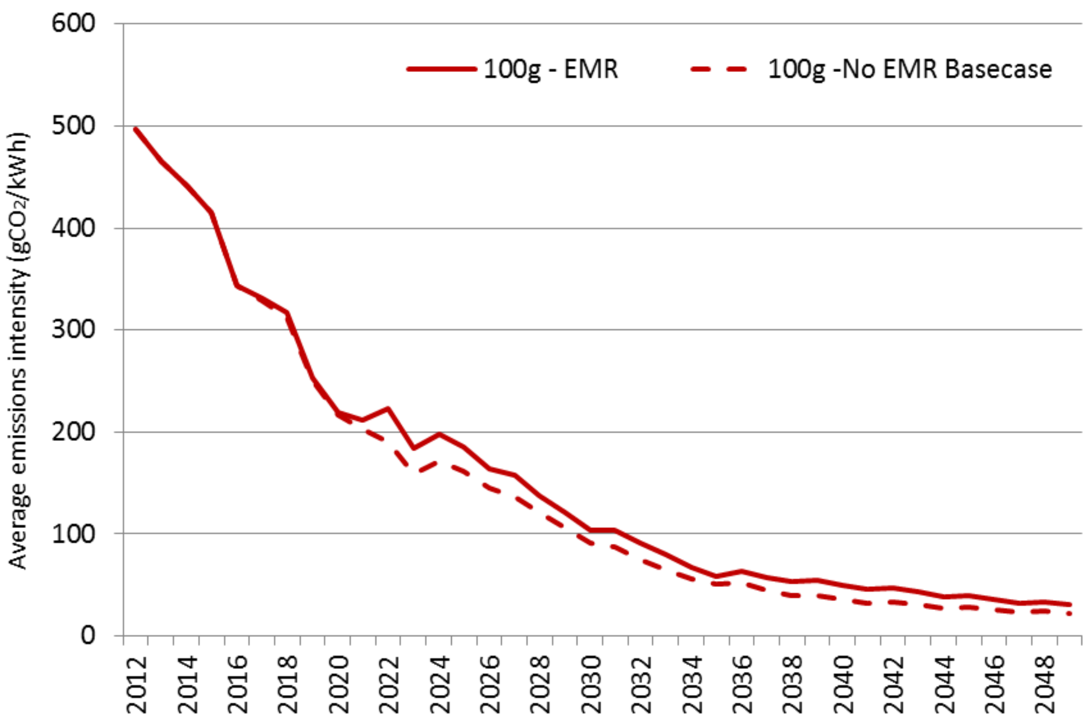
Annex C: Basecase – decarbonisation trajectory and generation mix

Decarbonisation Profiles

Analysis based on emissions intensity of 100gCO_2/kWh in 2030

181. Chart 5 below presents the decarbonisation profiles under EMR and basecase in the 100g decarbonisation scenario. The introduction of a higher carbon price to incentivise nuclear investment under the basecase results in a sharper reduction in emissions around 2020. Within the modelling, the higher carbon price in 2022 to incentivise investment in nuclear at the same rate as under EMR has additional impacts on the modelled generation mix. The higher carbon price level under the basecases influences the generation and retirement profile of unabated coal plants, relative to the EMR scenario. As a result gas generation tends to substitute for coal generation in the basecase scenarios in the early 2020s.[130] As a consequence, the basecases have a lower emission intensity level in the early 2020s.

Chart 5: Decarbonisation Profiles – EMR and no-EMR basecase (assumed emissions intensity in 2030 = 100gCO_2/kWh)



Source: DECC modelling

182. The higher carbon prices in the basecase, relative to the EMR scenario (as shown in Chart 1 earlier), and the associated impact on capacity and generation profiles results in

[130] 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.

a lower emissions intensity under the basecase in comparison to that realised under EMR by 2030 (92gCO_2/kWh and 104gCO_2/kWh).[131] This will influence the Net Welfare impacts reported previously. This lower level of decarbonisation is achieved at greater cost relative to EMR. Looking at the decomposition of these savings (as set out in Table 7 earlier), despite the value of carbon savings being around £1.7bn lower under EMR up to 2030, these are more than outweighed by the capital cost savings (£8.2bn up to 2030). This is also reflected in the price & bill impacts (as set out in section 3), with average annual household bills for 2016-2030 being around 6% cheaper under EMR, relative to the basecase.

183. The increase in the carbon price in the basecase also has significant impacts on the decarbonisation trajectory during the 2030s and early 2040s. As result of the higher carbon price under the basecase in the late 2020s (in order to bring on CCS, as well as new nuclear plants) a lower decarbonisation profile is achieved during the 2030s, such that the carbon emissions intensity in 2040 (at 36gCO_2/kWh) is significantly lower than the EMR scenario (49gCO_2/kWh). By 2049 the differences have narrowed but remain (23 and 30gCO_2/KWh respectively).

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

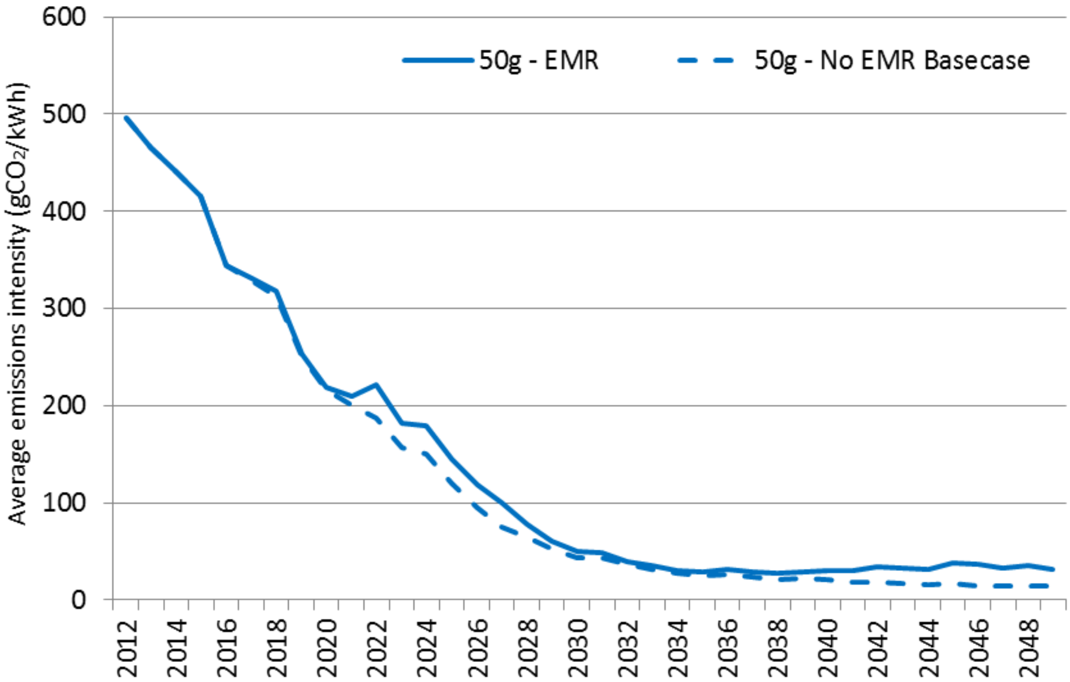
184. When targeting an emissions intensity of 50gCO_2/kWh in 2030, the decarbonisation trajectory of the EMR scenario is slightly higher up to the late 2020s, when significant increases in the carbon price under the counterfactual are necessary to bring on sufficient low-carbon generation to achieve the required reduction in carbon emissions by 2030.[132]

185. 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.

[131] In 2030 biomass generation also plays a role in the relatively lower average emissions intensity. Higher carbon prices in the basecase incentivise greater biomass generation in the late 2020s, and greater offshore wind build (and associated generation), relative to the EMR scenario, with accompanying lower unabated gas generation.

[132] The emissions intensity in the basecase is 44gCO_2/kWh, relative to 50g in the EMR scenario. As discussed below, the generation profile of the 50g basecase and EMR scenario differ more than the 100g & 200g scenarios. The differences in the emissions intensities reflects the combined impact of differences in generation across all technologies.

Chart 6: Decarbonisation Profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh)



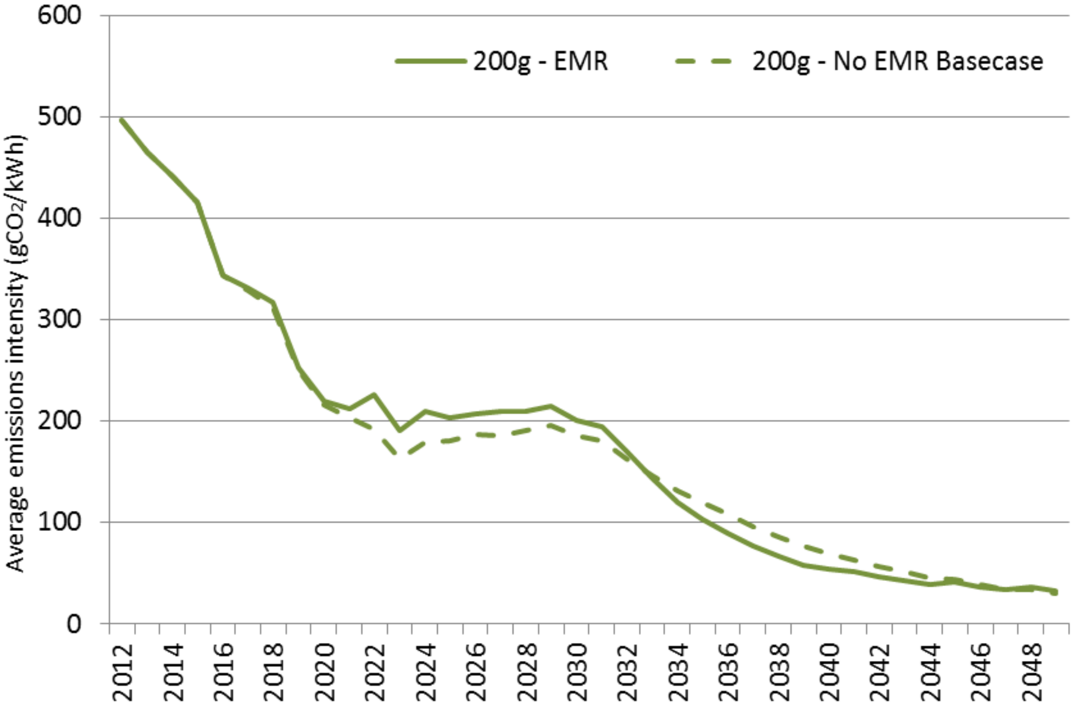
Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

186. When targeting an emissions intensity of 200gCO_2/kWh in 2030, the decarbonisation trajectory of the EMR scenario is again slightly higher up to 2030. As the emissions intensity reaches 200gCO_2/kWh around 2020 in the EMR scenario it remains broadly flat from 2020 to 2030. In the basecase further reductions in the emissions intensity take place in the early 2020s as a result of the carbon price increasing to incentivise new nuclear. As a result the average emissions profile of the counterfactual falls and then rises over the 2020s.[133] The carbon price remains flat from 2030, which produces a similar emissions profile to that achieved under EMR out to 2049.

