Title: Electricity Market Reform – ensuring electricity security of supply and promoting investment in low-carbon generation	Impact Assessment (IA)
IA No: DECC0104	**Date:** 26/11/2012
Lead department or agency: DECC	**Stage:** Final
	Source of intervention: Domestic
	Type of measure: Primary legislation
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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**
£1.3bn to £7.4 bn	-	-	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 low-carbon intermittent generation.

What are the policy objectives and the intended effects?

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

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

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

This IA presents updated analysis of the combined impact of the identified lead policy options to deliver low-carbon investment and mitigate against risks to security of supply.

The revised analysis presents Cost Benefit Analysis (CBA) and price and bill impact analysis as a result of updated input and modelling assumptions for the lead policy package. The new analysis uses DECC's in-house Dynamic Dispatch Model (DDM)[3], and rather than a point estimate, presents a range representing possible counterfactuals that meet the same decarbonisation objectives.

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, but with no affordability constraint. This set of assumptions is set out in Annex A. It has not been possible to reflect the very recent decision on the levy control framework or the OBR growth figures to be published alongside the Autumn Statement.

[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 accompanying the Energy Bill.
[2] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2176-emr-white-paper.pdf
[3] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/analytic_projs.aspx

However, as outlined in this IA, we believe the EMR framework and policy suite are robust to various states of the world as reflected in the range of scenarios included in this IA.

In addition, in the Energy Bill the Government will take a power to set a decarbonisation target range for the power sector in secondary legislation. The power will provide for flexibility in the setting or reviewing of the range by consideration of wider economic factors. The decision to set a target range for power sector carbon emissions in 2030 will be taken when the Committee on Climate Change has provided advice on the 5th Carbon Budget in 2016, which will cover the corresponding period (2028 – 2033), and once the Government has set that budget. The power will not be exercised until the Government has set the 5th Carbon Budget.

The analysis presented in the Energy Bill Impact Assessment uses 100gCO_2/kWh as an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments. The design of EMR and Contracts for Difference will lower the cost of financing the large investments we will need in electricity infrastructure irrespective of the level of decarbonisation in the sector to 2030.

To reflect the decision to take a power to set a decarbonisation target range (and the decision on the levy control framework) and show the wider range of costs and benefits of EMR, the Impact Assessment will be updated early in the New Year to include analysis of decarbonising the power sector to an average emissions level of 200gCO_2/kWh in 2030. In addition, the update will include a range of fossil fuel price scenarios and sensitivity analysis of a 50gCO_2/kWh emissions intensity level.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:**					
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**
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: 28/11/2012

Contents

Section 1 Overview

1. The Summary Impact Assessment (IA) published alongside the Draft Energy Bill in May 2012 stated that the analysis of the Feed in Tariff Contract for Differences (FiT CfD) and Capacity Market would be revised in Autumn 2012 following the publication of DECC's annual updated assumptions on technology costs, fossil fuel prices, and demand. In addition, the modelling would be migrated to a DECC in-house Dynamic Dispatch Model (DDM) and would incorporate further methodological changes to enhance the robustness of the analysis assessing the Capacity Market.[4]

2. 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, but with no affordability constraint. This set of assumptions is set out in Annex A. It has not been possible to reflect the very recent decision on the levy control framework or the OBR growth figures to be published alongside the Autumn Statement. However, as outlined in this IA, we believe the EMR framework and policy suite are robust to various states of the world as reflected in the range of scenarios included in this IA.

3. In addition, in the Energy Bill the Government will take a power to set a decarbonisation target range for the power sector in secondary legislation. The power will provide for flexibility in the setting or reviewing of the target range by consideration of wider economic factors. The decision to set a target range for carbon emissions in 2030 will be taken when the Committee on Climate Change has provided advice on the 5th Carbon Budget in 2016, which will cover the corresponding period (2028 – 2033), and once the Government has set that budget. The power will not be exercised until the Government has set the 5th Carbon Budget.

4. The analysis presented in the Energy Bill Impact Assessment uses 100gCO_2/kWh as an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments. The design of EMR and Contracts for Difference will lower the cost of financing the large investments we will need in electricity infrastructure irrespective of the level of decarbonisation in the sector to 2030.

5. To reflect the decision to take a power to set a decarbonisation target range (and the decision on the levy control framework) and show the wider range of costs and benefits of EMR, the Impact Assessment will be updated early in the New Year to include analysis of decarbonising the power sector to an average emissions level of 200gCO_2/kWh in 2030. In addition, the update will include a range of fossil fuel price scenarios and sensitivity analysis of a 50gCO_2/kWh emissions intensity level.

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[4] A description of DECC's Dynamic Dispatch Model is available here: http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/5425-decc-dynamic-dispatch-model-ddm.pdf. Further details can also be found in Annex A.

6. Previous EMR Impact Assessments have focused on analysing which policy options would best deliver our decarbonisation, security of supply and affordability objectives. The key conclusions from previous impact assessments are:

   - The CfD is the preferred instrument to deliver investment in low carbon technology, compared to alternatives including a premium feed in tariff.[5]

   - A Capacity Market is the preferred instrument to mitigate security of supply risks, compared to alternatives including a strategic reserve and doing nothing.[6]

7. Accompanying this Impact Assessment is a separate assessment providing the analytical evidence behind the choice of an Administrative Capacity Market, compared to alternatives, most notably a Reliability Market and doing nothing.

8. Section 2 of this IA presents updated Cost Benefit Analysis (CBA) and price and bill impact analysis for the EMR lead policy package, a CfD FiT with a Capacity Market. In this analysis we have updated our approach to assessing the costs and benefits of EMR, the details of which are set out below. As a result net welfare figures have changed from previous published estimates. However, the relative ordering of the policy choices has not changed.[7] Section 3 provides an update of the payment model, and its effect on cost of capital.

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[5] This decision was assessed in the IA accompanying the White Paper in 2011 (http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2180-emr-impact-assessment.pdf), and was represented in the IA accompanying the draft Energy Bill in May 2012. Section 3 of this IA provides a further overview of the analysis to support the CfD.

[6] This decision was first presented in the December 2011 Technical Update to EMR (http://www.decc.gov.uk/assets/decc/11/consultation/cap-mech/3883-capacity-mechanism-consultation-impact-assessment.pdf).

[7] The conclusions on the relative attractiveness of the different options as set out in the EMR consultation and IA and EMR White Paper and IA are considered robust and therefore there is no need to update the full analysis on all the potential policy packages assessed in previous IAs. Instead the new analysis has sought to update and present the impact of the lead package only.

Overview of key estimates

Net Present Value (NPV) – Impact of EMR policy package relative to basecases A & B

(2012 prices)	2012-2030	2012-2040	2012-2049
NPV £bn	**+£1.3 to £7.4**	**+£4.6 to £14**	**+£6.1 to £16**
Of which: Contracts for Difference	*+£3.1 to £9.1*		
Of which: Financing Impact	*+1.7*		
Of which: Tech Mix impact	*+£1.3 to £7.4*		
Of which: Capacity Market	-£1.7*		

*2030 NPV estimates also include expected administrative costs of approximately £0.4bn (estimates post 2030 do not); * the figure for the capacity market is based on assumption in counterfactual of perfectly functioning energy market (see below)*

Price and Bill impact – Impact of EMR policy package relative to basecases A & B (Domestic Electricity bills, annual average)

Time Period	Impact of EMR on Electricity Bills, relative to basecases (real 2012 prices)
2016-2030	**-£32 to -£61 (-5% to -9%)**

- In undertaking the cost-benefit analysis for the EMR with the CfD and a Capacity Market, the policy package is compared to a basecase counterfactual, without the EMR package. The policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown. To reflect the uncertainty over what policies might be used in practice, alternative ways of achieving the same decarbonisation ambition using existing policy instruments (e.g. Renewables Obligation and carbon pricing) are modelled. Reflecting the uncertainty over the basecase, the impact of EMR is reported as a range.

- 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.

- In the Energy Bill the Government will take a power to set a decarbonisation target range for the power sector in secondary legislation. The power will provide for flexibility in the setting or reviewing of the range by consideration of wider economic factors. The decision to set a target range for power sector carbon emissions in 2030 will be taken when the Committee on Climate Change has provided advice on the 5th Carbon Budget in 2016, which will cover the corresponding period (2028 – 2033), and once the Government has set that budget. The power will not be exercised until the Government has set the 5th Carbon Budget.

- The analysis presented in the Energy Bill Impact Assessment uses 100gCO_2/kWh as an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments. The design of EMR and Contracts for Difference will lower the cost of financing the large investments we will need in electricity infrastructure irrespective of the level of decarbonisation in the sector to 2030.

- To reflect the decision to take a power to set a decarbonisation target range and show the wider range of costs and benefits of EMR, the Impact Assessment will be updated early in the New Year to include analysis of decarbonising the power sector to an average emissions level of 200gCO_2/kWh in 2030. In addition, the update will include a range of fossil fuel price scenarios and sensitivity analysis of a 50g emissions intensity level.

- In a scenario where power sector emissions are 100gCO_2 in 2030, the Cost Benefit Analysis (CBA) suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers up to 2030 and beyond. EMR could lead to an improvement in welfare of between £1.3bn and £7.4bn up to 2030, with larger benefits up to 2050.

- The key benefit of decarbonising using EMR is in terms of reducing financing costs for investors and minimising generator rents under high wholesale prices. The greater revenue certainty from the contracts for difference allows financing at a lower cost, and our evidence set out in the EMR White Paper suggested this effect could be up to a 1.5% reduction in the cost of capital for developers, depending on the technology type. In the updated analysis we have used updated hurdle rate and hurdle rate reductions (presented in Annex A). With these updates we have valued this benefit to be around £1.7bn (including the expected administrative costs of CfDs).

- There will also be impacts on the generation mix and including these effects the overall net impact rises to between £3.1 billion and £9.1 billion.

- The overall net impact reflects a net loss from the Capacity Market of -£1.7 billion. However, this modelled figure measures the benefits of a Capacity Market against a perfectly operating energy market. In reality the market may not deliver the optimal level of investment due to a range of market failures, including market prices that do not reflect the full scarcity value of electricity and the difficulty investors face in making optimal investment decisions in the face of volatile electricity prices. This is reflected in the Capacity Market impact assessment, that accompanies this EMR impact assessment.

- For domestic consumers, EMR has the potential to reduce average annual household electricity bills by between 5% and 9% (£32 to £61) over the period 2016-2030, relative to a basecase which achieves the same decarbonisation level of 100gCO_2/kWh using existing policy instruments. The impact on average bills for businesses and energy intensive industries will be similar.

Section 2 Updated Cost Benefit Analysis (CBA)

2.1 Rationale for intervention

2.1.1 Decarbonisation

9. 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.

10. In the Energy Bill the Government will take a power to set a decarbonisation target range for the power sector in secondary legislation. The power will provide for flexibility in the setting or reviewing of the target range by consideration of wider economic factors. The decision to set a target range for power sector carbon emissions in 2030 will be taken when the Committee on Climate Change has provided advice on the 5th Carbon Budget in 2016, which will cover the corresponding period (2028 – 2033), and once the Government has set that budget. The power will not be exercised until the Government has set the 5th Carbon Budget.

11. 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. The electricity system needs to be substantially decarbonised by the 2030s, particularly if it is to play its part in decarbonising the heat and transport sectors in the 2030s and beyond.

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

13. 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.

14. 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. There are currently no scalable low-carbon alternatives to flexible 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.

15. 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. As a consequence, investment in conventional capacity is less risky than investment in low-carbon capacity.

16. 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.

17. 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 inclusion of the current Carbon Price Floor trajectory.[8]

18. 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.

19. 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. The general consensus is, therefore, that 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

20. 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 infrequent; and there is currently a lack of a responsive demand side as consumers do not choose the

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

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 Meters, which are expected to be rolled out by 2019, should help to enable a more responsive demand side but it is anticipated that it would take time for a real-time responsive market to evolve.

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

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

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

23. In the Electricity Market Reform White Paper[9], we set out the potential market and regulatory failures in the current market that could prevent these signals from being realised.

24. 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.

25. 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.

26. 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.

[9] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2176-emr-white-paper.pdf

- 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 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.

27. The latter regulatory risk is exacerbated if there are significant **barriers to entry**, effectively restricting the number of participants in the wholesale electricity market. As margins become tighter and prices more volatile in the future, market participants may have more opportunities to withhold supply to drive up prices – particularly so as demand is inelastic and so there are potentially significant gains from withholding at times of scarcity. This could result in a greater likelihood of gaming in the energy market and difficulties in differentiating such gaming from legitimate prices, which would increase the risk that the Government may want to intervene in the wholesale market to cap prices. This has not previously been a significant concern as prices historically have not risen above £938/MWh[10] as a result of excess capacity on the system depressing wholesale market prices. In the future, analysis suggests that prices could need to rise to up to £10,000/MWh (or even higher) for short periods to allow flexible plant to recover investment. Investors are concerned that Government or the regulator would intervene if this were to happen. The perception of this regulatory risk could increase 'missing money' and under-investment.

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

2.2 Option under consideration

28. The modelling work for EMR has estimated the overall costs and benefits to society, or 'net welfare', of the various policy options. Net welfare is measured in terms of the net present value (NPV), which is the sum of all the social costs (-) and benefits (+) associated with the policy, with an adjustment made to reflect the time at which the different costs and benefits occur (known as discounting). This uses the Green Book social discount rates.[11]

29. 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.[12]

2.2.1 EMR Package

30. This IA presents an updated analysis of the lead EMR package modelled against a basecase. The EMR package includes a low-carbon instrument (the CfD) and a Capacity Market, combined with an Emissions Performance Standard (EPS). Carbon pricing is included in the basecase against which the policy package is assessed.[13]

31. 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.

32. In the Energy Bill the Government will take a power to set a decarbonisation target range for the power sector in secondary legislation. The power will provide for flexibility in the setting or reviewing of the range by consideration of wider economic factors. The decision to set a target range for power sector carbon emissions in 2030 should be taken when the Committee on Climate Change has provided advice on the 5th Carbon Budget which will cover the corresponding period (2028 – 2033), and once

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

[12] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2180-emr-impact-assessment.pdf & http://www.decc.gov.uk/assets/decc/Consultations/emr/1042-ia-electricity-market-reform.pdf

[13] 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: http://www.decc.gov.uk/assets/decc/statistics/analysis_group/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: http://www.decc.gov.uk/en/content/cms/meeting_energy/aes/impacts/impacts.aspx. Overall, it shows that by 2020 households will, on average, save £94 (7%) on their energy bills, compared to what they would have paid in the absence of government intervention.

the Government has set that budget. The power will not be exercised until the Government has set the 5th Carbon Budget.