[133] The emissions intensity in the counterfactual is significantly lower than the emissions intentisy in the EMR scenario (185gCO_2/kWh and 201gCO_2/kWh) respectively. As for the 100g scenario this reflects the impact of greater biomass and offshore wind generation in the counterfactual, and lower unabated gas generation, in comparison to the EMR case.

Chart 7: Decarbonisation Profiles – EMR and 200g basecase (assumed emissions intensity in 2030 = 200gCO_2/kWh)



Source: DECC modelling

Generation mix

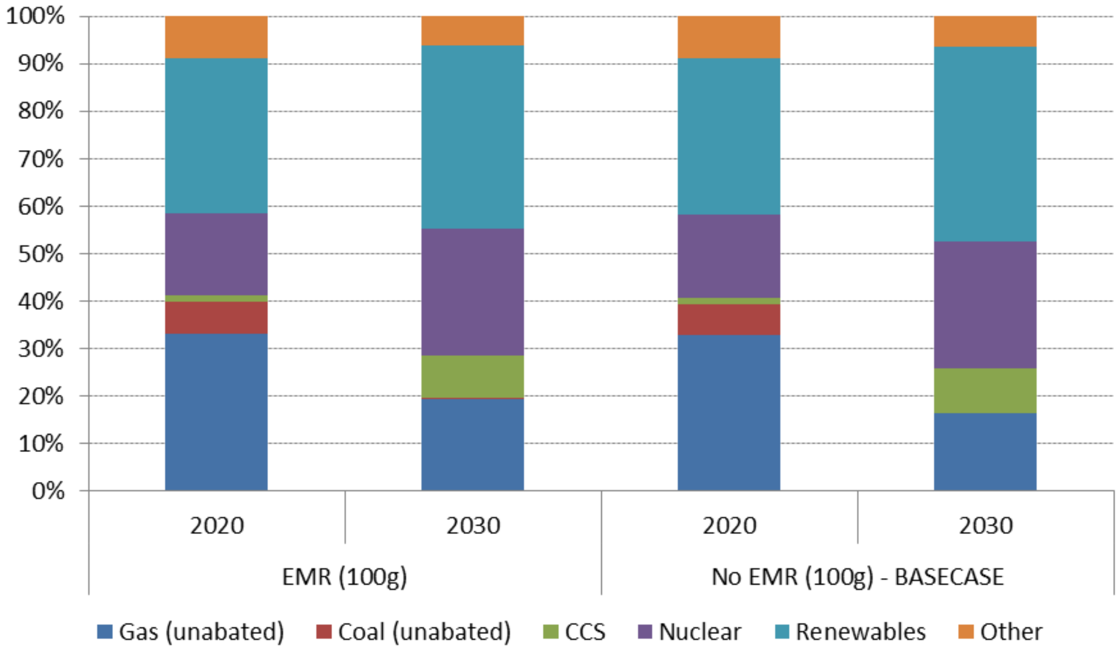
Analysis based on emissions intensity of 100gCO_2/kWh in 2030

187. Chart 8 presents generation mix profiles in 2020 and 2030 under EMR, and the basecase.[134] Under the basecase, carbon prices are set such that nuclear and CCS investments take place at the same rate as under EMR. However in the current analysis carbon prices do not increase until after 2020, therefore the generation mix in 2020 is broadly similar across the EMR and basecase scenarios. By 2030 the impact of the higher carbon price in the basecacse scenarios results in relatively more renewable generation, and slightly less unabated gas generation in comparison to the EMR scenario.[135]

[134] 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 (although it is assumed that CCS demonstration projects do take place). Without nuclear, coal and CCS generation, under the no targeting basecase gas generation accounts for a proportionately large 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 230gCO_2/kWh (further details are provided in Annex E).

[135] As discussed previously greater biomass generation as a result of the high carbon price also plays a role in the proportionately higher renewables generation.

Chart 8: Generation mix profiles – EMR and no-EMR basecase (assumed emissions intensity in 2030 = 100gCO_2/kWh)



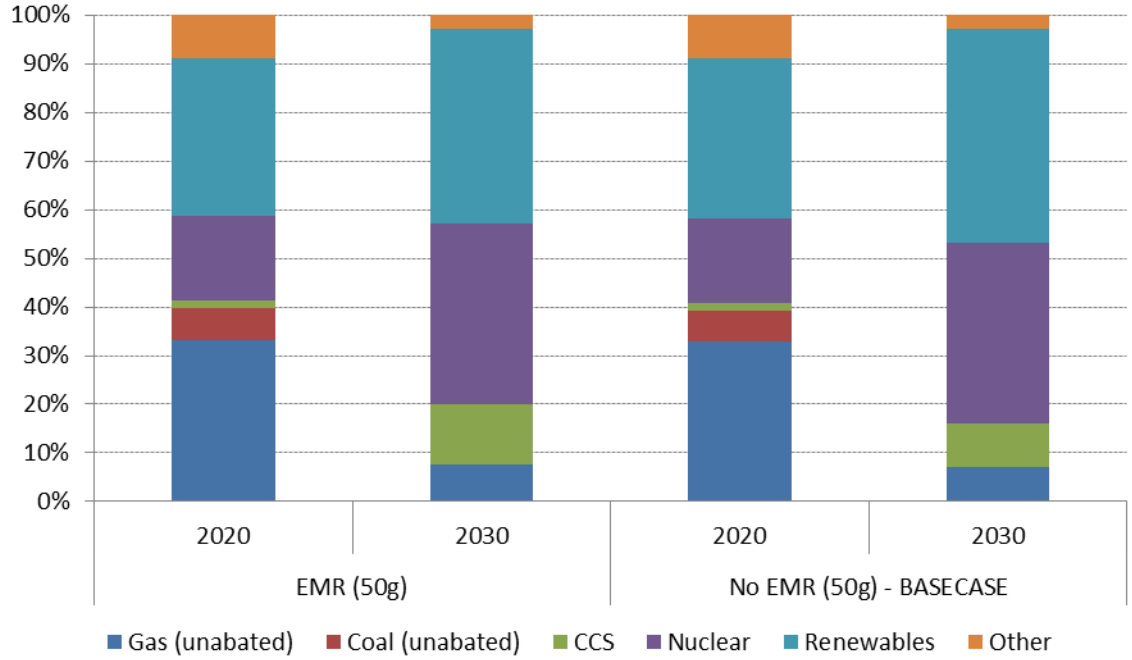
Source: DECC modelling

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 50gCO_2/kWh in 2030

188. The generation mixes under EMR and basecase under the 50gCO_2/KWh scenario are broadly similar to the 100g scenario in 2020. However, in 2030 the EMR and basecase scenarios achieve the decarbonisation ambition in slightly different ways. Under EMR, proportionately more CCS new build takes place, relative to the counterfactual, with the higher carbon price under the basecase resulting in a greater renewable new build, and therefore a higher renewable generation proportion in 2030.

Chart 9: Generation mix profiles – EMR and 50g basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh)



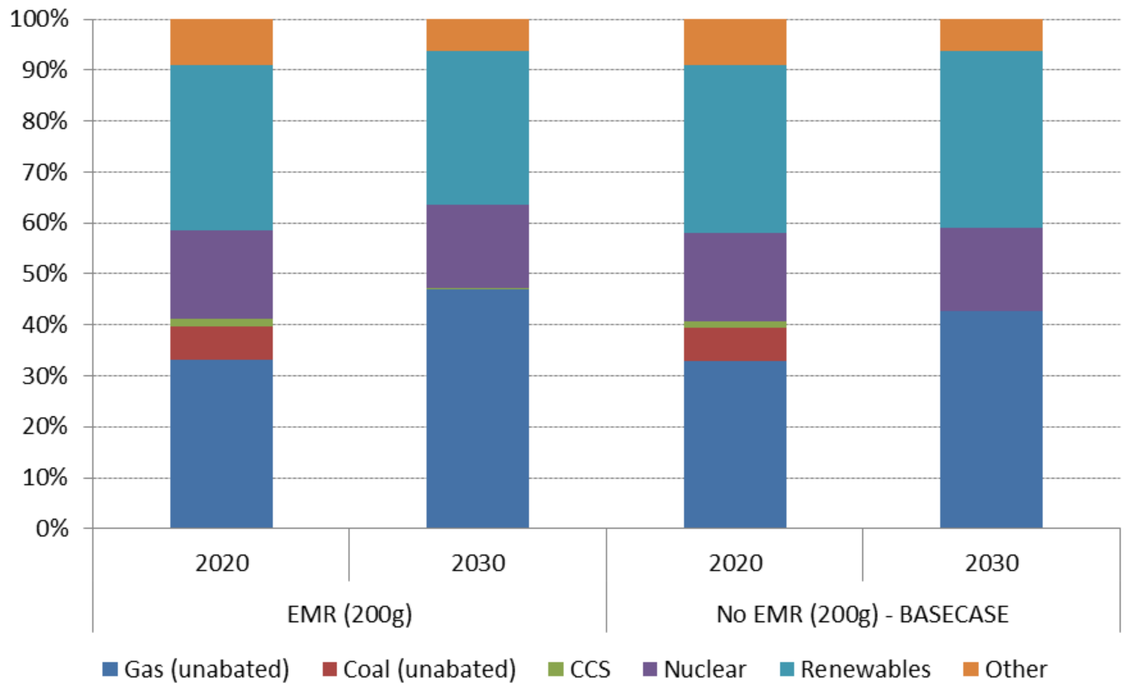
Source: DECC modelling
Note: Within the modelling 'renewables' include both large scale and small-scale FITs generation but only large scale renewable generation counts towards the 2020 renewable electricity ambition.