33. The December 2011 Carbon Plan states that during the 2020s, cuts in emissions from the power sector are necessary to keep us on a cost effective path to 2050.[14] The Committee on Climate Change (CCC) has recommended decarbonising the power sector to 50gCO_2/kWh by 2030. The Government will take a decision on whether to set a decarbonisation target range for the power sector once the CCC has provided advice on the 5th carbon budget.

34. The analysis presented in the Energy Bill Impact Assessment uses 100gCO_2/kWh as an illustrative level of decarbonisation in the power sector, consistent with previously published EMR impact assessments.[15] The design of EMR and Contracts for Difference will lower the cost of financing the large investments we will need in electricity infrastructure irrespective of the level of decarbonisation in the sector to 2030.

35. To reflect the decision to take a power to set a decarbonisation target range and show the wider range of costs and benefits of EMR, the Impact Assessment will be updated early in the New Year to include analysis of decarbonising the power sector to an average emissions level of 200gCO_2/kWh in 2030. In addition, the update will include a range of fossil fuel price scenarios and sensitivity analysis of a 50gCO_2/kWh emissions intensity level.

36. The modelling results presented show CfDs continuing to be issued post 2030. These results depend strongly on the particular combination of assumptions made, and will be sensitive to many factors, including required levels of decarbonisation, levels of investor foresight, technology learning rates and underlying fossil fuel and carbon prices. While Government envisages eventual exit from CfDs, the focus of this IA is not on projecting the precise point of exit, but on assessing the EMR package relative to other policy options for meeting Government's long-term decarbonisation and security of supply goals. [16]

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[14] http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/carbon-plan/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf

[15] Although this is not reflected in the counterfactual in previous IAs

[16] As noted in the EMR Policy Overview Document, Government envisages that, by the late 2020s/beyond, its role in the electricity market will largely be restricted to the setting of high-level objectives for diversity and security of supply. The following conditions will need to be in place for Government to stop issuing CfDs, and for the wholesale market (and Capacity Market if required) to support ongoing investment to ensure decarbonisation and security of supply goals are met at least cost:

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

Contracts for difference

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

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

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

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

40. As a result of lower exposure to fossil fuel price risk and the revenue certainty which this gives, the cost of capital for investors in low carbon generation is lower under a CfD than under a Premium FiT. In the White Paper IA this is quantified: financing costs are expected to be lower by £2.5bn over the period to 2030 as a whole under a CfD than a Premium FiT. For this latest analysis, the hurdle rates are based on data from Oxera (2011) and Arup (2011).[17] The hurdle rate reductions are derived from the DDM model in conjunction with Oxera's maximum possible hurdle rate reductions.[18] They are

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[17] Available at: http://hmccc.s3.amazonaws.com/Renewables%20Review/Oxera%20low%20carbon%20discount%20rates%20180411.pdf and http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf

[18] Oxera conclude that targeted support for a technology could reduce hurdle rates for "non-risky" mature technologies, e.g. CCGTs by 0-2% and for more risky, less mature technologies e.g. offshore wind by 2-3%. To calculate the impact of the reduction in risk as a result of CfDs, a baseline was first run with current RO banding levels. This was done using the stochastic mode in DDM with each simulation including inter alia a different outturn for fossil fuel prices. This gave a distribution of returns to investment in each technology under the RO. This was then compared to a run with CfDs to get a new distribution of returns. The summary measure of risk used to compare the two distributions was the downside spread in returns, measured by the

presented in Annex A and show reductions up to a maximum of 1.2% depending on the technology type.

41. It is assumed that EMR measures are generally deployed to achieve a least cost decarbonisation pathway. However in order to take account of uncertainty in the future costs of alternative technologies, for the purposes of modelling it has been assumed that EMR supports a broader diversity of technologies to 2030 than would be the case based purely on current central projections for generation costs, demand and fossil fuel prices to 2030. There is uncertainty about how the electricity sector will develop in the long term and supporting a diverse generation mix in the medium term will help manage some of the technology risks associated with achieving the sector's share of the 2050 economy-wide 80% decarbonisation target under a range of different future scenarios. However, over time, it is expected that the benefits of technology-neutral competition can be brought in, moving to competitive price-setting for low carbon technologies.

Capacity Market

42. 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.

43. The lead form of Capacity Market assessed here as part of the overall lead EMR package is an Administrative Capacity Market (where providers are subject to administrative penalties in addition to energy market incentives if they fail to be available at times of scarcity and where providers are able to keep any revenues they earn in the energy market).

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

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

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spread between 10% and the median of returns. The reduction in hurdle rate as a result of the policy is then calculated based on the proportional reduction in this risk measure from the baseline run i.e. if risk is reduced for a risky technology by half, then the effect on hurdle rates is a reduction of 2.5 (mid-point of Oxera range) multiplied by half = 1.25%.

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

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

2.2.2 Basecase

48. In undertaking the cost-benefit analysis for EMR with the CfD and a Capacity Market, the policy package is compared to a basecase counterfactual, without the EMR package. The basecase includes existing policies such as the Renewables Obligation (RO) and the EU-ETS and policies which the Government has committed itself to delivering, such as the Carbon Price Floor (CPF) policy announced in the Budget 2011.[19]

Security of supply under the basecase

49. Modelling of the basecases assumes that there is no "missing money" and that energy prices rise to the Value of Loss Load (VoLL) if load is shed. This means that an energy-only market in the basecases delivers the "economically efficient" capacity margin albeit based on the simplifying assumption that energy investors have perfect foresight of future energy demand up to five years ahead and that energy prices rise to the VoLL (assumed to be £10,000/MWh) at times of scarcity. Modelling also assumes that investors have certainty about demand when deciding whether to build capacity.

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

[19] 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: http://www.decc.gov.uk/assets/decc/statistics/analysis_group/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: http://www.decc.gov.uk/en/content/cms/meeting_energy/aes/impacts/impacts.aspx. Overall, it shows that by 2020 households will, on average, save £94 (7%) on their energy bills, compared to what they would have paid in the absence of government intervention.

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

Modelling assumptions on decarbonisation, security of supply and renewable objectives

Renewables targets under the basecase

51. Under the basecase the EU target for 15% renewable energy consumption across the UK economy by 2020 is assumed to be met with around 30% of electricity generated coming from renewables by 2020.[20] The latest modelling is in line with stated ambitions in the RO banding review for renewable domestic deployment in 2020.[21] Renewable policy objectives after this date vary across the different basecase scenarios (discussed further below).

Decarbonisation ambitions under the basecases

52. 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.[22] We are therefore now comparing the EMR package against alternatives which meet a similar decarbonisation profile as met under EMR. This impact assessment principally assumes the electricity sector reaches an emissions intensity of around 100gCO_2/kWh in 2030, 50gCO_2/kWh in 2040 and 25gCO_2/kWh in 2049. Please see paragraph 79 for indicative analysis on other decarbonisation sensitivities.

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

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

[21] 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, but with no affordability constraint. This set of assumptions is set out in Annex A. It has not been possible to reflect the very recent decision on the levy control framework or the OBR growth figures to be published alongside the Autumn Statement. We will update the analysis early in the New Year.

[22] Previous analysis of EMR 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 assumption 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 and now updated. 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).

54. Previous modelling has assessed EMR up to 2030. The updated analysis has been able to assess the impact of EMR up to 2049. However, extending the analysis beyond 2030 creates a number of modelling complexities. In particular the difficulty in defining the policy environment in a counterfactual world without EMR. This was also true of earlier modelling. However, as previous modelling assessed EMR up to 2030, and modelled a basecase where decarbonisation ambitions are not met, earlier modelling focused on current Government commitments and therefore a continuation of the RO and carbon pricing based on existing commitments.[23]

55. The policies Government might use to meet its decarbonisation ambitions in a world without EMR are unknown.[24] The basecases presented below have been designed to achieve a similar decarbonisation profile to that realised under EMR using existing policy instruments, namely the RO and carbon pricing. There are a number of different ways the RO and carbon pricing could be combined to achieve Government's decarbonisation ambitions. Due to this uncertainty, two separate hypothetical basecases have been developed, leading to a range of NPV estimates below. The two scenarios are defined as:

- **Basecase A**: Carbon prices increase pre 2030 to achieve the same profile in nuclear new build as achieved under EMR. To realise deployment of the first new nuclear plants as under EMR, the carbon price is increased to £100 per tonne in 2019. The carbon price value is held at this level until an assumed trajectory of carbon prices towards the Interdepartmental Analysts' Group (IAG) high appraisal carbon price value in 2049 reaches £100/tonne after 2030, at which point the carbon price is assumed to increase towards the IAG high appraisal carbon price in 2049.[25] The RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies.

[23] Carbon pricing is currently based on a combination of the EU-ETS and the carbon price floor (CPF). The CPF was introduced in the Budget in March 2011 (and to be 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 (2013-2020) and then a linear path to £70/tCO_2 (2020-2030).

[24] As the focus of these no-EMR counterfactual basecases is EMR's relative efficiency in meeting the 2030 decarbonisation ambition, in all basecases the 2040 and 2049 emission intensity levels are met in the same way. Carbon prices increase post 2030 to lead to a long-term emissions intensity in 2040 and 2049 consistent with that achieved under EMR. The profile of carbon prices are not the same across all basecases, however the end point is assumed to be the same. Specifically, in 2049 carbon prices are assumed to be equal to the high appraisal carbon price presented in IAG guidance (in all scenarios it resulted in an emissions intensity roughly consistent with the level achieved under EMR).

[25] For further details see DECC (2009) *Carbon Valuation in UK Policy Appraisal: A Revised Approach,* available at https://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/carbon%20valuation/1_20090715105804_e_@@_carbonvaluationinukpolicyappraisal.pdf & http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

- **Basecase B**: Carbon prices increase pre 2030 to achieve the same profile in nuclear new build and a similar profile in CCS new build as under EMR. To realise deployment of the first nuclear plants as under EMR, the same carbon price as in the scenario above is used. However, to generate investment in CCS technology by the end of the 2020s the carbon price must rise to around £180/tonne by 2030. The carbon price value is held at this level until an assumed trajectory of carbon prices towards the Interdepartmental Analysts' Group (IAG) high appraisal carbon price value in 2049 reaches £180/tonne after 2030, at which point the carbon price is assumed to increase towards the IAG high appraisal carbon price in 2049.[26] The RO is used to achieve the 2020 renewable target and meet the 2030 decarbonisation ambition with a balanced range of renewable technologies.

56. Table 1 provides a summary of the different outcomes and policy environments assumed under each basecase scenario.

Table 1: Summary of basecase A&B assumptions

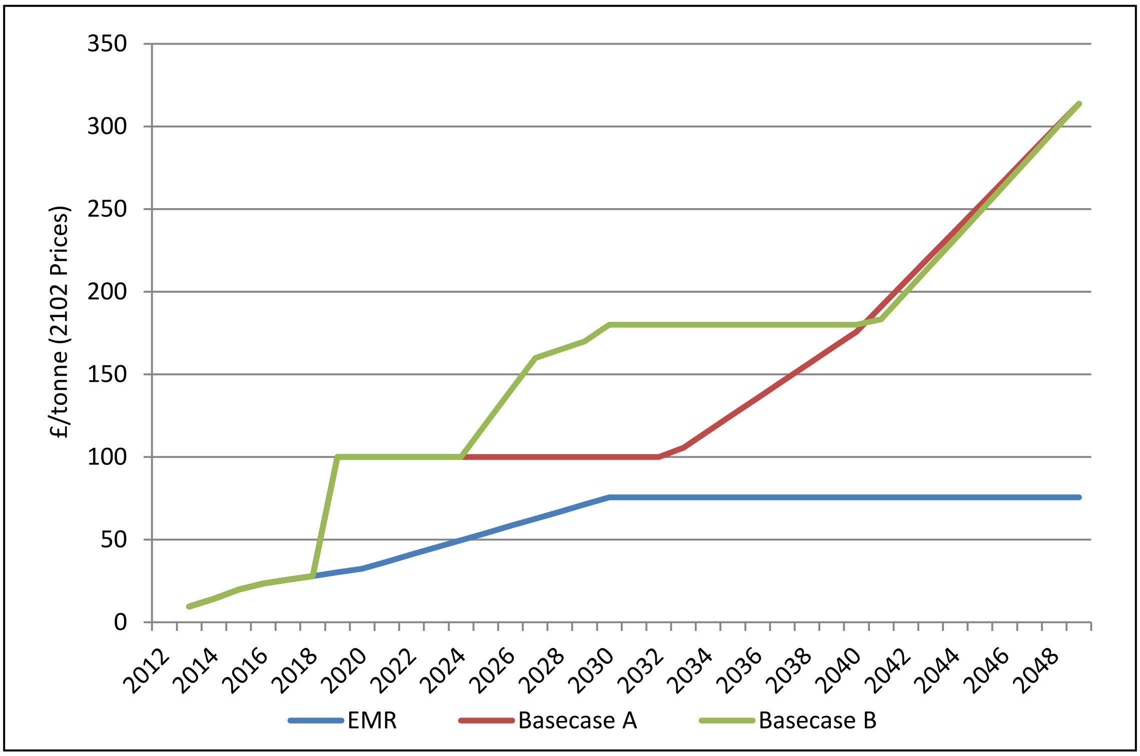
	2030 emissions intensity gCO_2/KWh	2049 emissions intensity gCO_2/KWh	Carbon pricing	Renewables Obligation (RO)
Basecase A	105	25	Carbon prices increase to £100/tonne in 2019, remaining at that level until after 2030, when carbon prices tend to the IAG high appraisal carbon value in 2049.	RO support to meet 2020 renewable target and 2030 ambition. RO stays open to new renewable plants beyond 2017, closing in 2037.[27]
Basecase B	103	21	Carbon prices increase to £100/tonne in 2019, and rise to £180/tonne in 2030 before remaining at that level until after 2030, when carbon prices tend to the IAG high appraisal carbon value in 2049.	RO support to meet 2020 renewable target and 2030 ambition. RO stays open to new renewable plants beyond 2017, closing in 2037.

[26] For further details see DECC (2009) *Carbon Valuation in UK Policy Appraisal: A Revised Approach,* available at https://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/carbon%20valuation/1_20090715105804_e_@@_carbonvaluationinukpolicyappraisal.pdf

[27] The total amount of renewable support under basecase A is larger than under basecase B, as more renewables are needed to meet the 2030 target in the absence of CCS. Annex C discusses in more detail.

57. Chart 1 presents the assumed profile of carbon prices. Further details of basecase A and basecase B are presented in Annex C.

Chart 1: Carbon price profiles under EMR and basecases



58. To provide further sensitivity tests on the cost effectiveness of EMR, relative to alternative decarbonisation instruments, a number of sensitivities have been assessed, and are presented in Annex E. Under the first sensitivity (basecase C), to provide a point of comparison to earlier modelling results, the impact of EMR, is assessed against a basecase without any explicit decarbonisation ambition. 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. Under the second sensitivity (basecase D), carbon prices do not increase above the announced trajectory of the carbon price floor. The RO is therefore used to meet the 100gCO_2/KWh 2030 ambition, and decarbonisation takes place through renewable technology only.

2.3 Net Present Value of EMR

59. The section assesses the benefits of the EMR as a whole, including the combined impact of CfDs and the Capacity Market, before the individual impact of CfDs and the Capacity Market are presented.

60. The tables below present the NPV results from assessing EMR relative to basecase A and basecase B, both of which achieve the same decarbonisation ambition using the Renewables Obligation (RO) and the carbon price, but do not mitigate against security of supply risks. The NPV range reflects the alternative ways the carbon price and RO may be combined to realise these aims, as discussed above.[28]

Table 2: Change in Net Welfare (NPV) - CfD and Capacity Market compared to Basecase A[29]

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,400	89	-810
	Generation cost savings	-660	-2,700	-1,400
	Capital cost savings	9,000	14,000	14,000
	Unserved energy savings	190	1,900	3,100
	Cost of Interconnector energy saved	680	1,200	2,000
	Change in Net Welfare	**7,800**	**14,000**	**16,000**
	Change in Net Welfare*	**7,400**		

Source: DECC modelling

*Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.5.2 for details)

61. Assessed up to 2030, decarbonising the electricity sector through EMR compared to the basecases, results in welfare improvements of between **£1.3bn and £7.4bn**. Assessed up to 2049 EMR results in net welfare improvements of between **£6.1bn and £16bn**.[30] These results reflect the combined impact of decarbonising through CfDs and mitigating against risks to security of supply through a Capacity Market. In the following section, the impact of each of these two policy instruments is assessed in turn.[31]

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

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

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

[31] The analysis presented in this IA is based on an one set of assumptions, including assumed technology costs. These are described in more detail in various reports outlined at: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/gen_costs/gen_costs.aspx

Table 3: Change in Net Welfare (NPV) - CfD and Capacity Market compared to Basecase B

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-720	-2,800	-5,200
	Generation cost savings	-170	1,100	5,600
	Capital cost savings	1,200	1,900	-410
	Unserved energy savings	240	2,200	3,200
	Cost of Interconnector energy saved	1,200	2,100	2,900
	Change in Net Welfare	**1,700**	**4,600**	**6,100**
	Change in Net Welfare*	**1,300**		

Source: DECC modelling

*Inclusive of administrative costs of approximately £0.4bn up to 2030 (see section 2.5.2 for details)

2.3.1 Net Present Value of CfDs only

62. To assess the relative merits of CfDs in 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 Table 4 and Table 5.

Table 4: Change in Net Welfare (NPV) – CfDs only compared to Basecase A

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,000	330	-760
	Generation cost savings	92	-1,500	260
	Capital cost savings	9,700	16,000	18,000
	Unserved energy savings	-150	230	-63
	Cost of Interconnector energy saved	660	1,100	1,800
	Change in Net Welfare	**9,300**	**16,000**	**19,000**
	Change in Net Welfare*	**9,100**		

Source: DECC modelling:

*Inclusive of administrative costs of approximately £0.2bn up to 2030 (see section 2.5.2 for details)

Assumptions about technology costs are uncertain and future costs depend 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.

Table 5: Change in Net Welfare (NPV) – CfDs only compared to Basecase B

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-330	-2,600	-5,100
	Generation cost savings	590	2,400	7,200
	Capital cost savings	1,900	4,500	4,200
	Unserved energy savings	-98	500	95
	Cost of Interconnector energy saved	1,200	2,000	2,700
	Change in Net Welfare	**3,200**	**6,800**	**9,100**
	Change in Net Welfare*	**3,100**		

Source: DECC modelling:

* Inclusive of administrative costs of approximately £0.2bn up to 2030 (see section 2.5.2 for details)

63. Relative to the basecases, decarbonising through CfDs would result in a positive NPV of between £3.1bn and £9.1bn to 2030.[32] The key benefit of CfDs is their its ability to lower the capital costs associated with decarbonisation. Relative to the basecases set out, CfDs result in a range of capital cost reductions of between £1.9bn and £9.7bn up to 2030. The lower capital costs reported in the table above reflect the combined impact of two factors.

- **Financing cost impact:** Financing cost benefits of decarbonising through CfDs rather than the RO and a higher carbon price.
- **Technology mix impact**: CfDs are better able to target a cost effective generation mix, in comparison to existing policy instruments.

Financing cost impact

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

65. Electricity sector modelling which provided the evidence base for the EMR White Paper suggested that the preferred EMR option of a CfD could reduce hurdle rates for low carbon investments by up to 1.5%. [33] Independent verification of the cost of capital

[32] Inclusive of CfD administrative costs up to 2030, post 2030 estimates do not include administrative costs, due to uncertainty over estimated costs.
[33] Electricity sector dispatch modelling by Redpoint Energy Consultants, 2011

impacts showed broadly similar results.[34] The EMR White Paper Impact Assessment also determined what the impact of hurdle rate reductions would mean for total investment costs. It found that cost of capital under the FiT CfD proposal, in comparison to the Premium FiT option, would be £2.5bn lower over the period to 2030.

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

67. In order to isolate the part of the capital cost savings which are due to reductions in costs of capital, capital cost estimates under EMR, with and without CfD hurdle rate reductions, are compared. The results suggest that CfDs would generate an NPV of around £1.7bn from lower costs of capital (up to 2030), £6bn up to 2040 and around £11bn up to 2049.[35] 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.[36]

Technology Mix Impact

68. 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.[37]

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

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[34] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2180-emr-impact-assessment.pdf & http://www.decc.gov.uk/assets/decc/11/policy-legislation/emr/2174-cepa-paper.pdf

[35] The 2030 figure is inclusive of administrative costs as estimates of administrative costs up to this date have been made. They have not been made post 2030.

[36] 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.

[37] CCS demonstration projects also have an important role to play in the technology mix and NPV results. The assumption in the basecases is that in the absence of EMR, there would be no CfDs to fund early stage CCS projects. This is because all hypothetical modelled basecases only include existing policy instruments. However, in the absence of EMR, a likely scenario is that alternative funding would be sought for CCS consistent with the Government's commitment to help support the development of this technology. The NPV results for EMR are particularly sensitive to how the CCS projects are treated in the counterfactual basecase, due to their modelled delivery date. In addition within the modeling, estimates of the costs of the demonstration projects are used as the exact costs of the demonstration projects remains unknown. If the CCS demonstration projects are included in the basecase, the EMR NPV range would increase from around £1.7-£7.8bn to £4-£9.5bn (NPV, 2012 prices). The increased benefit of EMR reflects capital cost savings, as the demonstration projects costs are accrued under both scenarios (all estimates exclude expected administrative costs).

part of the modelled £9.7bn capital cost saving under basecase A reflects the benefits of decarbonising through CCS rather than offshore wind.[38]

70. The indicative scale of this impact can be illustrated by basecase B, where a similar level of CCS investment takes place to that achieved under EMR. Compared to this basecase the capital cost savings fall to around £1.9bn, suggesting that once we control for differences in technology mix the benefits of EMR from lower capital costs are smaller. These benefits therefore broadly reflect the pure cost of capital benefits associated with CfDs.

71. In contrast to the basecases which use carbon prices, CfDs allow technology specific targeting, such that nuclear and CCS investments can be deployed without directly impacting the investment and generation decisions of alternative technologies, such as unabated coal and gas.

72. The technology mix also drives the differences in carbon and generation costs. Against both basecases carbon costs are higher under EMR reflecting the slightly slower decarbonisation profile followed. This is driven by EMR's focus on targeting a cost effective generation mix, at the expense of fuel switching. For more detail see Annex C. In addition, carbon costs under EMR are higher in later years, in comparison to basecase B, as the lower carbon prices in the EMR run result in a slower decarbonisation trajectory post 2030.[39]

73. Assessed up to 2030, generation costs (defined as fixed and variable operating costs and fuel costs) are lower under CfDs in comparison to both of the basecases. Relative to the basecase A, EMR results in lower fixed operating costs but higher variable operating and fuel costs due to a lower proportion of renewable generation. EMR has a greater share of nuclear and CCS. In contrast, relative to basecase B EMR results in lower variable costs but higher fixed costs. The low-carbon mix is broadly similar between EMR and this basecase, so differences largely reflect the different decarbonisation profiles (more detail on these are in Annex C).

2.3.2 Net Present Value of the Capacity Market

74. Our Central Case analysis shows that a Capacity Market is expected to have a net cost of £1.7bn relative to a scenario of an efficient energy market – i.e. where the energy price is reformed to reflect consumer's value of lost load and where the market is able

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

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

to invest on the basis of scarcity rents. However as this assumes a perfectly efficient energy market it necessarily concludes that a Capacity Market has a net cost.

75. In practice the energy market does not work perfectly. We are concerned that the market may fail to deliver an adequate level of reliable capacity due to imperfections in the current cash out arrangements and due to the lack of liquid forward markets for investors to attain project finance. Modelling is also likely to understate the cost of a Capacity Market as it assumes that investors have perfect foresight of demand and other factors up to five years ahead – and so concludes that an efficient capacity margin is close to zero. In practice demand predictions five years ahead are highly uncertain and an efficient market may be likely to bring forward a higher capacity margin to mitigate against the risk of demand being higher than expected.

76. A Capacity Market could have a significant net benefit if the market would fail to bring on an adequate level of capacity. Our modelling suggests that if prices were not able to rise sufficiently to reflect consumers' aversion to being disconnected a Capacity Market could have a net benefit of up to £4.2bn in our Stress Test (as discussed in the Capacity Market IA).

2.3.3 Disaggregated NPV Impact

77. Based on the results presented thus far, it is possible to break down the overall NPV result presented above into its constituent parts. The results are presented in Table 6.

Table 6: Disaggregated Change in Net Welfare (NPV) - CfD with Capacity Market (2012-2030), £m 2012 Prices [40]

		Basecase A	Basecase B
EMR (CfD + Capacity Market)		**7,400**	**1,300**
Of Which:			
CfDs		9,100	3,100
	Of which:		
	Financing Impact	1,700	1,700
	Technology Mix Impact	7,400	1,300
Capacity Market		-1,700	-1,700
Net Impact		**7,400**	**1,300**

Source: DECC modelling

78. The CBA suggests that EMR is a cost-effective way of decarbonising the electricity sector in comparison with using existing policy levers up to 2030, leading to an improvement in welfare of between £1.3bn and £7.4bn up to 2030. This reflects £3.1bn to £9.1bn worth of net benefits as a result of decarbonising through CfDs and an offsetting £1.7bn net cost of mitigating against security of supply risks through the

[40] Inclusive of administrative costs

Capacity Market. Of the £3.1bn to £9.1bn benefit from decarbonising through CfDs, around £1.7bn can be attributed to the benefit of lower financing costs under CfDs. As a result between £1.3bn and £7.4bn of the benefit of EMR can be attributed to the different technology mix it generates relative to the basecase.[41]

79. In addition, preliminary indicative analysis assuming a 200gCO_2/kWh decarbonisation ambition suggests the NPV of EMR under this scenario could be around -£3.6bn. Indicative analysis assuming a 50gCO_2/kWh decarbonisation ambition suggests the NPV of EMR under this scenario could be around +£1.2bn. We will update the analysis early in the New Year.

[41] The technology mix impact reflects the combined impact the different technology mixes in the basecase and EMR scenarios have across the NPV categories. Under basecase A the majority of the combined technology mix benefit is the result of lower capital costs under EMR (independent of the benefit of lower financing costs). The impact on generation costs, carbon costs, unserved energy and interconnectors offset this benefit to produce a combined benefit of EMR from a different technology mix of around £7.4bn. Under basecase B the technology mixes are closer and as a result the capital cost impact (after taking account of the realised financing cost benefits) is in fact marginally negative, implying that due to the technology mix capital costs are slightly higher under EMR relative to the basecase (after taking account of the realised financing cost benefits). The combined technology mix benefit of EMR is therefore the result of lower interconnector and generation costs, with an offsetting impact of higher carbon costs. The combined impact of all these factors results in a net benefit of EMR from a different technology mix of around £1.3bn.

2.4 Distributional Analysis

80. 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.

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

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

83. Consumer welfare is improved under EMR when assessed up to 2030, 2040 and 2049 relative to both basecases. The driver of this result are the lower wholesale prices realised under EMR in comparison to the basecases. This benefit is only in part offset by larger low carbon and capacity payments under EMR.

84. In contrast, producers' welfare is lower under EMR. Despite benefiting from lower producer costs under EMR and receiving capacity payments and higher low carbon payments, the lower wholesale prices they receive are large enough to offset these factors and lead to the net reduction in producer surplus.

85. The impact of EMR on consumer electricity prices and bills is presented in Section 2.6 . 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 between 9% and 13% lower under EMR when assessed up to 2049 relative to the basecases.[42]

86. In contrast, returns for producers are lower under EMR. Total discounted producer surplus is between 8% and 32% lower under EMR in comparison to what they would be under basecases A and B respectively (when assessed over the period 2012 to 2030). Up to 2049, total producer benefits could be between 25% and 46% lower under EMR.[43]

87. The negative impact of EMR on environmental tax revenue reflects the different mechanisms used to decarbonise the electricity sector. The use of the lower carbon

[42] Consumer costs include wholesale costs, low carbon payments and capacity payments. Unserved energy costs are not reflected in this estimate.

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

price to decarbonise will generate lower environmental tax revenues under EMR in comparison to the reliance on a carbon price in the counterfactuals. Environmental taxes are a transfer from producers to the Exchequer.

88. The final row, 'Change in non-internalised social costs of carbon', values the wider impact on UK society of changes in greenhouse gas emissions, less the value of a European Union Allowance (EUA). The EUA value is subtracted from this item in the distributional analysis as the value of the EUA is reflected elsewhere in the 'Change in producer surplus' line. See Annex B for details.