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

189. When targeting an emissions intensity of 200gCO_2/kWh, up to 2020 there is a similar generation mix to that realised under the 50g and 100g scenarios, and little difference between the EMR and basecase scenarios. However by 2030 the higher carbon price in the basecase scenario incentivises more renewable investment in comparison to the EMR scenario, resulting in higher renewables generation and less unabated gas generation[136].

[136] As discussed previously, greater biomass generation as a result of the high carbon price also plays a role in the proportionately higher renewables generation. Under the 200g counterfactual, within the modeling, the number of nuclear and gas CCS plants are restricted so that the build profile matches that realised under the EMR scenario. Without this restriction the carbon price in the 200g counterfactual would incentivise too much new build.

Chart 10: Generation mix profiles – EMR and 200g basecase (assumed emissions intensity in 2030 = 200gCO_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

190. 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.

191. The first analysis assessing the costs and benefits of various potential EMR options was presented in the Government’s December 2010 consultation on EMR.[137] 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.

192. In July 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.[138] 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.

193. 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.[139] 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[140] in the EMR White Paper, under central fossil fuel price assumptions.

194. This was subsequently updated in the analysis accompanying the publication of the Energy Bill, which was introduced into Parliament in November 2012.[141] 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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[137] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42637/1042-ia-electricity-market-reform.pdf

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

[139] 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

[140] This number reflects DECC’s new carbon appraisal methodology for CBA (12th August 2011) and revises the White Paper number.

[141] 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[142]); 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**.

195. In January 2013 an updated IA was released, updating the modelling to include fossil fuel price sensitivities, and to reflect the agreement over the Levy Control Framework to 2020/21. In addition, to reflect the decision to take a power in the Energy Act 2013 to set a decarbonisation target range and show the wider range of costs and benefits of EMR, the Impact Assessment included analysis based on an average emission level of both 50gCO_2/kWh and 200gCO_2/kWh in 2030– in addition to analysis based on a carbon emissions intensity of 100gCO_2/kWh for the power sector in 2030, consistent with previous EMR impact assessments. This IA was updated in May 2013 to reflect a small change in administrative costs. It presented a positive net benefit of between **£4.2bn and £7.6bn up to 2030.**

196. In the Impact Assessment published alongside the EMR draft Delivery plan, in July 2013, updated evidence and assumptions about technology costs resulted in the two basecases used to generate an NPV range in the 100g CO_2/kWh scenario aligning. As a result of these changes, and a number of other modelling changes, for example, inclusion of proposed strike prices, the NPV of EMR up to 2030 was reported as £9.5bn (NPV to 2030, 2012 prices). In addition to the 100g CO_2/kWh scenario, scenarios targeting 50g CO_2/kWh and 200g CO_2/kWh in 2030 were also presented, as well as fossil fuel price scenarios and a no-decarbonisation ambition scenario.

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

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

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

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

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

- **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, up to 2030 this is based on the published Carbon Price Floor trajectory, with post 2030 traded carbon prices rising above the Carbon Price Floor (based on the assumption of a global deal on climate change action with a global carbon market).

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

- **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.[143]

No-decarbonisation ambition

200. The table below provides a summary of the different outcomes and policy environments assumed under the no-decarbonisation ambition scenario.[144]

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

[144] The emissions intensity under this scenario falls to around 230gCO_2/kWh in 2020 as a result of meeting the 2020 renewables target and the impact of the Carbon Price Floor. Post-2020, the RO is assumed to realise a broadly similar proportion of renewable generation, up to 2030, as realised in 2020. Beyond 2036, the carbon price is the only policy impacting the basecase.

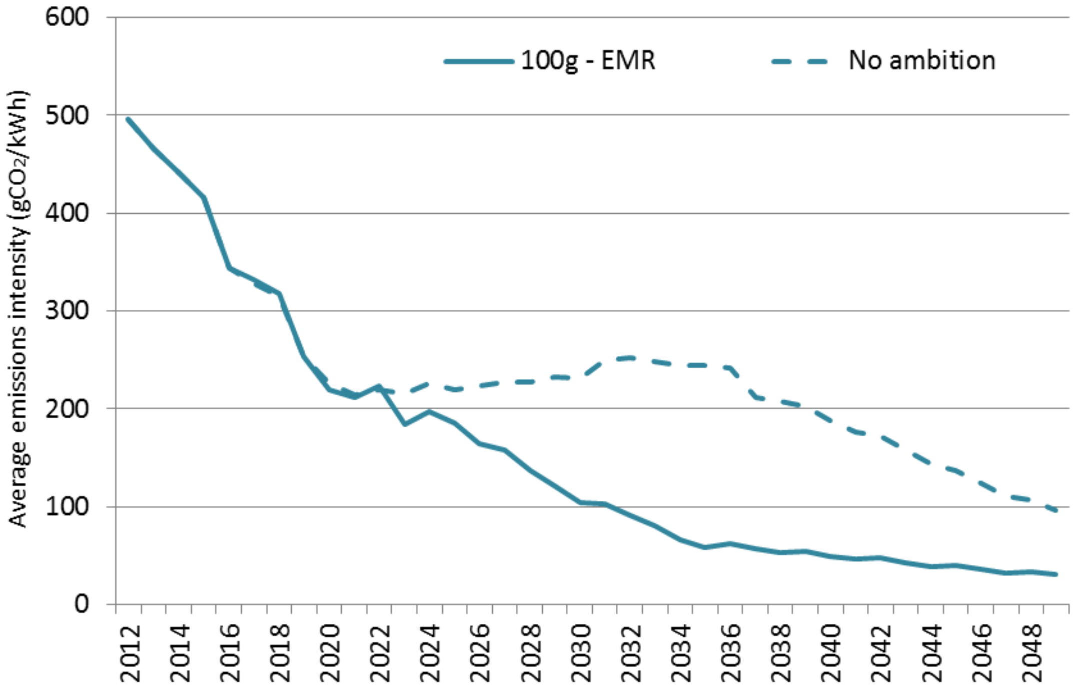
Table 24: Summary of assumptions – no-decarbonisation ambition

	2030 emissions intensity gCO_2/KWh	2049 emissions intensity gCO_2/KWh	Carbon Pricing	Renewables Obligation (RO)
No-decarbonisation Ambition				
No-decarbonisation ambition	232	96	Published Carbon Price Floor trajectory up to 2030, post 2030 traded carbon prices rise above the Carbon Price Floor (based on the assumption of a global deal on climate change action with a global carbon market).	RO stays open to new renewable plants beyond 2017, closing in 2037.

Decarbonisation profiles

201. Chart 11 presents the decarbonisation profiles under EMR and the no-decarbonisation ambition basecase (described above). Under the no-decarbonisation basecase, which does not set a decarbonisation ambition for any time period, emission intensities stay broadly at the same level from 2020 to the mid 2030's, before declining up to 2049. However, the emission intensities remain above the levels achieved under EMR from around 2020 onwards.

Chart 11: Decarbonisation Profiles – EMR and no-decarbonisation ambition



Source: DECC modelling

202. An implicit assumption is that with less decarbonisation in the power sector (i.e. higher emissions, as shown for the no-decarbonisation ambition basecase above), carbon targets would be met by reductions in other sectors. These costs are not considered in EMR modelling. The HMG Carbon Plan, and the CCC, suggest that carbon targets can be met cost-effectively by early decarbonisation of the power sector. A basecase which assumes less decarbonisation in the power sector in 2030 will therefore underestimate the costs of meeting long-term carbon targets, by failing to consider the costs of decarbonising in more expensive sectors outside the power sector (assuming that emission reductions are met domestically, rather than through trading).

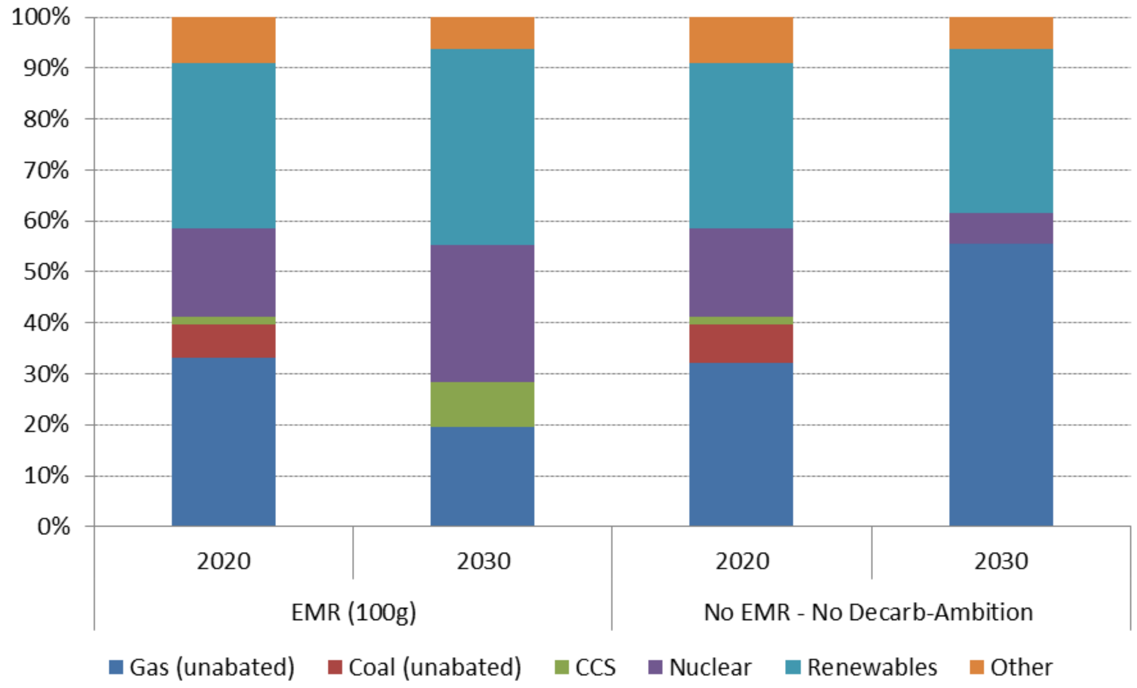
Generation mix

203. The chart below presents generation mix profiles for the no-decarbonisation ambition basecase, compared to the generation mix realised under EMR (100gCO_2/kWh scenario).

204. Under the no-decarbonisation ambition Basecase, where no decarbonisation ambition is set, generation becomes increasingly gas-dependent up to 2030. In this no-EMR scenario, 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 take place without CfDs).[145] Without nuclear, coal and CCS generation, under the no-decarbonisation ambition scenario gas generation accounts for a much larger proportion of total generation by 2030. As a result, the emission intensity of this scenario in 2030 is roughly double the level realised under EMR, at around 230gCO_2/kWh.

Chart 12: Generation mix profiles – EMR and No-Decarbonisation ambition basecase



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

Cost Benefit Analysis (CBA)

205. Table 25 presents the net welfare impact of the EMR package relative to 'no-decarbonisation ambition' basecase, for a carbon emissions intensity in 2030 of 100gCO_2/kWh. The results suggest that the EMR package would lead to a net welfare loss of around **£9.2bn**, up to 2030.

[145] The inclusion of costs for the CCS demonstration projects represents a change from previous EMR IAs, where CCS demonstration costs were not included in the main counterfactual scenarios for the presentation of the main NPV results. Nevertheless, the NPV of EMR including these demonstration project costs was reflected in a footnote. Given the degree of progress in these demonstration projects and the independence of their delivery relative to EMR, we believe it is more analytically consistent to include these costs in the counterfactual, as well as the EMR case.

Table 25: Change in Net Welfare (NPV) – Combined EMR impact (CfDs with Capacity Market), compared to 'no-decarbonisation ambition' basecase (EMR emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
	Value of carbon savings	6,400	40,000	68,000
	Generation cost savings	5,300	22,000	37,000
	Capital cost savings	-19,000	-70,000	-99,000
Net Welfare	System cost savings	-1,500	-3,400	-5,000
	Unserved energy savings	220	570	660
	Cost of Interconnector energy saved	52	540	950
	Change in Net Welfare	**-8,600**	**-9,900**	**+2,700**
	Change in Net Welfare*	**-9,200**		

Source: DECC modelling - Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.6bn up to 2030*

206. This result is driven by increased capital costs generated under EMR relative to the 'no-decarbonisation ambition' basecase, as a result of the increased investment in capital-intensive low-carbon technologies, such as nuclear and renewables. Up to 2030, these costs outweigh the significant carbon and generation cost savings under EMR.

207. The greatest benefits of EMR are seen in the longer term. Therefore, considering the costs and benefits over a longer period – for example, over the complete lifetime of the low-carbon generation technologies – is likely to result in an increasingly positive NPV. Indeed, assessed up to 2049 EMR results in a positive net welfare impact of around £2.7bn.

208. When assessing up to 2049, the generation and carbon cost savings realised under EMR more than offset the higher capital costs incurred (though this is the period for which uncertainties are greatest).

209. Table 26 presents the consumer and producer surplus under the no-decarbonisation ambition basecase. 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 the no-decarbonisation ambition scenario (which leads to transfers from producers to consumers). However, across all assessment years EMR leads to lower consumer surplus, relative to the no-decarbonisation ambition scenario, as low-carbon and capacity payment transfers outweigh the benefits of lower wholesale prices and less unserved energy. Conversely, producers see greater welfare under EMR, as the low-carbon and capacity payments outweigh the lower wholesale prices realised under EMR (relative to the no-decarbonisation ambition scenario).

210. Relative to the no-decarbonisation ambition scenario, EMR results in lower carbon emissions and therefore a reduction in environmental tax revenue.

Table 26: Distributional analysis: Combined EMR impact (CfDs with Capacity Market), relative to No decarbonisation ambition basecase (emissions intensity in 2030 = 100gCO_2/kWh) excluding administrative costs

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	1,700	24,000	46,000
	Low carbon payments	-7,200	-24,000	-23,000
	Capacity payments	-15,000	-22,000	-26,000
	System cost savings	-1,500	-3,400	-5,000
	Unserved energy	220	570	660
	Change in Consumer Surplus	**-22,000**	**-25,000**	**-7,800**
Producer Surplus	Wholesale price	-1,600	-23,000	-45,000
	Low carbon support	7,200	24,000	23,000
	Capacity payments	15,000	22,000	26,000
	Producer costs	-6,600	-6,900	6,900
	Change in Producer Surplus	**14,000**	**16,000**	**11,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-750**	**-750**	**-750**
Net Welfare	**Change in Net Welfare**	**-8,600**	**-9,900**	**2,700**

Source: DECC modelling

Changes from previous analysis

211. This latest modelling represents a change in the overall NPV for EMR compared to a 'no-decarbonisation ambition' basecase – the NPV up to 2030 has improved by around £2.8bn. There are several important drivers of this change:[146]

- The difference between capital costs under EMR and the 'no-decarbonisation ambition' basecase is around £3.1bn smaller than in the July analysis, this results in the NPV of EMR increasing by £3.1bn relative to the July analysis. This predominately reflects a positive impact from later nuclear deployment and the inclusion of CCS demonstration projects in the 'no-decarbonisation ambition' scenario, as well as other small changes (£4.1 bn), offset by a £1.0bn reduction in pure cost of capital benefits.

[146] Component parts may not sum to totals due combined impact of small changes not detailed here as well as rounding.

- Offsetting this improvement in the NPV is a small net reduction as a result of lower carbon cost savings and smaller unserved energy benefits, offset by larger generation cost savings (£700m).

212. Considering the costs and benefits of EMR over a longer period – for example, over the complete lifetime of the low-carbon generation technologies – results in an increasingly positive NPV. The latest modelling suggests that EMR has a positive net welfare impact of £2.7bn up to 2049.

213. However, if there is less decarbonisation in the power sector, carbon targets would need to be met by reductions in other sectors; such costs are not considered in EMR modelling. Therefore, this basecase will underestimate the costs of meeting long-term carbon targets, by failing to consider the costs of decarbonising in more expensive sectors outside the power sector (assuming that emission reductions are met domestically, rather than through trading). In addition, this 'no decarbonisation ambition' scenario does not mitigate against security of supply risks.

Table 27: NPV Analysis – comparison to previously published CBA (assumed emissions intensity in 2030 = 100gCO2/kWh)

		Current NPV, £m (real 2012) 2012-2030	Previous NPV, £m (real 2012) 2012-2030
Net Welfare	Value of carbon savings	6,400	7,300
	Generation cost savings	5,300	5,000
	Capital cost savings	-19,000	-22,000
	System cost savings	-1,500	-1,300
	Unserved energy savings	220	430
	Cost of Interconnector energy saved	52	92
	Change in Net Welfare	**-8,600**	**-11,000**

Source: DECC modelling (not inclusive of administrative costs)

Electricity Price and Bills Analysis

214. Chart 13 presents the net impact of EMR on prices relative to the no-decarbonisation ambition scenario, which does not meet the same decarbonisation ambitions and does not mitigate against security of supply risks.

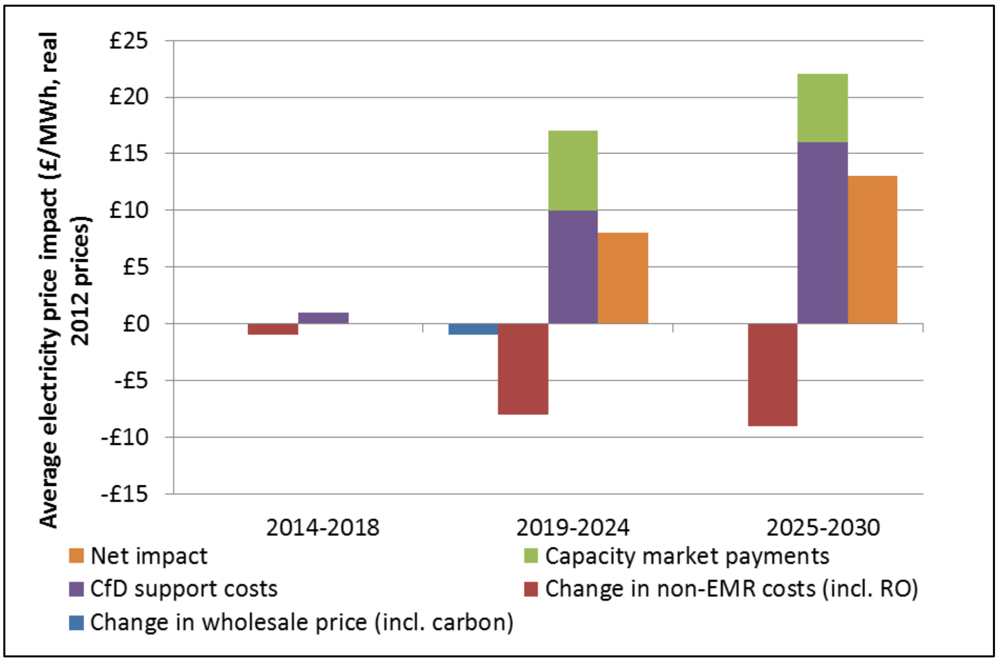
Analysis based on emissions intensity of 100gCO_2/kWh in 2030

215. Assessed over the period 2014-2030, EMR increases prices relative to a basecase where no decarbonisation objective is targeted. Domestic electricity prices to 2030 are on average, around 4% higher under EMR, in comparison to what they would be under the 'no-decarbonisation ambition' basecase (over the period 2014-2030). Despite the impact EMR has in lowering wholesale prices and resulting in lower RO support costs

relative to the 'no-decarbonisation ambition' basecase, the size of the EMR support costs outweigh these effects, leading to an overall increase in prices.