89. The relatively small societal benefit associated with changes in the non-internalised social costs of carbon reflects the fact that we are assessing EMR relative to a basecase which follows a similar decarbonisation trajectory, and therefore there are comparable additional social costs of carbon.

Table 7: Distributional analysis: CfD with Capacity Market compared to basecase A

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	33,000	68,000	130,000
	Low carbon payments	-3,600	-11,000	-41,000
	Capacity payments	-5,500	-20,000	-33,000
	Unserved energy	190	1,900	3,100
	Change in Consumer Surplus	**24,000**	**39,000**	**61,000**
Producer Surplus	Wholesale price	-32,000	-67,000	-130,000
	Low carbon support	3,600	11,000	41,000
	Capacity payments	5,500	20,000	33,000
	Producer costs	20,000	29,000	37,000
	Change in Producer Surplus	**-3,600**	**-6,200**	**-19,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-12,000**	**-19,000**	**-26,000**
Societal benefit	**Change in non-internalised social costs of Carbon**	**-850**	**470**	**-340**
Net Welfare	**Change in Net Welfare**	**7,800**	**14,000**	**16,000**

Source: DECC modelling

Table 8: Distributional analysis: CfD with Capacity Market compared to basecase B

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	59,000	120,000	180,000
	Low carbon payments	-12,000	-26,000	-56,000
	Capacity payments	-5,500	-20,000	-33,000
	Unserved energy	240	2,200	3,200
	Change in Consumer Surplus	**42,000**	**77,000**	**92,000**
Producer Surplus	Wholesale price	-58,000	-120,000	-170,000
	Low carbon support	12,000	26,000	56,000
	Capacity payments	5,500	20,000	33,000
	Producer costs	21,000	31,000	38,000
	Change in Producer Surplus	**-20,000**	**-41,000**	**-49,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-20,000**	**-29,000**	**-33,000**
Societal benefit	**Change in non-internalised social costs of Carbon**	**-320**	**-2,200**	**-4,300**
Net Welfare	**Change in Net Welfare**	**1,700**	**4,600**	**6,100**

Source: DECC modelling

2.5 Wider Impacts

2.5.1 Air Quality

90. The IA accompanying the White Paper provided an assessment of the air quality impact the different EMR packages would generate. That modelling has been updated to provide an assessment of EMR's net air quality impact, relative to the revised basecases presented above.

91. As with previous modelling, annual generation output to 2030 is converted into emissions and combined with impact factors from the UK Integrated Assessment Model.[44] The impacts on air quality have been assessed using the agreed methodology of the Inter-Departmental Group on the Costs and Benefits of Air Quality.[45]

Table 9: Monetised Air Quality impacts of EMR (NPV 2012-2030, real 2012, £m)

	Basecase A	Basecase B
Air quality impact	-257	-230

Source: DECC modelling

[44] Impact factors represent the relationship between emissions and impacts on human health. While ecosystem impacts can be quantified they cannot currently be directly monetised.
[45] More information on this modelling can be found at: http://www.defra.gov.uk/environment/quality/air/air-quality/economic/

92. Table 9 presents EMR's air quality impact relative to the basecase range described above.[46] Relative to basecases A and B which achieve the same decarbonisation ambition as EMR using existing policy instruments, EMR results in a net welfare loss of between -£257m and -£230m (real 2012, NPV 2012-2030). Much of this result is explained by the role coal plays under EMR and the basecases. Under EMR a coal CCS demonstration project is assumed, where as it is not under the relevant basecases.[47] In addition, unabated coal generation is lower under the basecase scenarios, as coal plants retire earlier in response to higher carbon prices up to 2030.[48] The difference in costs between basecases A and B reflects differences in biomass generation. Under basecase B, greater biomass generation takes place in the years leading up to 2030 increasing air quality costs.[49] The impacts presented in Table 9 only include the monetised impacts in terms of impact on human health and not the resulting change in risk to compliance with biodiversity targets through impacts on the natural environment.

2.5.2 Institutional costs

93. 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, the costs cover the whole of the UK. The total discounted costs (NPV, 2012-2030) are estimated to range between £192m to £664m (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. 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 EMR's NPV taking into account administrative costs.[50]

[46] The air quality impact relative to a basecase which does not target a decarbonisation ambition shows an improvement in welfare of around £12m under EMR.
[47] The assumption in the basecases is that in the absence of EMR, there would be no CfDs to fund early stage CCS projects. This is because all hypothetical modelled basecases only include existing policy instruments. However, in the absence of EMR, a likely scenario is that alternative funding would be sought for CCS consistent with the Government's commitment to help support the development of this technology.
[48] For more information see Annex C.
[49] No RO support is provided to biomass at this time, therefore higher biomass generation under this basecase reflects the impact of carbon prices.
[50] A midpoint estimate of around £400m is used in both basecase A and B. The costs reflect a gross estimate of administrative costs under EMR, they do not consider what costs might have been in the absence of EMR. For example, they do not consider what the additional administrative costs of greater reliance on carbon pricing or the RO might be in the basecase scenarios.

Table 10: NPV with administrative costs (NPV 2012-2030, Real 2012, £bn)[51]

	NPV – Energy market only		NPV – Energy market and administrative costs*	
	Basecase A	Basecase B	Basecase A	Basecase B
NPV, £bn	7.8	1.7	**7.4**	**1.3**
Of which: CfDs	9.3	3.2	**9.1**	**3.1**
Of which: CM	-1.5	-1.5	**-1.7**	**-1.7**

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

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

2.6 Updated Price and Bill Impacts[52]

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

95. 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.

96. 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

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

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

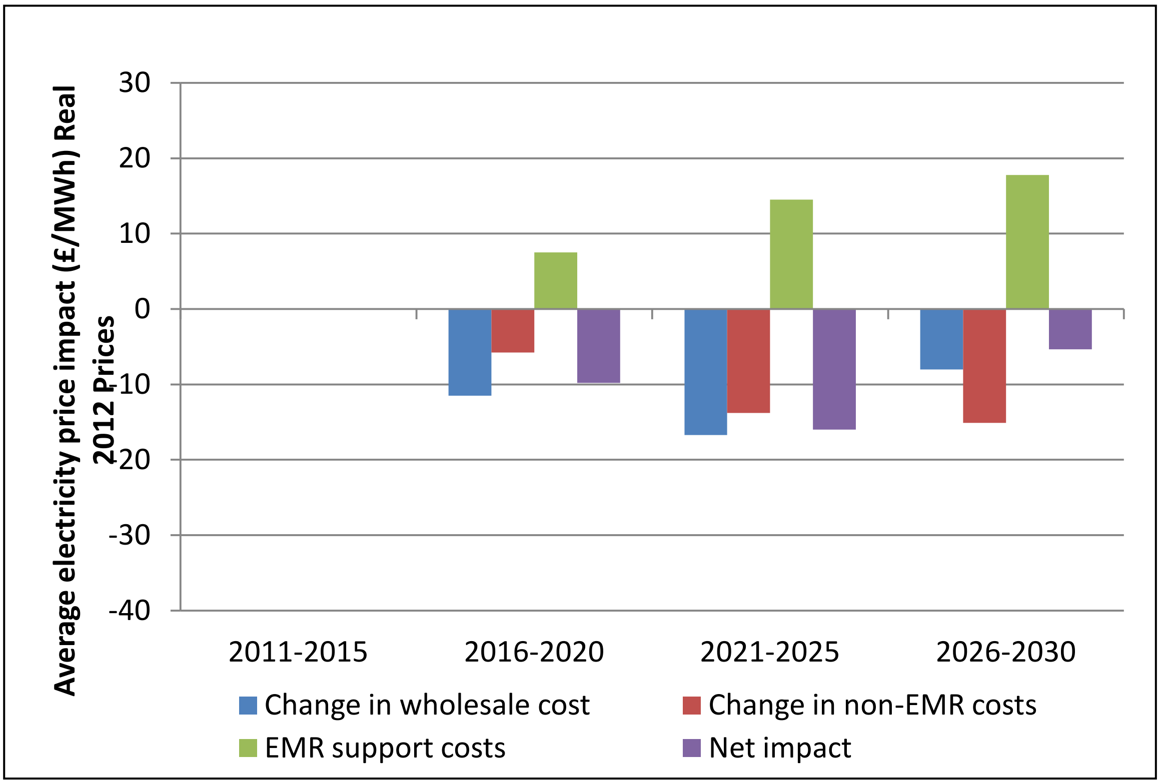
99. In addition, the EMR policies could affect the capacity margin on the system. In some periods, the EMR package could deliver larger capacity margins than in the basecase, and therefore contribute to a dampening effect on wholesale prices.

[52] 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, but with no affordability constraint. This set of assumptions is set out in Annex A. It has not been possible to reflect the very recent decision on the levy control framework or the OBR growth figures to be published alongside the Autumn Statement. As such, there may be differences between the results presented here and the finalised modelling which will be published in the forthcoming Price and Bills Publication. We will update the analysis early in the New Year. However, as outlined in this IA, we believe the EMR framework and policy suite are robust to various states of the world as reflected in the range of scenarios included in this IA.

100. The price and bill impact modelling assesses the net impact of these three effects for the basecase above.

101. The charts below present the average net impact of EMR on domestic retail prices relative to the basecases A and B described above. Relative to these basecases EMR results in lower retail prices over the 2016-2030 period.[53] Over the period 2016-2030 average prices would be between 5% and 9% lower under EMR, in comparison to what they would be under the basecases. Despite the impact of EMR support payments, lower wholesale prices and smaller RO support costs offset this increase in all periods, resulting in lower prices relative to the basecases.[54]

Chart 2: Net Impact of EMR on Domestic Electricity prices (relative to basecase A)[55]



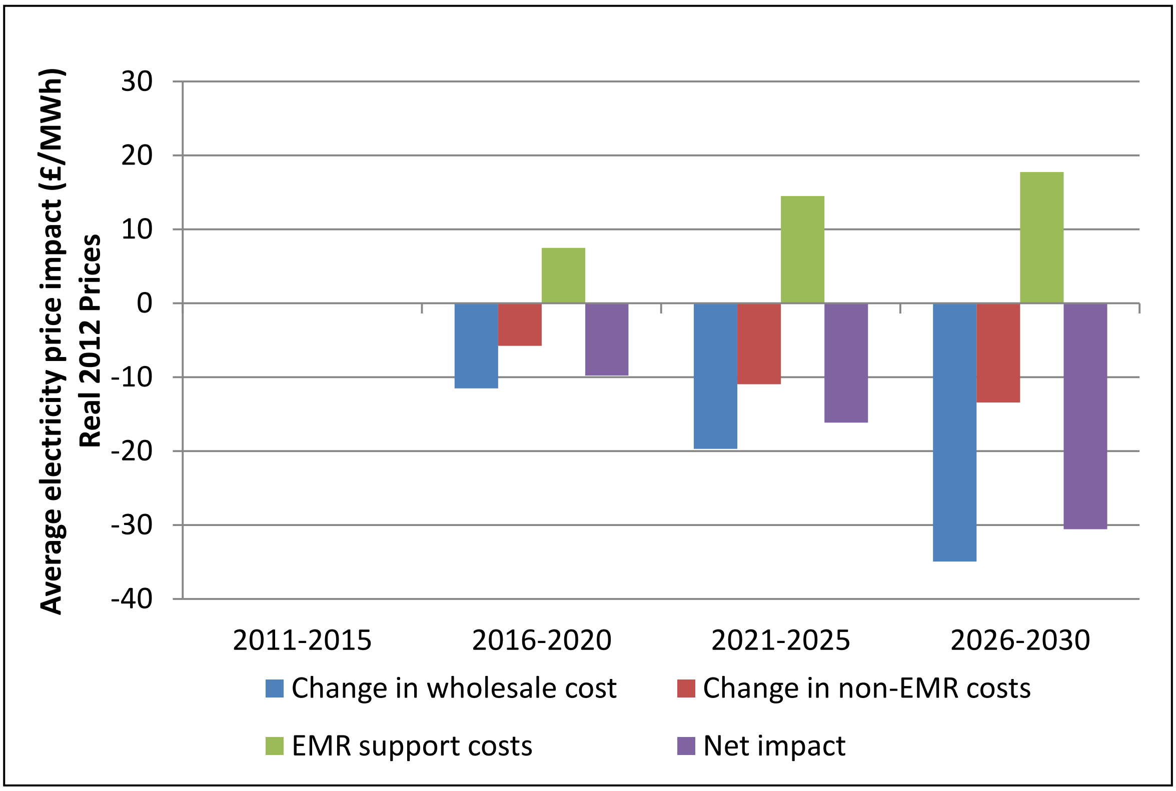
Source: DECC modelling

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

[54] 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.

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

Chart 3: Net Impact of EMR on Domestic Electricity prices (relative to basecase B)



Source: DECC modelling

2.6.1 Bill Impacts by consumer type

102. The impact of the EMR package on different consumer bills – distinguishing between domestic and non-domestic - are presented in Table 11 to Table 13.

103. For domestic consumers, EMR has the potential to reduce average annual household electricity bills by between 5% and 9% (£32 to £61) over the period 2016-2030, relative to a basecase which achieves the same decarbonisation objective using existing policy instruments. Household bills would be lower under EMR over the period 2021-2030, reflecting the higher carbon prices in the basecase, and therefore the benefit to consumers of incentivising investment using CfDs.

Table 11: Domestic Bill Impacts[56]

	Bill under basecase(s) £	Change in bill as a result of EMR, £ (%)
Domestic, (£) Real 2012 prices		
2011-2015	580	-
2016-2020	640	-£30 (-5%)
2021-2025	659 to 660	-£49 to -£50 (-7 to -8%)
2026-2030	709 to 795	-£18 to -£104 (-3 to -13%)
2016-2030	**669 to 698**	**-£32 to -£61 (-5 to -9%)**

Source: DECC modelling

Table 12: Non-domestic Bill impacts (With CRC)[57]

	Bill under basecase(s) £	Change in bill as a result of EMR, £ (%)
Non-Domestic, (£ 000's) (rounded) Real 2012 prices		
2011-2015	1,150	-
2016-2020	1,450	-£70 (-5%)
2021-2025	1,600 to 1,610	-£130 to -£140 (-8 to -9%)
2026-2030	1,600 to 1,830	-£40 to -£270 (-2 to -15%)
2016-2030	**1,550 to 1,630**	**-£80 to -£160 (-5 to -10%)**

Source: DECC modelling

104. The table above presents the impact of EMR on non-domestic electricity bills. Average annual bills are between 5% and 10% lower under EMR, relative to the basecases. Electricity bills could be 8% to 9% lower under EMR over the period 2021-2025. Over the period 2026-2030 they could be between 2% and 15% lower under EMR, in comparison to the basecases.

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

Table 13: Energy Intensive Industry (EII) Bill impacts[58]

	Bill under basecase(s) £	Change in bill as a result of EMR, £ (%)
EII, (£ 000's) (rounded)Real 2012 prices		
2011-2015	8,340	-
2016-2020	11,470	-£660 (-6%)
2021-2025	13,270 to 13,320	-£1,200 to -£1,250 (-9%)
2026-2030	13,070 to 15,210	-£290 to -£2,430 (-2 to -16%)
2016-2030	**12,600 to 13,330**	**-£710 to -£1,440 (-6 to -11%)**

Source: DECC modelling

105. The table above presents the modelled bill impacts of EMR on Energy Intensive Industry (EII). The modelling suggests EMR could reduce annual average EII electricity bills by between 6% and 11% relative to the basecases (over the period 2016-2030). Over the period 2026-2030 under EMR electricity bills could be 2% to 16% lower, in comparison to the basecases.[59]

106. In addition, as discussed above, the impact of EMR on consumer bills will reflect the impact of decarbonising and mitigating against security of supply risks. EMR bill impacts therefore reflect the combined impact of decarbonising through CfDs, relative to existing instruments, and the cost mitigating against security of supply risks though the Capacity Market (which the basecase(s) do not do). The Capacity Market is estimated to add around £14 to average consumer bills in years in which it is bringing on additional capacity, however in practice the costs of a Capacity Market could be lower as it should help reduce financing costs for investment in new capacity.

107. Energy prices are volatile, and there are significant uncertainties around estimates, in particular, of wholesale electricity prices for the next 20 years. Therefore these

[58] 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.

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

estimates are likely to change as projections change over time. However, the latest results suggest that average electricity bills are likely to be lower under EMR, relative to basecases A and B, which achieve the same decarbonisation ambition using existing policy instruments.

2.6.2 Distributional Impacts – vulnerable consumers

108. As the EMR White Paper IA set out, increases in average domestic electricity bills can have disproportionate impacts on consumers on low incomes. Poorer households, although facing a lower absolute increase in their electricity bill due to lower levels of consumption, will spend a larger proportion of their expenditure on electricity compared with the average household.[60]

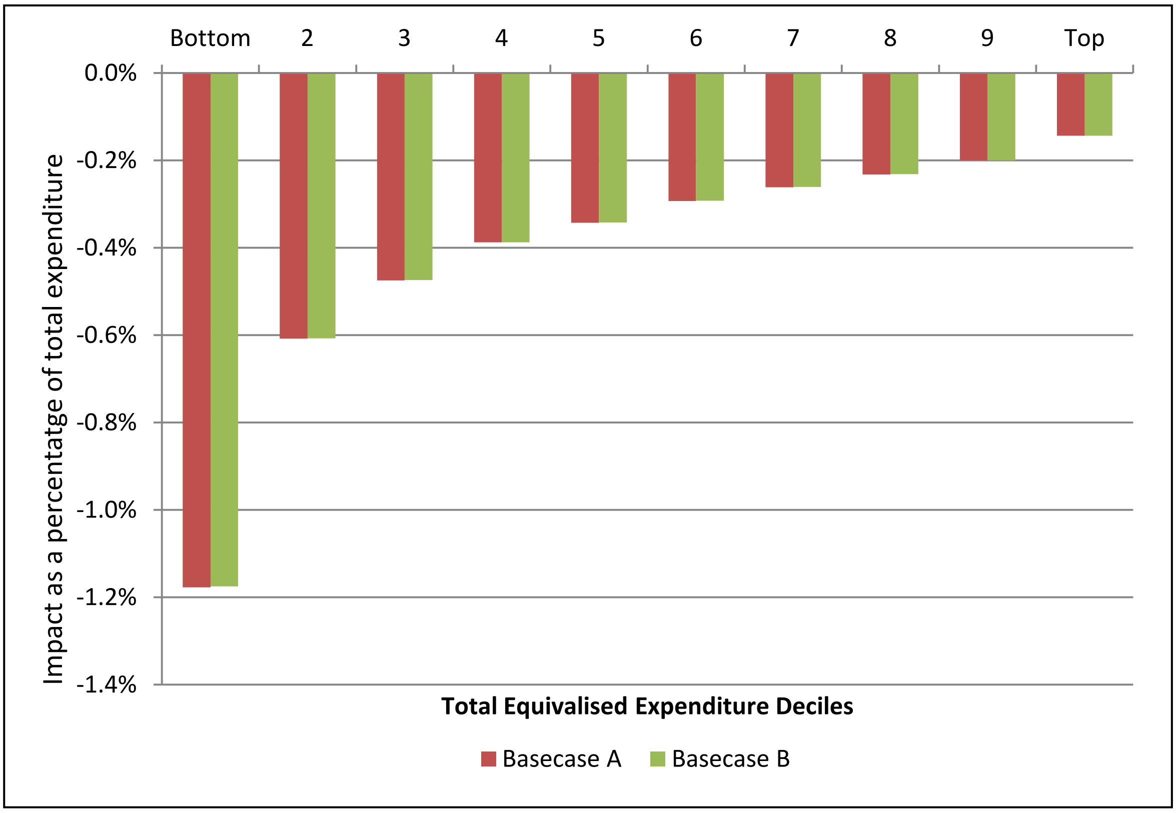
109. Distributional analysis provides insights into the affordability of the reform options for different households by looking at the increase in the electricity bill as a percentage of total household expenditure, when compared to the basecases. The following analysis assesses the distributional impacts by expenditure decile and by building and heating fuel type. In all cases the scale of the impact is lower than the bill impacts presented above, as the effect on electricity spending as a share of total expenditure is relatively small. To provide an indicative assessment of the distributional impacts of EMR, relative to the basecases, impacts in 2020 are presented, rather than averaging across periods.

Impact by Expenditure Group

110. As presented above, relative to the range of basecases which decarbonise through exiting policy instruments, average electricity bills are lower under EMR. As a result, relative to these basecases, EMR reduces expenditure on electricity as a share of total expenditure. The effect is largest in the bottom expenditure decile.

[60] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/3593-estimated-impacts-of-our-policies-on-energy-prices.pdf

Chart 4: EMR Electricity Bill impact relative to basecase as a % of Total Expenditure (2020) by Expenditure Decile[61]



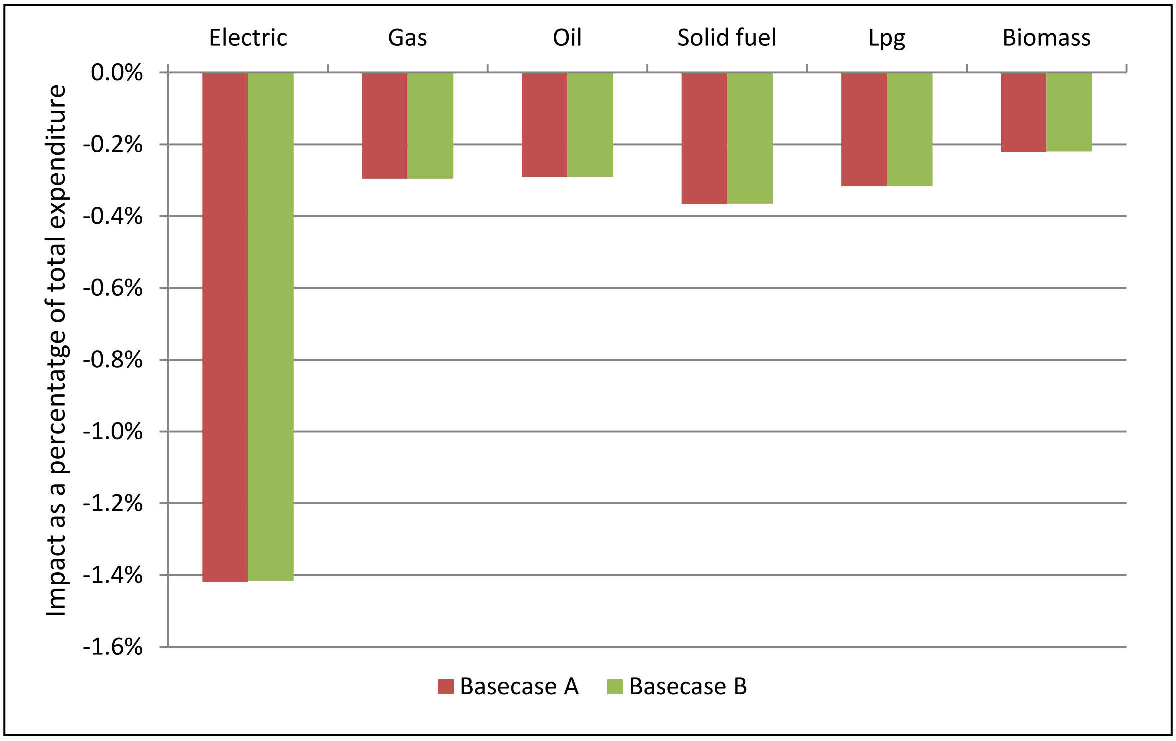
Source: DECC modelling

Impact by heating fuel type

111. Chart 5 presents the impact of EMR, relative to the basecase range, on electricity expenditure as a share of total expenditure by heating fuel type. EMR results in a decrease in expenditure, relative to the basecases, for all heating fuel type customers. The largest impact accrues to those customers who heat their homes through electricity.

[61] Expenditure decile 1 refers to households in the lowest group of expenditure when the total population of households is divided into ten equal groups and ranked by expenditure (decile 10 refers to the top ten per cent).

Chart 5: EMR Electricity Bill impact relative to basecase as a % of Total Expenditure (2020) by heating fuel type



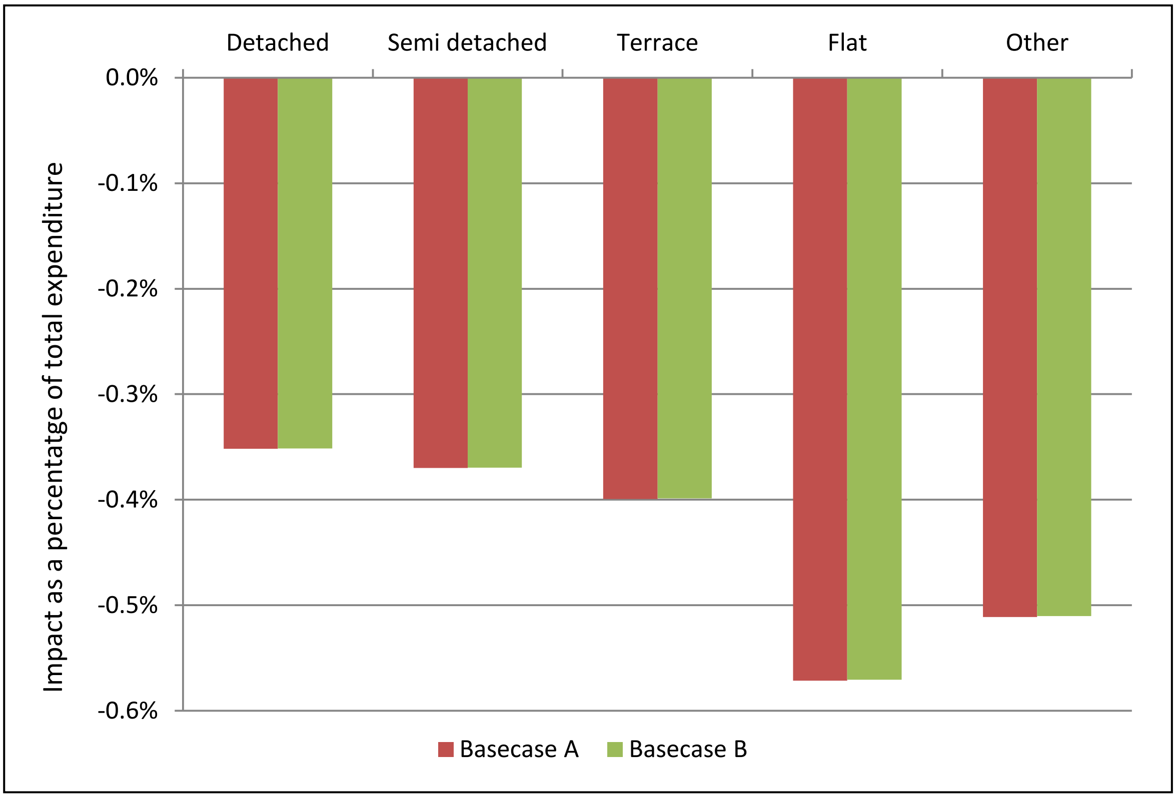
Source: DECC modelling

Impact by building type

112. Chart 6 presents the impact of EMR, relative to the basecase range, on electricity expenditure as a share of total expenditure by building type. EMR results in an average decrease in expenditure, relative to the basecases, across all building types. Differences across building types reflect differences in assumed consumption and expenditure profiles. On average, the bills of consumers who reside in flats will be most reduced when taken as a percentage of their total expenditure.[62]

[62] This reflects the expenditure and consumption profile of consumers who reside in flats.

Chart 6: EMR Electricity Bill impact relative to basecase as a % of Total Expenditure (2020) by building type



Source: DECC modelling

2.6.3 Fuel Poverty

113. In the Impact Assessment published alongside the EMR White Paper an estimate of the impact of the packages of reform on the number of households in fuel poverty was published. Following the updated analysis these estimates have been revised. Table 14 shows the impact of the EMR policy in isolation, with positive numbers showing an increase in fuel poverty, negative numbers showing a decrease in fuel poverty.

Table 14: Impact on fuel poverty in England per year (number of households, 000's)

	Impact of EMR on total number of households in Fuel Poverty (relative to Basecase A)	Impact of EMR on total number of households in Fuel Poverty (relative to Basecase B)
2020	-470 to -670	-465 to -670
2025	-200 to -255	-320 to -440

Source: DECC Modelling

114. Reflecting the net impact of EMR on domestic electricity prices, relative to the basecase(s), the results suggest that EMR would result in fewer households in fuel poverty up to 2025.