216. There are uncertainties when modelling wholesale prices into the future and therefore results are averaged over periods, rather than focusing on individual years. EMR achieves a significantly lower carbon intensity than the 'no-decarbonisation ambition' basecase (as a result of investment in low-carbon generation), as well as mitigating against security of supply risks.

Chart 13: Net Impact of EMR on domestic electricity prices, relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 100gCO_2/kWh)



Source: DECC modelling

217. The table below presents the impact of EMR on consumer bills relative to the 'no-decarbonisation ambition' basecase. Annual average household electricity bills under EMR are expected to be, on average, around 4% (£25) higher than they would have been under the 'no-decarbonisation ambition' basecase, over the period 2014-2030. Bills for both non-domestic consumers and EIIs are expected to be between 5% and 6% higher.

Table 28: EMR Bill Impacts relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 100gCO_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 (%)
2014-2018	588	-	1,240	-	9,390	-10 (0%)
2019-2024	599	+26 (+4%)	1,390	+80 (+6%)	11,220	+780 (+7%)
2025-2030	663	+44 (+7%)	1,470	+120 (+8%)	11,940	+1,100 (+9%)
2014-2030	**618**	**+25 (+4%)**	**1,380**	**+70 (+5%)**	**10,940**	**+660 (+6%)**

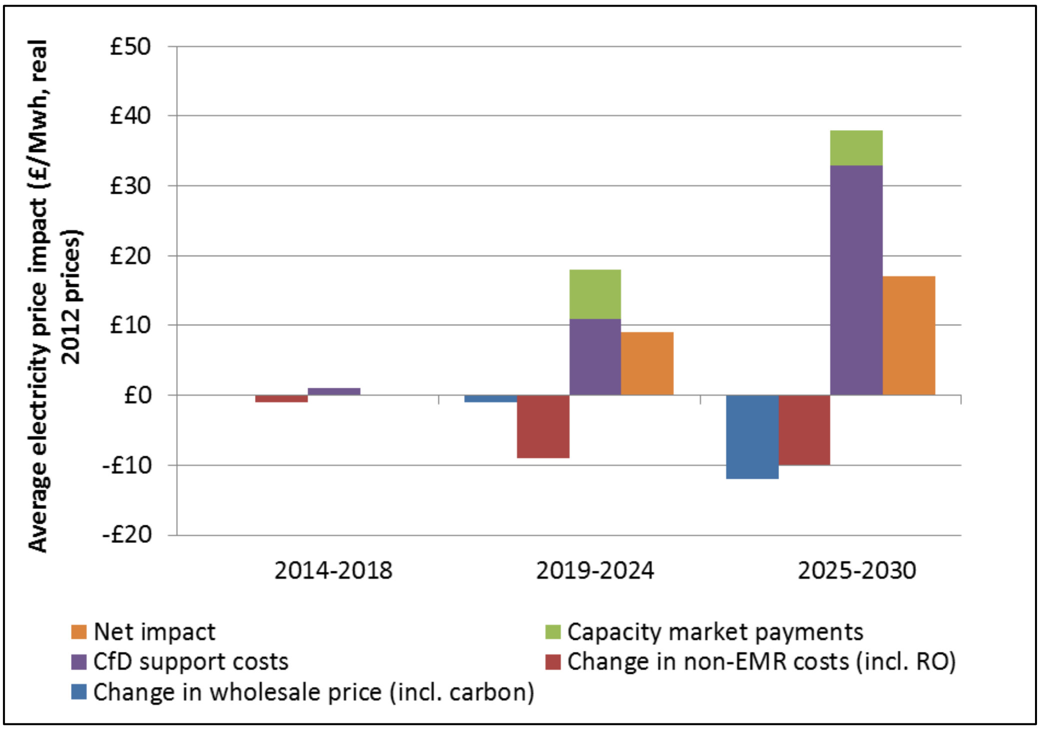
Source: DECC modelling

218. Between 2019 and 2024, average annual electricity bills are estimated to be higher under EMR compared to a 'no-decarbonisation ambition' basecase, with annual household electricity bills around £26 (4%) higher. In the late 2020s, the costs of EMR increase, with average annual domestic electricity bills £44 (7%) higher under EMR in comparison to a 'no-decarbonisation ambition' basecase.

Analysis based on emissions intensity of 50gCO_2/kWh in 2030

219. Under this scenario, EMR again increases prices relative to a 'no-decarbonisation ambition' basecase, with average prices to 2030 estimated to be around 5% higher under EMR, in comparison to what they would be under a 'no-decarbonisation ambition' basecase (over the period 2014-2030). Similarly, despite the downward impact of EMR on bills through lower wholesale prices and lower RO support costs, EMR support costs outweigh these benefits and result in an overall increase in prices. This increase is of slightly greater magnitude than for the 100g scenario above.

Chart 14: Net Impact of EMR on Domestic Electricity prices, relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh)



Source: DECC modelling

220. The table below presents the impact of EMR on consumer bills relative to a 'no-decarbonisation ambition' basecase. Annual average household electricity bills under EMR are expected to be, on average, around 5% (£29) higher than they would have been under a 'no-decarbonisation ambition' basecase, over the period 2014-2030. Bills for non-domestic consumers and EIIs are also expected to be between 5% and 6% higher.

Table 29: EMR Bill Impacts relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 50gCO_2/kWh)

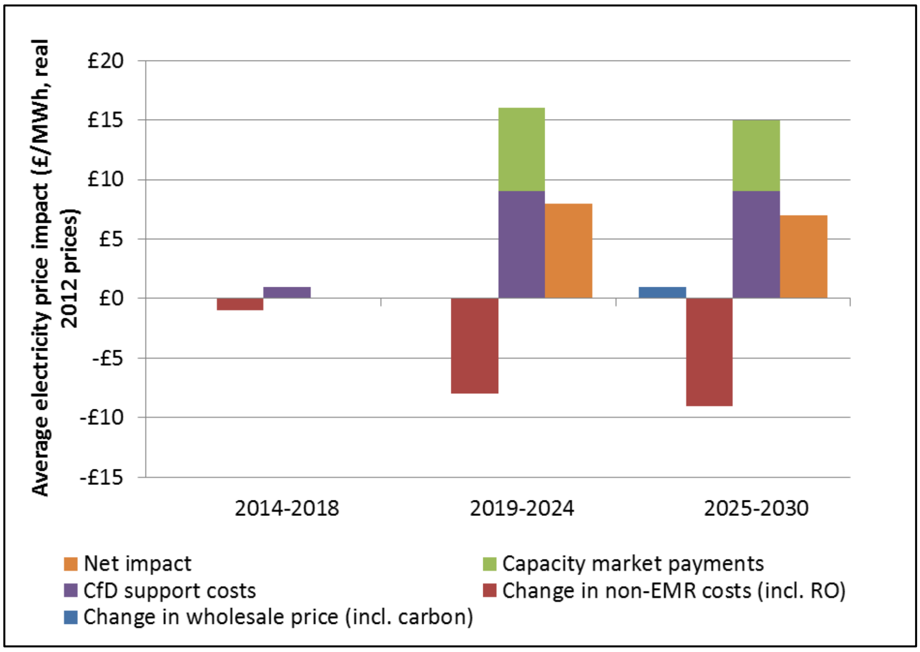
Real 2012 prices	Domestic (£)		Non-Domestic (with CRC) (£'000s)		Energy Intensive Industry (£'000s)	
	Bill under basecase	Change in bill due to EMR (%)	Bill under basecase	Change in bill due to EMR (%)	Bill under basecase	Change in bill due to EMR (%)
2014-2018	588	-	1,240	-	9,390	-10 (0%)
2019-2024	599	+26 (+4%)	1,390	+80 (+6%)	11,220	+770 (+7%)
2025-2030	663	+57 (+9%)	1,470	+120 (+8%)	11,940	+1,210 (+10%)
2014-2030	**618**	**+29 (+5%)**	**1,380**	**+70 (+5%)**	**10,940**	**+700 (+6%)**

Source: DECC modelling

Analysis based on emissions intensity of 200gCO_2/kWh in 2030

221. Under this scenario, EMR increases prices relative to a 'no-decarbonisation ambition' basecase. On average prices are estimated to be around 3% higher under EMR, in comparison to a 'no-decarbonisation ambition' basecase (over the period 2014-2030).

Chart 15: Net Impact of EMR on Domestic Electricity prices, relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 200gCO_2/kWh)



Source: DECC modelling

222. The table below presents the impact of EMR on consumer bills relative to a 'no-decarbonisation ambition' basecase. As might be expected, the increases in annual average domestic electricity bills under EMR for this scenario are smaller than for either the 50g or 100g scenario, being only 3% (£16) higher than they would have been under a 'no-decarbonisation ambition' basecase, over the period 2014-2030. Bills for non-domestic consumers and EIIs are also estimated to be 4% higher over this period.

Table 30: EMR Bill Impacts relative to 'no-decarbonisation ambition' basecase (assumed emissions intensity in 2030 = 200gCO_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 (%)
2014-2018	588	-	1,240	-	9,390	-10 (0%)
2019-2024	599	+24 (+4%)	1,390	+80 (+6%)	11,220	+730 (+6%)
2025-2030	663	+22 (+3%)	1,470	+60 (+4%)	11,940	+590 (+5%)
2014-2030	**618**	**+16 (+3%)**	**1,380**	**+50 (+4%)**	**10,940**	**+460 (+4%)**

Source: DECC modelling

Fuel Poverty

223. Estimates of the impact of EMR on the number of households in Fuel Poverty, relative to the 'no-decarbonisation ambition' basecase, using both the previous '10%' measure and new Low Income High Costs (LIHC) definition are presented below:

Table 31: EMR Fuel Poverty impact in 2030 in England (difference in fuel poor households and fuel poverty gap under EMR and 'no-decarbonisation ambition' scenarios)[147]

Average emissions intensity in 2030 (gCO_2/kWh)	Number of households (1,000s) Previous definition (10% measure)		Number of households (1,000s) New definition (LIHC measure)		Aggregate Fuel Poverty gap (£m) (LIHC measure)	
	Low	High	Low	High	Low	High
50g	+230	+335	+20	+30	+55	+75
100g	+205	+285	+15	+30	+50	+65
200g	+90	+105	+5	+5	+15	+20

224. Relative to the 'no-decarbonisation ambition' basecase, the results suggest that EMR would lead to a small increase in the number of households in fuel poverty under the LIHC definition in 2030 across all decarbonisation scenarios (consistent with the net

[147] The projection model is based on data from the 2011 English Housing Survey. The changes in energy prices use DECC's most recent price projections for gas and other non-electric fuels, released in September 2013. Price projections for electricity under different decarbonisation scenarios were taken from Delivery plan consistent modeling. Projecting disposable income involves combining information on the different types of household income, such as earnings, benefits and savings, and applying the relevant rates of change (OBR projections or assuming growth in line with inflation). The fuel poverty aggregate gap is expressed in real terms, using 2011 prices. In the high scenario, fuel prices are 10% higher than projected and incomes are 10% lower, whereas in the low scenario the converse is true. Figures are rounded to the nearest 5,000 households and 5 million pounds.

impact of EMR on domestic electricity prices relative to the 'no-decarbonisation ambition' basecase). The increase is larger under the previous '10%' measure, as it is unduly sensitive to changes in energy prices, which is one of the key reasons the Hill review gave for moving away from it.

225. The figures also show a small but notable increase in the fuel poverty gap across all decarbonisation scenarios, suggesting an increase in the depth of the problem faced by the fuel poor, and this reflects the net increase EMR has on domestic electricity prices relative to the 'no-decarbonisation ambition' basecase.

Post-2030 carbon price assumptions

226. The impact of EMR has been assessed up to 2049. However, extending the analysis beyond 2030 creates a number of modelling complexities – notably uncertainty over the future traded carbon market price.

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

228. Before the draft Delivery Plan (published in July 2013) EMR analysis assumed that the traded carbon market price would remain below the Carbon Price Floor, which therefore represented the carbon price faced by fossil fuel generators. The Carbon Price Floor was assumed (in the EMR scenario) to follow its announced profile to 2030[148], and then to remain flat in real terms at the 2030 value of £76/tCO_2e (2012 prices).

229. In the draft Delivery Plan, and in this analysis, this assumption was altered so that the traded carbon price rises above the Carbon Price Floor from 2030 onwards, based on the assumption of a global deal on climate change action with a global carbon market. The price rises progressively as more abatement is required and the cheaper options are used up.[149]

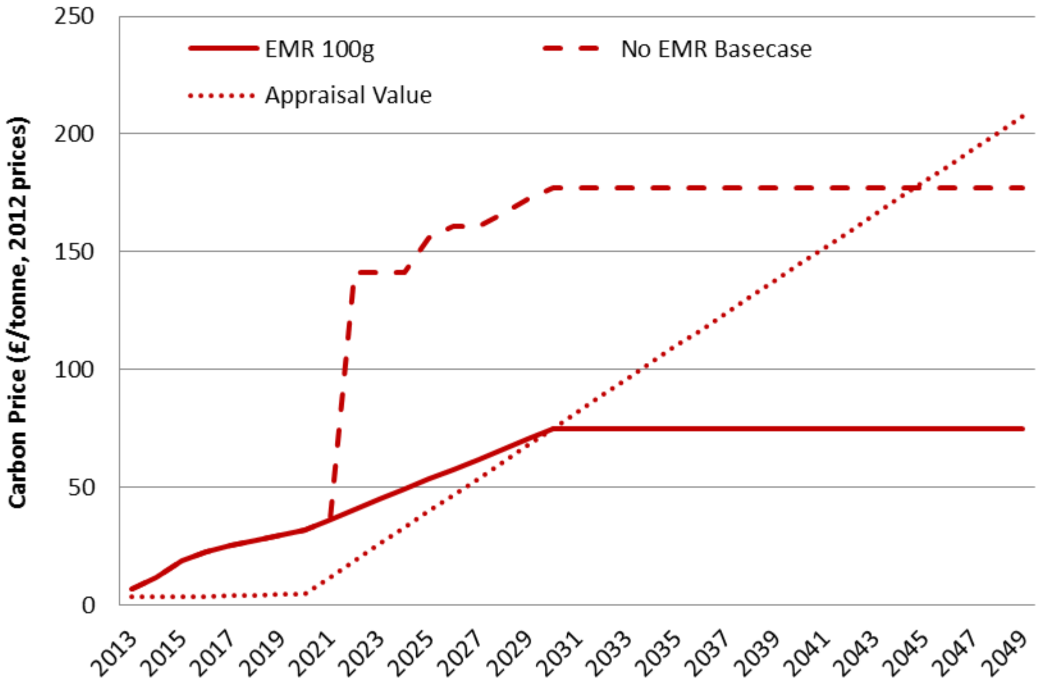
230. However, given the uncertainty over future carbon prices and to show results consistent with previous IAs, here we present results showing the impact of EMR under a scenario where traded carbon prices stay below the Carbon Price Floor (i.e. assuming

[148] 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/tCO_2 (2009 prices) and takes a linear path to £30/ tCO_2 (during 2013-2020) and then a linear path to £70/tCO_2 (during 2020-2030).

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

that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030). This alternative EMR scenario is then compared to a slightly altered basecase, as the assumed carbon price level in the basecase goes slightly below the assumed traded carbon price in the late 2040s (as shown in Chart 16 below).

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



231. Table 32 below shows that, under this alternative carbon price scenario post-2030, EMR has a slightly higher net welfare benefit in 2049: £35bn (NPV, 2012 prices), compared to £31bn under the central EMR case.

Table 32: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to basecase, alternative post-2030 carbon price assumptions (emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (2012-2030, real 2012)			
		EMR (appraisal values)		EMR (CPF)	
		2040	2049	2040	2049
Net Welfare	Carbon costs	-4,500	-7,600	-4,600	-7,000
	Generation costs	4,100	5,700	4,300	5,700
	Capital costs	19,000	27,000	19,000	28,000
	System costs	690	1,300	640	1,100
	Unserved energy	3,300	3,300	3,800	3,900
	Interconnectors	2,000	1,800	2,400	2,900
	Change in Net Welfare	**24,000**	**31,000**	**25,000**	**35,000**

Source: DECC modelling

232. This change also affects the analysis of the No-decarbonisation ambition scenario. Therefore, again in order to show results consistent with the previous analysis of the No-decarbonisation ambition scenario, here we present results showing the impact of EMR, relative to the No-decarbonisation ambition scenario, but where traded carbon prices stay below the Carbon Price Floor (i.e. assuming that the prevailing carbon price faced by fossil fuel generators follows the path of the Carbon Price Floor after 2030).

233. Table 33 below shows that, under this alternative carbon price scenario post-2030, EMR has a slightly more negative net welfare impact in 2040 (-£10bn, compared to -£9.9bn under the central EMR case; both in NPV terms) and a much higher positive net welfare impact in 2049 (£19bn, compared to £2.7bn under the central EMR case; again, both in NPV terms).

Table 33: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to No-decarbonisation ambition scenario, alternative post-2030 carbon price assumptions (emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (2012-2030, real 2012)			
		EMR (appraisal values)		EMR (CPF)	
		2040	2049	2040	2049
Net Welfare	Carbon costs	40,000	68,000	49,000	120,000
	Generation costs	22,000	37,000	22,000	35,000
	Capital costs	-70,000	-99,000	-78,000	-130,000
	System costs	-3,400	-5,000	-3,600	-5,200
	Unserved energy	570	660	370	320
	Interconnectors	540	950	470	800
	Change in Net Welfare	**-9,900**	**2,700**	**-10,000**	**19,000**

Source: DECC modelling

Fossil fuel price scenarios

234. The robustness of EMR to different assumptions about fossil fuel prices has been tested using the 2013 update to DECC's annual fossil fuel price projections.[150] 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.

235. 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 100gCO_2/kWh; it does not compare the results relative to the No-decarbonisation ambition scenario. This therefore measures the efficiency of EMR as a tool for decarbonising the economy, rather than the relative impact of decarbonisation.

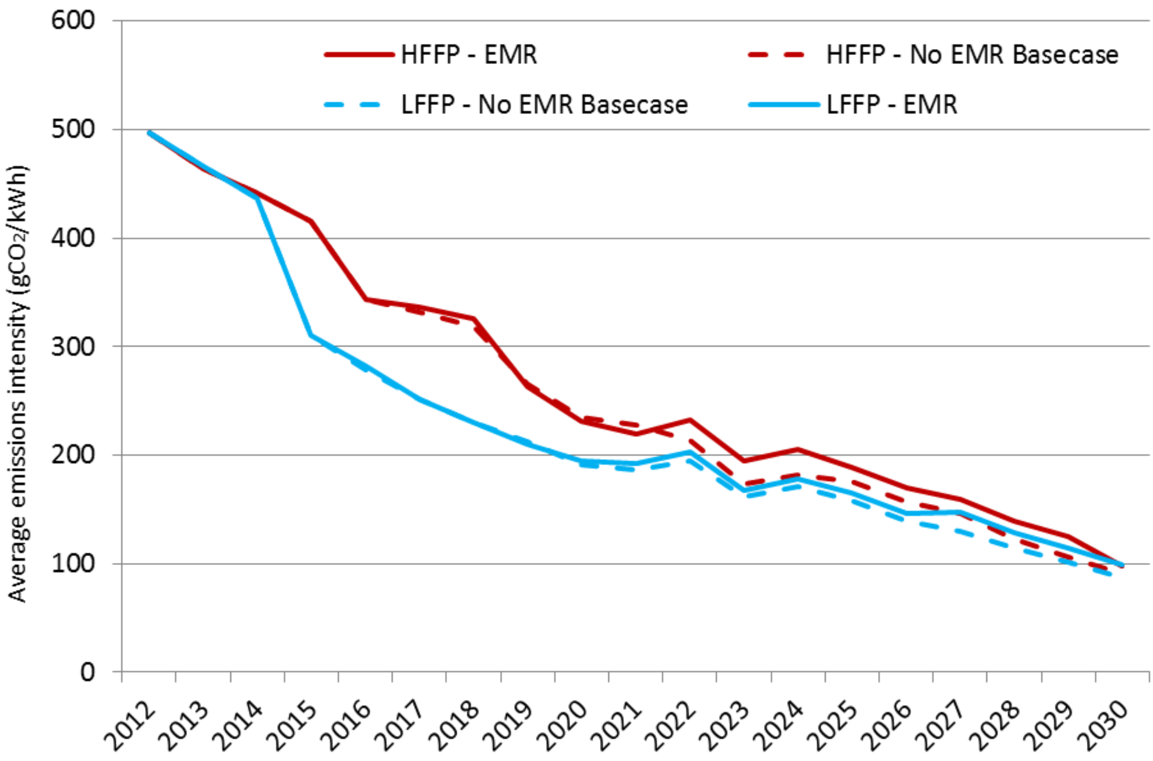
Decarbonisation profiles

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

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

proportion of unabated coal generation in the EMR high fossil fuel price sensitivity (discussed further below).[151]