115. These projections should be treated with caution, as they only reflect projected changes in price and incomes between 2010 and 2025. 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 properties, such as cavity wall insulation and loft insulation. However, it is likely that the housing stock will improve considerably in this time period.

116. The number of households in fuel poverty in England is currently projected to be 3.9m in 2012, an increase of 0.4m households from the level reported in 2010. Government is currently consulting on proposals to amend the definition of fuel poverty in England.[63]

2.6.4 Wider Impacts

117. 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.

[63] See: http://www.decc.gov.uk/en/content/cms/consultations/fuel_poverty/fuel_poverty.aspx for more details.

Section 3 Update on CfD payment model

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

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

120. Electricity sector modelling[64] which provided the evidence base for the EMR White Paper suggested that the preferred EMR option of a CfD could reduce hurdle rates for low carbon investments by up to 1.5%, depending on the technology type. Independent verification of the cost of capital impacts showed broadly similar results.[65] For the latest analysis, the hurdle rates are based on data from Oxera (2011) and Arup (2011). The hurdle rate reductions are derived from the DDM model in conjunction with Oxera's maximum possible hurdle rate reductions.[66] Again the results are broadly similar to the Redpoint analysis.

121. The EMR White Paper Impact Assessment also determined what the impact of hurdle rate reductions of this size would mean for total investment costs. It found that cost of capital under the FiT CfD proposal, in comparison to the Premium FiT option, would be £2.5bn lower over the period to 2030. In the updated analysis, capital cost estimates under EMR, with and without CfD hurdle rate reductions are compared. The results suggest that CfDs would generate an NPV of around £1.7bn from lower costs of capital (up to 2030).[67]

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

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

were concerned that this was complex, about what would happen in a dispute, and whether this model fused public and private law in a way that could be off-putting to investors.

123. In response to these concerns, the Energy Bill introduces a single counterparty in the form of a Government owned company. It will sign contracts with generators and raise monies from suppliers. This is a simpler system which creates a private law contract, a model that investors will be familiar with, and gives certainty through an enforceable statutory obligation that monies will be raised from suppliers. This meets the concerns raised by generators and creates a credible and investable model, as assumed in our analysis. Further details are provided in the accompanying Bill documents.

124. The Energy and Climate Change (ECC) committee reported that they believed a single counterparty body underwritten by HMG would be the best way to reduce the cost of capital and if it was not underwritten, that DECC should assess the impacts of this. Whilst the counterparty is owned by Government, payments will come from suppliers to match payments to generators rather than Government stepping in to make payments. The obligation on suppliers to pay will be in statute and a requirement of their licence, regulated by Ofgem. The risk of supplier default impacting on payment flows is mitigated by a series of backstops that will feature as part of the design of the supplier obligation including the advance posting of credit and collateral to cover any payment period and the mutualisation of any remaining unsecured losses across suppliers. In the event of an insolvency, the supplier of last resort regime, which effectively moves customers to a new supplier, and the Energy Company Administration Scheme, whereby an administrator continues to supply and meet obligations, would be in place to ensure that payments would continue.

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

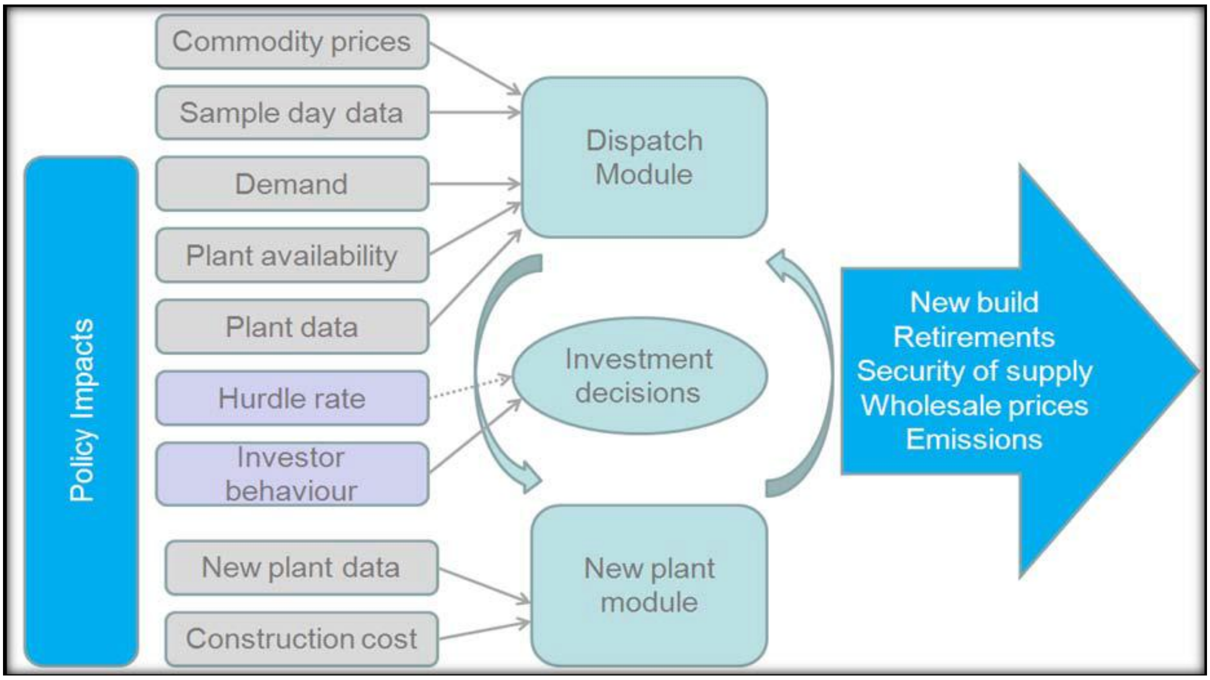
Annex A: The Dynamic Dispatch Model (DDM)

1. 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

2. 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

3. Economic, energy and climate policy, generation and demand assumptions are external inputs to the model. The model runs on sample days, including demand load curves for

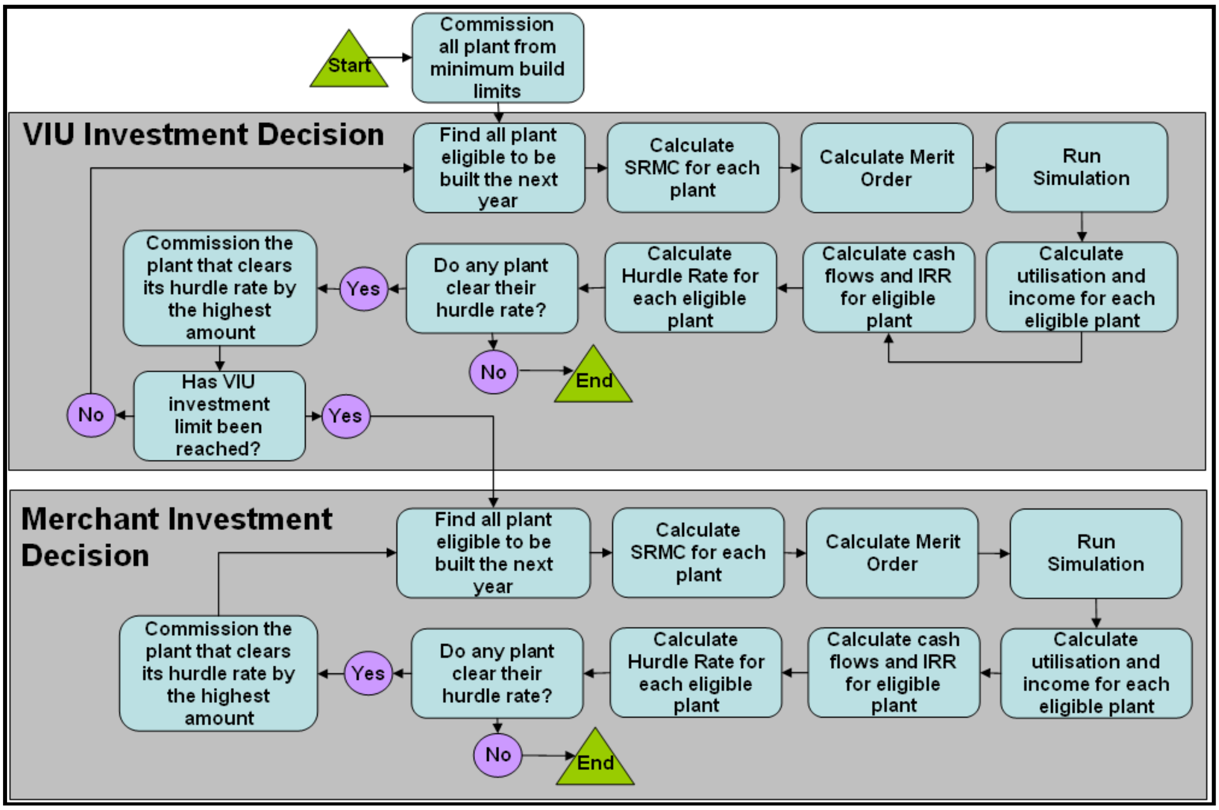
both business and non-business days, including seasonal impacts and are variable by assumptions on domestic and non domestic sectors and smart meter usage. Also, there are 3 levels of wind load factor data applied to the sample days to reflect the intermittency of on- and offshore wind. The generation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

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

Investment Decisions

5. The model requires input assumptions of the costs and characteristics of all generation types, and has the capability to consider any number of technologies. In investment decision making the model considers an example plant of each technology and estimates revenue and costs in order to calculate an IRR. This is then compared to a user specified technology specific hurdle rate and the plant that clears the hurdle rate by the most is commissioned. This is then repeated allowing for the impact of plants built in previous iterations until no plant achieves the required return or another limit is reached. The model is also able to consider investment decisions of both Vertically Integrated Utilities (VIUs) and merchant investors, see figure 2. Limitations can be entered into the model such as minimum and maximum build rates per technology, per year, and cumulative limits.

Figure 2. Investment decisions in the DDM



Policy Tools

6. 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 be varied over time and duration. Policies can be financed through Government spending/taxation or charged to consumers.

Outputs

7. 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.

8. 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

9. 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' (http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/5427-ddm-peer-review.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 http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx

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

Carbon Prices

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

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

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Central	6	6	6	6	7	7	8	8	9	9	9	10	10	10	11	11	11	12	12

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

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

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

Carbon Price Floor, 2012 £/tonne of CO_2e

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
10	14	20	24	26	28	30	32	37	41	45	50	54	58	63	67	71	76

Technology Assumptions

Cost and technical data for new plant is taken from the 2012 PB Power study (for non-renewable technologies) and the Renewables Obligation Banding Review for renewable technologies. Details can be found at:
http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/gen_costs/gen_costs.aspx

Hurdle Rate Reductions by Technology Type under FiT CfDs

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

Electricity Demand

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

www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx#2012

Note: The UEP numbers are then adjusted downwards by 2.7% before use in the DDM model as they include Northern Ireland while the DDM models Great Britain alone.

Annex B: CBA Categories

Net welfare

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

Carbon costs

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

In valuing emissions, the UK Government adopts a target-consistent approach, based on estimates of the abatement costs that will need to be incurred in order to meet specific emissions reduction targets.[68] Policies that change emissions in sectors covered by the EU Emissions Trading System (ETS), and in the future other trading schemes, are appraised using the "traded price of carbon (TPC)". This is based on estimates of the future price of EU emissions Allowances (EUAs) and, in the longer term, estimates of future global carbon market prices. Up to 2020, the TPC is the estimated price of EUAs. From 2030, the working assumption is that there will be a functioning global carbon market with a price of £70/tCO2e in 2030, rising to £200/tCO2e in 2050 (2009 prices). During the adjustment phase between the EU and global carbon markets, the TPC is linearly interpolated between the values in 2020 and 2030. Therefore after 2020 the TPC used in appraisal is above the EUA price estimates.

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

Generation costs

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

Capital costs

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

[68] http://www.decc.gov.uk/assets/decc/Statistics/analysis_group/122-valuationenergyuseggemissions.pdf

Un-served energy

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

Interconnectors

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

Consumer surplus

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

Wholesale price

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

Low carbon payments

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

Low carbon payments are a transfer between consumers and producers.

Capacity payments

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

Capacity payments are a transfer between consumers and producers.

Un-served energy

This is calculated in the same was as in the net welfare calculation.

Producer surplus

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

Wholesale price

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

Low carbon support price

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

Capacity payments

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

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

Environmental tax

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

Environmental tax is a transfer between producers and the Exchequer.

Societal benefit

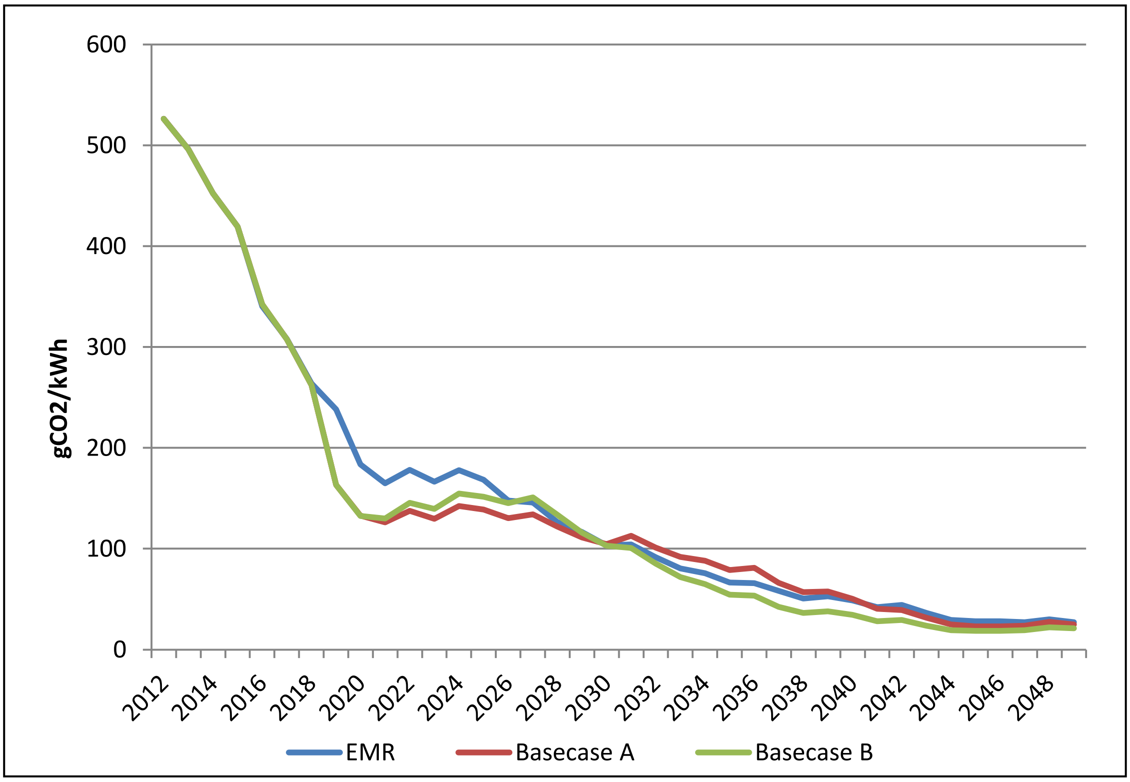
This is the change in non-internalised social costs of carbon, or non-internalised social costs of carbon as described in the carbon costs category.