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



Source: DECC modelling

Generation mix

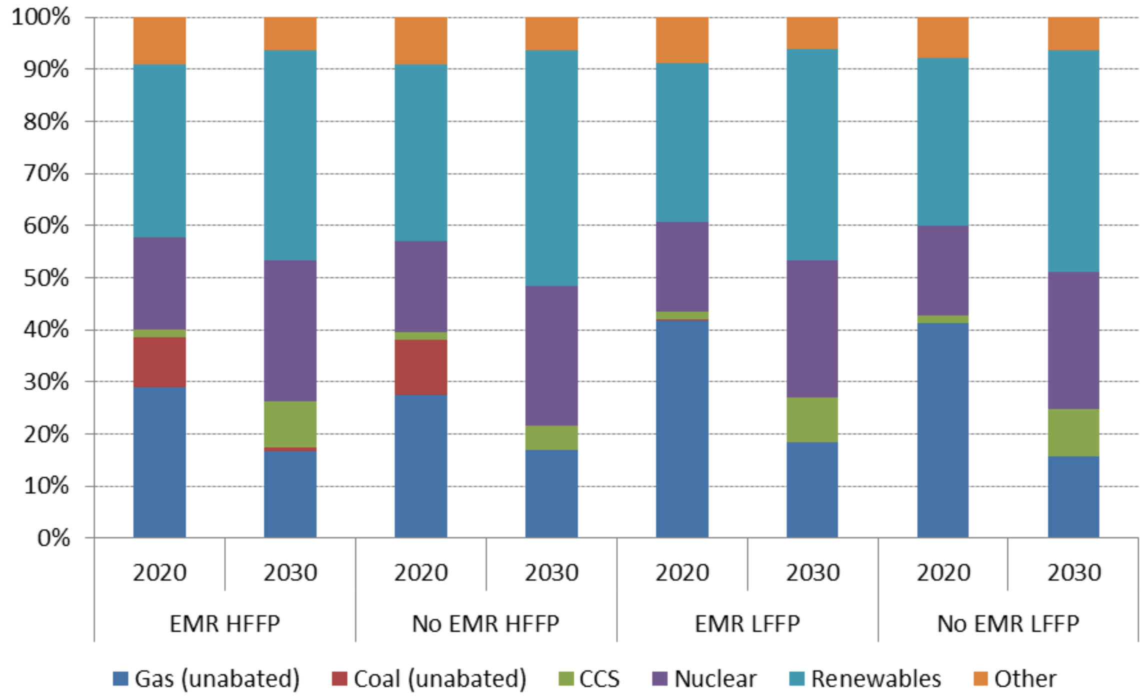
237. The chart below presents generation mix profiles for high and low fossil fuel price counterfactual scenarios, compared to the generation mix realised under the equivalent EMR scenario.

238. Under EMR with high fossil fuel prices, in 2020 unabated coal generation makes up a significant proportion of total generation. Under the counterfactual, as carbon prices to incentivise new nuclear do not increase until after 2020, the generation mix is broadly similar to that realised under the EMR scenario. By 2030, the carbon price necessary to incentivise new CCS plants in the late 2020's results in a higher proportion of renewable generation and lower CCS generation relative to the EMR high fossil fuel price scenario[152]. In the low fossil fuel price EMR scenario, a greater proportion of generation

[151] Reflecting the impact of fossil-fuel prices on wholesale prices, the carbon price used in the fossil-fuel price sensitivity counterfactuals differs to that used in the 100g counterfactual. Under the low fossil fuel price sensitivity the carbon price used to incentivise new nuclear is higher than that used in the central 100g counterfactual. In contrast the carbon price used under the high fossil fuel price sensitivity is initially lower.
[152] The high fossil fuel price counterfactual does not increase carbon prices to deliver the same number of new build CCS plants as achieved under EMR. In meeting the 2030 decarbonisation ambition, the use of the carbon

comes from unabated gas in 2020. Up to 2020 the low fossil fuel price counterfactual achieves a broadly similar generation mix to that realised under EMR. Up to 2030 the carbon price used to incentivise new nuclear in the low fossil fuel price counterfactual results in a broadly similar proportion generation, although the counterfactual results in higher renewable generation and lower unabated gas generation.[153]

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



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

Cost Benefit Analysis (CBA)

239. Table 34 presents the net welfare impact of the EMR package relative to the high and low fossil fuel price scenarios, for a carbon emission intensity in 2030 of 100gCO_2/kWh.

price in the counterfactual results in a higher proportion of renewable capacity and less CCS. As a result of the carbon price profile in the counterfactual and its impact on generation and new build decisions, the realised average emissions intensity in the counterfactual is lower than in the equivalent EMR scenario (91 and 98gCO_2/kWh respectively).

[153] As a result of the carbon price profile in the counterfactual and its impact on generation new build decisions (in particular biomass generation in the late 2020s) the realised average emissions intensity in the counterfactual is lower than in the equivalent EMR scenario (88 and 99gCO_2/kWh respectively).

High fossil fuel prices

240. Under high fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of £8.6bn up to 2030 relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). The largest benefit of EMR comes from lower capital costs and lower unserved energy, relative to the counterfactual, although the capital cost benefit will reflect differences in the generation mix used to meet 2030 decarbonisation ambitions under EMR and the counterfactual (as discussed above).

Low fossil fuel prices

241. Under low fossil fuel prices, EMR remains an effective tool to achieve decarbonisation, generating a positive impact of £10.6bn up to 2030 relative to the counterfactual (i.e. a similar generation mix to EMR, achieved using existing instruments). The largest benefit comes from lower capital costs under EMR.

Table 34: Change in Net Welfare (NPV) – EMR (CfD and Capacity Market) compared to basecase, fossil fuel price scenarios (emissions intensity in 2030 = 100gCO_2/kWh)

		NPV, £m (2012-2030, real 2012)		
		100g basecase	High FF prices	Low FF prices
Net Welfare	Carbon costs	-1,700	-1,200	-970
	Generation costs	1,600	-650	1,300
	Capital costs	8,200	7,900	7,400
	System costs	160	700	-200
	Unserved energy	1,700	1,800	1,600
	Interconnectors	1,400	830	2,000
	Change in Net Welfare	**11,000**	**9,300**	**11,000**
	Change in Net Welfare*	**10,700**	**8,600**	**10,600**

Source: DECC modelling – Figures rounded to two significant figures, totals may not sum due to rounding
**Inclusive of administrative costs of approximately £0.6bn up to 2030*

Annex F: Delivery Plan scenarios – reflecting uncertainty

242. As part of the final Delivery Plan, National Grid ran a number of scenarios looking at the impact of changes to a number of key input variables.[154] These scenarios test the effect of these inputs on output metrics such as total LCF spend in 2020/21 and the renewables generation percentage. Assigning robust probabilities to future outcomes for the key input variables is very difficult. Therefore the probabilities associated with these scenarios were not calculated. Instead the scenarios were intended to illustrate a range of plausible outcomes, and are not intended to cover the full range of possible outcomes.[155]

Scenarios

243. In the December Delivery Plan the three core scenarios presented in the July draft Delivery Plan publication were refined into a single scenario, called 'Scenario 1'. Alongside this scenario a range of other scenarios were presented. These scenarios were developed to consider a wide range of plausible uncertainties over the scenario period, and are discussed in more detail in Annex D of the Electricity Market Reform Delivery Plan.[156] This section summarises the scenarios related to three key input variables.

- **Fossil Fuel Prices:** The low fossil fuel prices scenario uses the low scenario from DECC's fossil fuel price projections.[157] The gas price used represents the lower end of estimates of the long run marginal cost of gas supplies to Europe. It does not represent an absolute floor on gas prices, but is instead a plausible low price scenario.

- **Electricity Demand:** The high and low demand scenarios use outputs from DECC's Energy Model. They are derived from Monte Carlo simulation of demand for energy, taking into account variation in economic growth, fuel prices, and the effectiveness of energy efficiency policies. The high demand scenario corresponds to the upper end of the 95% confidence interval, the low demand scenario to the lower end. These scenarios do not represent absolute maximum or minimum demands but instead are plausible low and high demand scenarios.

- **Technology costs:** The high and low technology cost scenarios use a +/- 10% variation in capital and predevelopment costs to represent a plausible range of future technology costs, but it is recognised that future cost variation could fall outside this range.

[154] See Annex D, https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan
[155] For further detail on Modelling Quality Assurance see Annex G, https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan
[156] https://www.gov.uk/government/publications/electricity-market-reform-delivery-plan
[157] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

244. All scenarios include a low-carbon instrument (the CfD) and a Capacity Market, combined with an Emissions Performance Standard (EPS). All scenarios aim to stay within the LCF profile up to 2020/21. All scenarios generate at least 30% of UK electricity from renewable sources by 2020 and, apart from the Higher Biomass Conversions scenario, assume around 1.7 GW of biomass conversion capacity by 2020.

245. All scenarios assume maximum Strike Prices for renewable technologies at the levels as set out in the December Delivery Plan. Technologies affected by constrained allocation would be likely to see their actual Strike Price set at a lower value than the maximum. This has been captured within the modelling.

Scenario 1

246. Scenario 1 spends around £7bn in 2020/21 and achieves around 33% renewable electricity in 2020.

Key results:

- The UK LCF spend is £7.0bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 33% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 10.2 GW offshore wind, 11.9 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions.