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

Decarbonisation Profiles

1. Chart 7 presents the decarbonisation profiles under EMR and the two basecases (A and B) from which the range of net welfare impacts of EMR is derived. The different basecases follow a broadly similar decarbonisation trajectory, although, reflecting the different policy instruments used to decarbonise, there are differences in the emission intensity profiles. For example, the introduction of a higher carbon price to incentivise nuclear investment under the basecase in both A and B results in a sharper reduction in emissions around 2020. Within the modelling , the higher carbon price in 2019 to incentivise investment in nuclear at the same rate as under EMR has additional impacts on the modelled generation mix. In response to the higher carbon price level under the basecase unabated coal plants retire more quickly than they do under EMR, and as a result gas generation substitutes for coal generation in the basecase scenarios.[69] As a consequence, the basecases have a lower emission intensity level in the early 2020's.

Chart 7: Decarbonisation Profiles



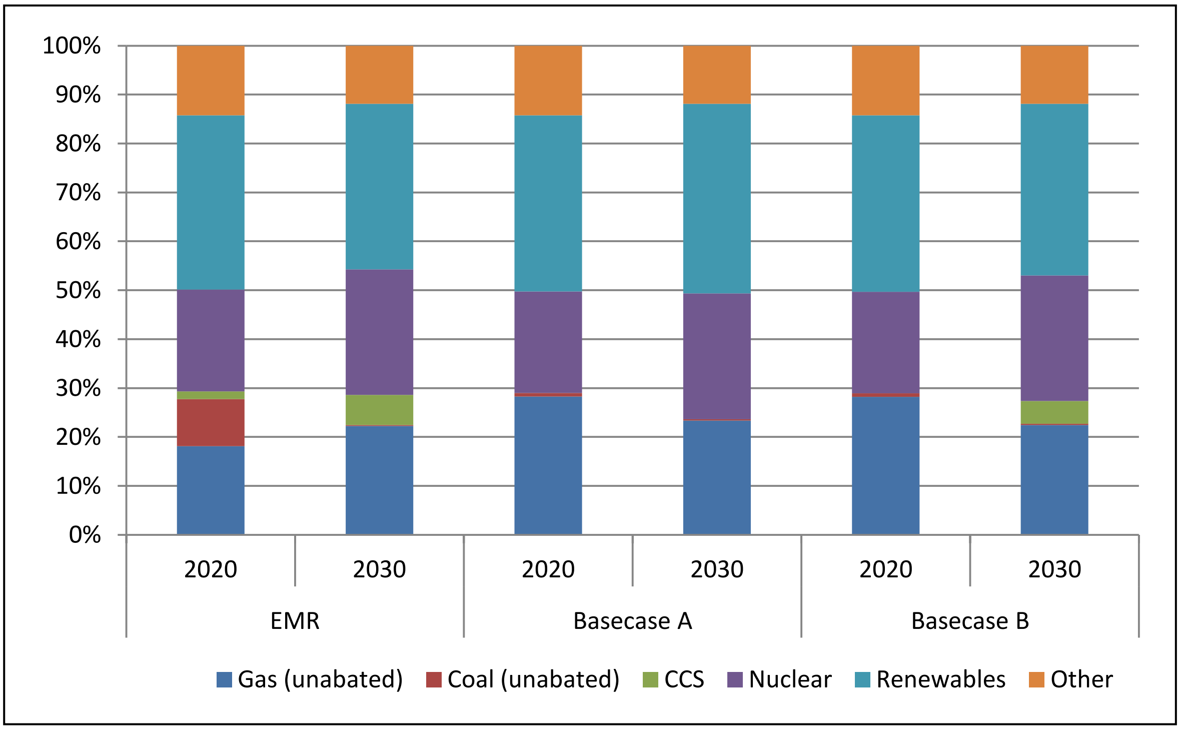
Source: DECC modelling

[69] 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.

Generation mix

2. Chart 8 presents generation mix profiles in 2020 and 2030 under EMR, and the basecases A and B.[70] Under basecase A wholesale prices are not high enough to incentivise CCS investment. Therefore in 2030 proportionately more renewable generation substitutes for the lost CCS generation in meeting the 2030 decarbonisation ambition. Under basecase B, prices are set such that nuclear and CCS investments take place at the same rate as under EMR. As a result, the proportion of electricity generated from nuclear and CCS is roughly equivalent to that realised under EMR.

Chart 8: Generation Mix profiles



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.

[70] Under a basecase where no decarbonisation ambition is targeted the basecase would become increasingly gas dependent. Without EMR, wholesale prices are insufficient to incentivise new nuclear or CCS investment and no new nuclear is built under the basecase until after 2030 (it is assumed that CCS demonstration projects do not take place without CfDs). Without nuclear, coal and CCS generation, under the no targeting basecase gas generation accounts for a proportionately larger amount of total generation by 2030. As a result the emission intensity of the no targeting basecase in 2030 is roughly double the level targeted under EMR, at around 200gCO_2/kWh (further details are provided in Annex E).

Annex D: Evolution of EMR Cost-Benefit Analysis

1. 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.

2. The first analysis assessing the costs and benefits of various potential EMR options was presented in the Government's December 2010 consultation on EMR.[71] 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. In March 2011 the EMR White Paper set out an estimate of £9.1 billion (NPV) in net benefits for an EMR package containing a FiT CfD and a Strategic Reserve.[72] 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.

3. 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.[73] 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[74] in the EMR White Paper under central fossil fuel price assumptions.

4. 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.

5. We have moved to quoting a range for the net welfare and bill impact figures for the EMR package, which reflects uncertainty in the estimates, and should be more robust to changes in future assumptions than point estimates.

6. 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

[71] http://www.decc.gov.uk/assets/decc/Consultations/emr/1042-ia-electricity-market-reform.pdf
[72] http://www.decc.gov.uk/assets/decc/11/policy-legislation/EMR/2180-emr-impact-assessment.pdf
[73] http://www.decc.gov.uk/assets/decc/11/policy-legislation/Energy%20Bill%202012/5342-summary-of-the-impact-assessment.pdf
[74] This number reflects DECC's new carbon appraisal methodology for CBA (12th August 2011) and revises the White Paper number.

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.

Annex E: Basecase sensitivity results

1. This annex presents the results of assessing EMR relative to the alternative basecases discussed in the main paper. Specifically, it presents the results of assessing EMR relative to:

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

   - **Basecase D – Decarbonisation with Renewables Obligation:** The RO is used to meet the 100gCO_2/KWh 2030 ambition. Resulting in a significant increase in renewable investment, particularly in offshore wind.

2. The table below provides a summary of the different outcomes and policy environments assumed under the different basecases.

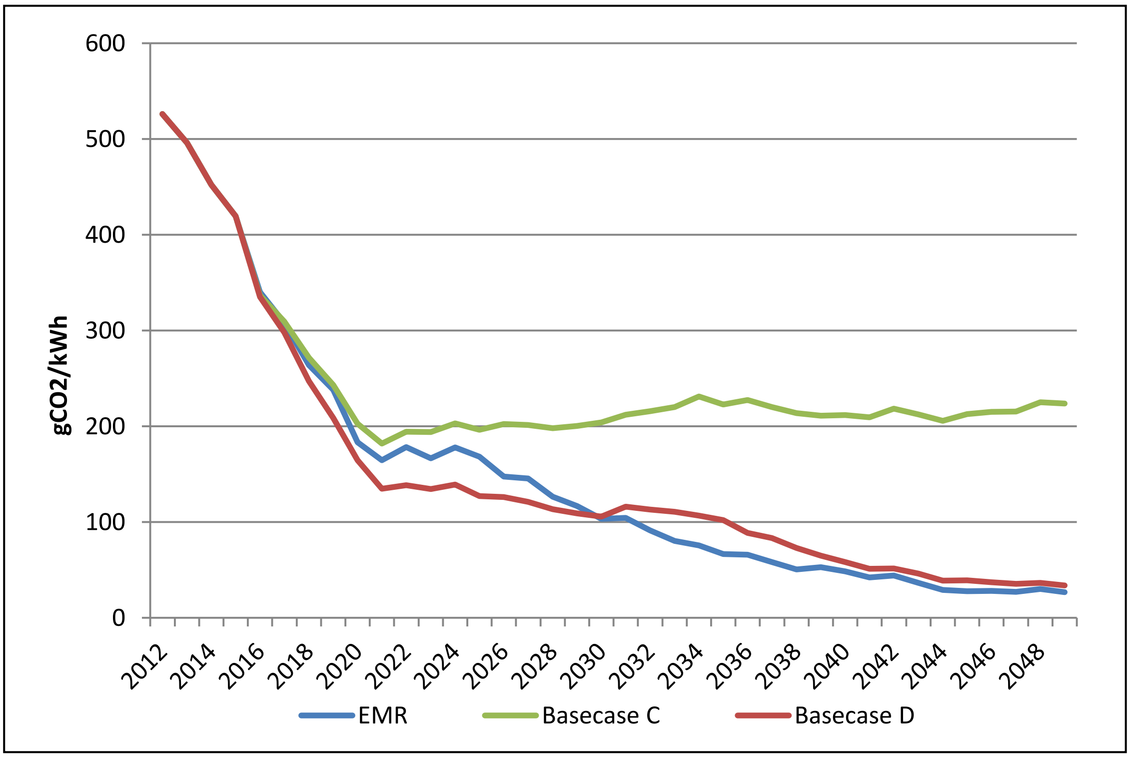
Table 15: Summary of basecase C&D assumptions

	2030 emissions intensity gCO_2/KWh	2049 emissions intensity gCO_2/KWh	Carbon Pricing	Renewables Obligation (RO)
No Emission Intensity Ambition				
Basecase C	204	224	Constant in real terms after 2030	RO stays open to new renewable plants beyond 2017, closing in 2037.
With Emission Intensity Ambition				
Basecase D (RO)	106	34	Increasing after 2030 to IAG high carbon value in 2049.	RO stays open to new renewable plants beyond 2017, closing in 2049.

Decarbonisation Profiles

3. Chart 9 presents the decarbonisation profiles under EMR and each of the sensitivity basecases described above (as well as under EMR). Basecase D achieves a slightly higher emissions intensity profile in comparison to the other scenarios. This reflects the fewer technology options available under this scenario through which to decarbonise and the deployability constraints assumed within the model on those that remain. Under basecase C which does not set a decarbonisation ambition, emission intensities stay broadly at the same level from 2020 onwards.

Chart 9: Decarbonisation Profiles



Source: DECC modelling

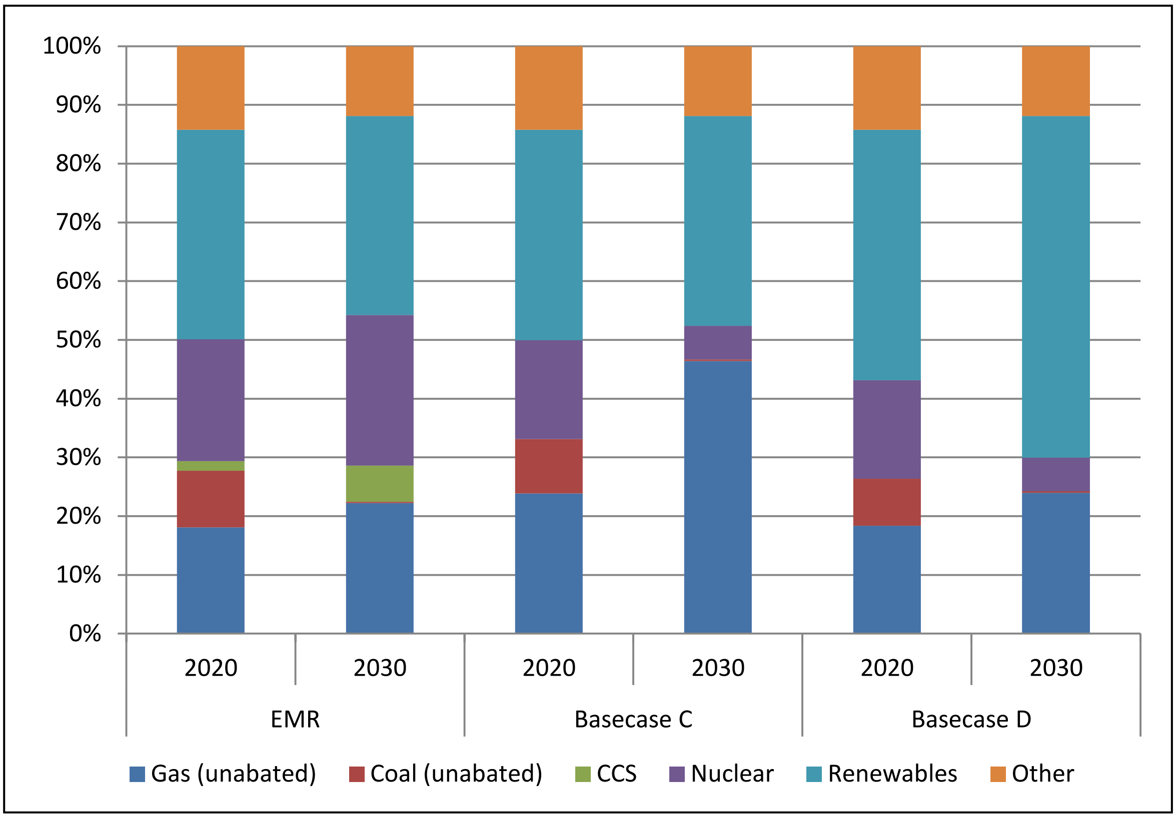
Generation mix

4. The chart below presents generation mix profiles across each of the sensitivity basecases in 2020 and 2030, in addition to the generation mix realised under EMR. Under basecase D nuclear and CCS generation accounts for a smaller proportion of total generation (relative to EMR) by 2020, and by 2030 the difference has increased. By 2030 renewables account for a significant proportion of total generation, reflecting the mechanism through which decarbonisation is achieved.