247. This scenario has a broadly balanced range of technologies and meets all ambitions.

Low Technology Costs scenario

248. This scenario tests the impact on the generation mix and support costs of lower technology costs as compared to those assumed in Scenario 1. The scenario assumes that low, central and high capital costs are 10% lower across all technologies. This is to reflect a downward risk/uncertainty in capital costs. This scenario assumes a modest reduction in Strike Prices from 2019 to reflect the lower technology costs.

Key results:

- The UK LCF spend is £7.6bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 36% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 12.2 GW offshore wind, 13.0 GW onshore wind (plus 0.7 GW on Scottish Islands) and 1.7 GW of biomass conversions. In addition large solar photo-voltaic increases to 4.0 GW from 2.7 GW in Scenario 1.

249. This scenario represents unexpectedly lower capital costs for generation technologies which lead to greater LCF costs this decade, due to higher deployment. Since costs are lower the Strike Prices are potentially over-rewarding developers. In order to restrict the LCF spend in 2020/21 modest reductions in Strike Prices in 2019/20 are required for some technologies.

High Technology Costs scenario

250. This scenario tests the impact on the generation mix and support costs should technology costs turn out to be higher than those assumed in Scenario 1. The scenario assumes that low, central and high capital costs are 10% higher across all technologies. This is to reflect an upward risk/uncertainty in capital costs. This scenario assumes a modest increase in Strike Prices from 2019 to reflect the higher technology costs.

Key results:

- The UK LCF spend is £6.5bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 30% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 8.1 GW offshore wind, 10.9 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions. In addition large solar photo-voltaic decreases to 2.4 GW from 2.7 GW in Scenario 1.

251. This scenario represents unexpectedly higher capital costs for generation technologies which lead to lower LCF costs this decade, due to lower build rates. In order to achieve at least 30% of renewable generation in 2020 modest increases in Strike Prices in 2019/20 are required for some technologies.

High Demand scenario

252. This scenario tests the impact on the generation mix and support costs of demand being higher than anticipated in Scenario 1. It uses DECC's high demand projections.

Key results:

- The UK LCF spend is £7.6bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 31% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 11.6 GW offshore wind, 11.9 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions.

253. This scenario represents a potential outcome with higher electricity demand. This requires more renewable generation to achieve at least 30% of renewable electricity in 2020. This scenario shows how potential demand uncertainty has been considered.

Low Demand scenario

254. This scenario tests the impact on the generation mix and support costs of demand being lower than anticipated in Scenario 1. It uses DECC's low demand projections.

Key results:

- The UK LCF spend is £6.8bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 35% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 9.1 GW offshore wind, 11.9 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions.

255. This scenario represents a potential outcome with lower electricity demand. This requires less renewable generation to help meet the overall 2020 renewable energy target. This scenario shows how potential demand uncertainty has been considered.

High Fossil Fuel Prices scenario

256. This scenario tests the impact on the generation mix and support costs of fossil fuel prices being higher than anticipated in Scenario 1. It uses DECC's fossil fuel price projections and demand consistent with higher fossil fuel prices.

Key results:

- The UK LCF spend is £6.5bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 34% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 10.7 GW offshore wind, 11.9 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions.

257. This scenario represents a potential outcome under high fossil fuel prices; in particular coal generation is favoured over gas generation. Strike Prices this decade are the same as Scenario 1 but renewable deployment is higher due to expectation of higher long term wholesale prices beyond the CfD contract period. Also higher wholesale prices reduce CfD top up payments. Thus, in spite of the lower LCF spend; the renewable generation percentage in 2020 is higher.

Low Fossil Fuel Prices scenario

258. This scenario tests the impact on the generation mix and support costs of fossil fuel prices being lower than anticipated in Scenario 1. It uses DECC's fossil fuel price projections and demand consistent with lower fossil fuel prices.

Key results:

- The UK LCF spend is £7.4bn in 2020/21, within the LCF cap.
- In 2020 the UK achieves 31% of generation from renewable sources.
- The key technologies see deployment levels in 2020 of 9.3 GW offshore wind, 11.3 GW onshore wind (plus 0.4 GW on Scottish Islands) and 1.7 GW of biomass conversions.

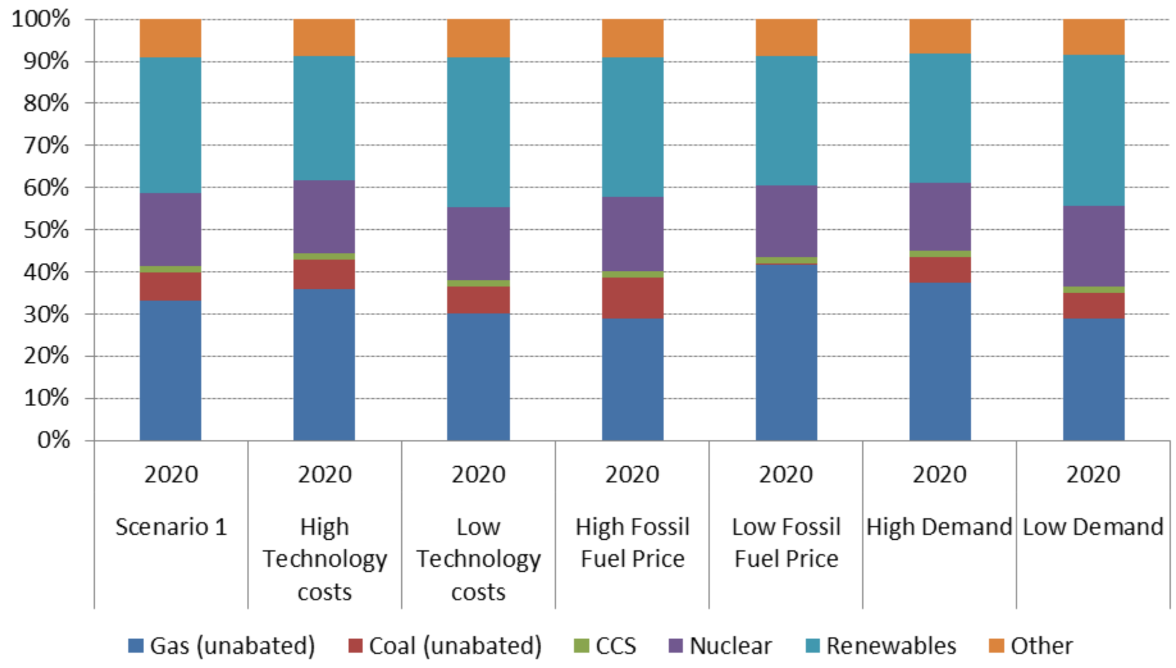
259. This scenario represents a potential outcome under low fossil fuel prices; in particular gas generation is favoured over coal generation. This leads to a lower wholesale price, as gas is the marginal plant with lower running costs. This is in turn increases the top up payments required under the CfD. Thus, given the high LCF spend the renewable generation percentage in 2020 is lower. This potentially presents risks for the electricity portion of the 2020 renewable energy target.

Conclusions

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

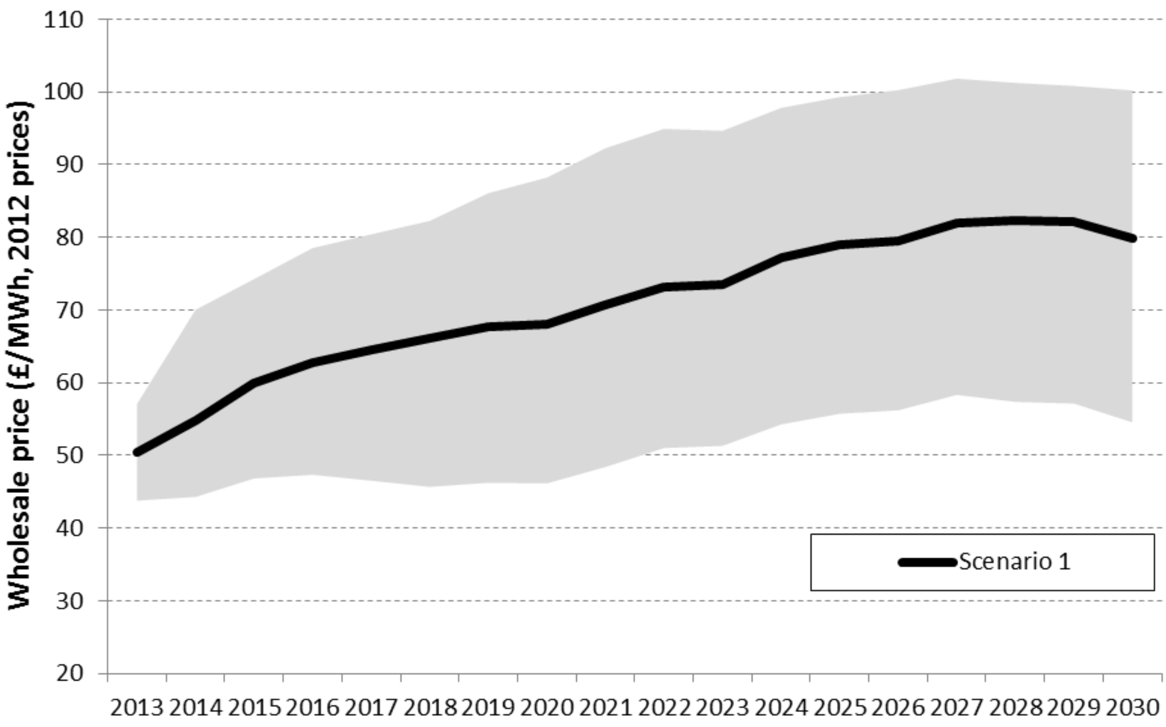
261. The outcomes outlined in the main body of this impact assessment therefore represent a specific state of the world based on central assumptions. However, we have undertaken sensitivity analysis around a range of potential alternative scenarios (2030 decarbonisation levels, fossil fuel prices, post-2030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

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



Source: DECC modelling

Chart 20: Variation in wholesale prices (2013-2030) – EMR, compared to high/low Fossil Fuel Price scenarios



Source: DECC modelling