5. Under basecase C, where no decarbonisation ambition is set, the generation would become increasingly gas dependent. Without EMR, wholesale prices are insufficient to incentivise new nuclear or CCS investment and no new nuclear is built under the

basecase until after 2030 (it is assumed that CCS demonstration projects do not take place without CfDs).[75] Without nuclear, coal and CCS generation, under the no ambition basecase gas generation accounts for a proportionately larger amount of total generation by 2030. As a result, the emission intensity of basecase C in 2030 is roughly double the level realised under EMR, at around 200gCO_2/kWh.

Chart 10: Generation Mix profiles



Source: DECC modelling

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

Basecase C - no emissions intensity ambition

6. EMR is assessed against a basecase which does not meet the decarbonisation ambitions achieved under EMR.[76] This basecase provides a point of comparison to earlier EMR analysis e.g. the EMR White Paper.

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

[76] The Emissions Intensity under this scenario falls to around 200gCO_2/kWh in 2020 as a result of meeting the 2020 renewables target and the impact of the Carbon Price Floor. Post 2020, the RO is assumed to realise a broadly similar proportion of renewable generation, up to 2030, as realised in 2020. Beyond 2036, the carbon price floor is the only policy impacting the basecase (it remains constant in real terms post 2030).

Cost Benefit Analysis (CBA)

7. Table 16 presents the net welfare impact of the EMR package relative to basecase C. Assessed up to 2030 (as previous modelling has done), the latest modelling would suggest that the EMR package would lead to a net welfare loss of around £6.7bn.[77]

Table 16: Change in Net Welfare (NPV) - CfDs with Capacity Market compared to basecase C

		NPV, £m (Real 2012)		
		2012 to 2030	**2012 to 2040**	**2012 to 2049**
Net Welfare	Value of carbon savings	4,500	31,000	72,000
	Generation cost savings	5,200	15,000	21,000
	Capital cost savings	-17,000	-48,000	-84,000
	Unserved energy savings	190	1,800	3,100
	Cost of Interconnector energy saved	46	280	630
	Change in Net Welfare	**-6,700**	**120**	**13,000**

Source: DECC modelling

8. The latest modelling suggests EMR produces significant carbon and generation cost savings, relative to basecase C. However, assessed up to 2030 these savings are not large enough to offset the increased capital costs generated under EMR as a result of the increased investment in capital intensive low-carbon technologies, such as nuclear and renewables.

9. The IA published alongside the EMR consultation document presented overall results which showed a negative NPV for all the decarbonisation options considered. At the time it was stressed that this reflected a number of factors, including potential benefits that are not monetised, such as innovation benefits, and the fact the modelling only covered the period up to 2030. Specifically, the IA highlighted that EMR is a policy with upfront costs and long-term benefits. 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 a positive NPV.

10. Assessed up to 2040 the latest modelling suggests EMR has a roughly neutral net welfare impact (a positive NPV of around £100m), however when assessed up to 2049 EMR produces a positive net welfare impact of around £13bn.

11. When assessing up to 2040, the generation and carbon cost savings realised under EMR, as a result of low carbon investment, offset the higher capital costs incurred. When assessing EMR up to 2049, for which the uncertainties are greatest, the carbon

[77] As discussed above, the basecase does not include the CCS demonstration projects present in the EMR scenarios. Including the CCS demonstration projects in the basecase would result in the NPV increasing from around -£6.7bn to around -£5.3bn as capital cost savings increase from around -£17bn to around -£15bn.

and generation cost savings realised under EMR more than offset the higher capital costs. In addition to the generation and carbon cost savings realised under EMR, by 2049 the policy package also generates significant benefits from lower unserved energy costs. Lower unserved energy costs under EMR reflect the additional capacity provided through the capacity market, and therefore a mitigation against security of supply risks under EMR.

12. Assessing EMR, relative to basecase C, over a longer time frame allows the long-term benefits of decarbonisation to be reflected through higher long-term carbon appraisal values. The latest modelling results suggest that the benefits of EMR relative to basecase C could be realised around 2040 and by 2049 could generate a net welfare benefit of around £13bn.

13. Table 17 presents the consumer and producer surplus under basecase C. There are transfers from consumers to producers from low carbon and capacity payments. These losses to consumer surplus are offset, to some extent, by lower wholesale prices under EMR, relative to the basecase (and therefore a transfer from producers to consumers). However, across all assessment years EMR leads to lower consumer surplus, relative to the basecase, as low carbon and capacity payments transfers outweigh the benefits consumers enjoy from lower wholesale prices and less unserved energy. In contrast, producers enjoy improved welfare under EMR as the low carbon and capacity payments outweigh the lower wholesale prices and higher producer costs realised under EMR (relative to the basecase).

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

Table 17: Distributional analysis: CfDs with Capacity Market relative basecase C

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Distributional analysis				
Consumer Surplus	Wholesale price	2,400	17,000	45,000
	Low carbon payments	-6,300	-17,000	-47,000
	Capacity payments	-5,500	-20,000	-33,000
	Unserved energy	190	1,800	3,100
	Change in Consumer Surplus	**-9,200**	**-17,00**	**-32,000**
Producer Surplus	Wholesale price	-2,400	-17,000	-44,000
	Low carbon support	6,300	17,000	47,000
	Capacity payments	5,500	20,000	33,000
	Producer costs	-6,200	-11,000	-21,000
	Change in Producer Surplus	**3,200**	**8,800**	**16,000**
Environmental Tax	**Change in Environmental Tax Revenue**	**-4,300**	**-19,000**	**-34,000**
Societal benefit	**Change in non-internalised Social Costs of Carbon**	**3,600**	**27,000**	**64,000**
Net Welfare	**Change in Net Welfare**	**-6,700**	**120**	**13,000**

Source: DECC modelling

Changes from previous analysis

15. In the Summary IA accompanying the Draft Energy Bill, published in May 2012, EMRs NPV was presented as £250m (real 2012 prices).[78] A similar figure from the latest round of modelling would suggest an NPV of around -£6.7bn (real 2012 prices). Therefore the latest modelling updates have resulted in a sizeable reduction in EMR's NPV. Table 18 presents the results.

[78] The draft energy bill presented the figures in real 2009 prices. The presented results have been inflated to 2012 prices and rounded to 2 significant figures in order to compare them to the latest estimates.

Table 18: NPV Analysis - comparison to previously published CBA

		Current NPV, £m (Real 2012) 2012-2030	Previous NPV, £m (Real 2012) 2010-2030[79]
Net Welfare	Value of carbon savings	4,500	7,100
	Generation cost savings	5,200	9,700
	Capital cost savings	-17,000	-17,000
	Unserved energy savings	190	400
	Cost of Interconnector energy saved	46	-
	Change in Net Welfare	**-6,700**	**250**

Source: DECC and Redpoint modelling

16. Generation cost savings are lower under the latest analysis. The benefit of EMR from generation cost savings is around £4.5bn lower in the latest modelling, in comparison to the modelling published in May 2012 (2012 prices). In addition, a significant proportion of the reduction in the NPV can be explained by the value of carbon savings under EMR being around £2.5bn lower in the latest modelling, in comparison to the modelling published in May.[80] Finally, in the latest modelling there is an increase in capital costs under EMR, relative to the basecase, of around £400m.

17. The changes in the NPV estimate under the latest modelling, can be explained by a number of input and methodological changes, including:

- **Lower short-term carbon values** – Carbon values used in the modelling have been updated.[81] Near-term values are lower than previously assumed and therefore attach a lower benefit to reduced carbon emissions.

- **Lower gas price –** Revised lower near-term gas prices make generation costs cheaper in the no-EMR basecase, reducing the net impact of lower generation costs under EMR.

- **Higher capital costs** – Nuclear cost assumptions have been revised such that the first nuclear plants incur higher capital costs. In addition, the higher capital costs

[79] Demand side response impacts are not presented for comparison.
[80] The updated results have been rounded to two significant figures in the table. The reported differences from the previous NPV reflect the differences in the modelled figures, and therefore may not match with the tables results due to the rounding.
[81] DECC's updated short-term traded carbon values for 2012 (http://www.decc.gov.uk/en/content/cms/emissions/valuation/valuation.aspx) are significantly lower than previous values. This fall in short-term traded carbon values is matched by a significant fall in market prices of allowances in the EU ETS, mainly driven by lower emissions as a result of the economic slowdown, low future expected growth and oversupply in the carbon market.

result in no new operational nuclear plants before 2030 in the no EMR basecase scenarios.

18. The methodology and input changes discussed above have a significant influence on the modelled basecase generation mix, which in turn influences the CBA results. In 2030, the updated basecase, in comparison to the May 2012 basecase:

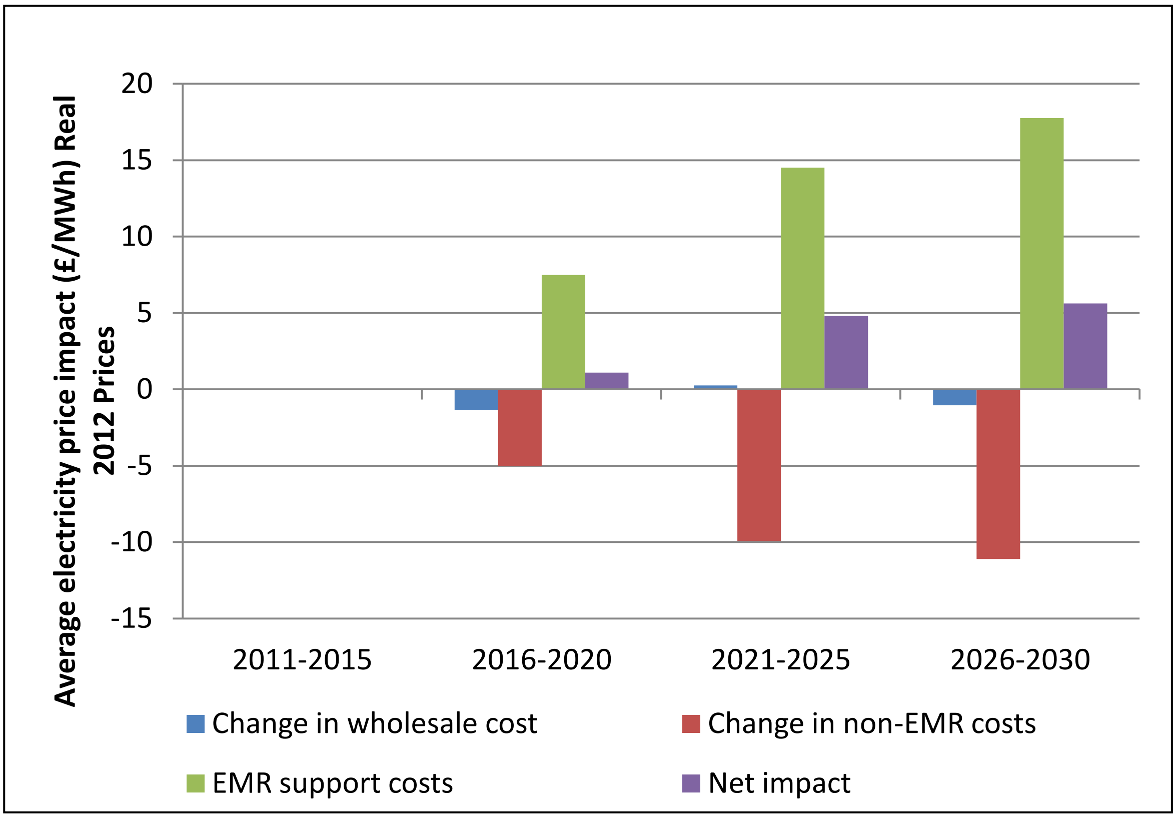
- has larger amounts of gas generation;
- has lower nuclear generation, reflecting the fact that wholesale prices are not high enough to generate new nuclear investment until the late 2020's (although there is an offsetting impact from later retirements);
- has no CCS, reflecting the fact wholesale prices are not high enough to stimulate investment, and it is now assumed that CCS demonstration projects do not take place in the basecase (in contrast to previous basecases).[82]

Price and Bills Analysis

19. Chart 11 presents the net impact on prices of EMR relative to a basecase which does not meet the same decarbonisation ambitions and does not mitigate against security of supply risks. Assessed over the period 2016-2030 EMR increases prices relative to the basecase. Prices to 2030 are on average, around 2% higher under EMR, in comparison to what they would be under basecase C (over the period 2016-2030). Although by the period 2026-2030 on average EMR marginally lowers wholesale prices, and results in lower RO support costs, the size of the EMR support costs outweigh these benefits.

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

Chart 11: Net Impact of EMR on Domestic Electricity prices (relative to basecase C)



Source: DECC modelling

20. There are uncertainties when modelling wholesale prices into the future and therefore results are averaged over periods, rather than focusing on individual years. However, the averaging does mask trends within those periods. For example, the final years leading up to 2030 show a decline in the impact of EMR on prices, such that prices in 2030 are only 1% higher under EMR than they would otherwise have been, after peaking in 2025 at around 4%. Thus, by the end of the next decade prices are slightly higher, in comparison to what they would have been under basecase C. However, EMR will have achieved a significantly lower carbon intensity as a result of the investment in low carbon technology and mitigated against security of supply risks.

Table 19: EMR Bill Impacts relative to basecase C

Real 2012 prices	Bill under basecase, £	Change in bill as a result of EMR, £ (%)	Bill under basecase, £	Change in bill as a result of EMR, £ (%)	Bill under basecase, £	Change in bill as a result of EMR, £ (%)
	Domestic, (£)		Non-Domestic (with CRC), (£ 000's) (rounded)		EII, (£ 000's) (rounded)	
2011-2015	580	-	1,150	-	8,340	-
2016-2020	607	4 (1%)	1,370	10 (1%)	10,720	90 (1%)
2021-2025	595	15 (3%)	1,420	50 (3%)	11,610	460 (4%)
2026-2030	672	19 (3%)	1,520	40 (3%)	12,370	410 (3%)
2016-2030	**625**	**12 (2%)**	**1,440**	**30 (2%)**	**11,560**	**330 (3%)**

Source: DECC modelling

21. Table 19 presents the impact of EMR on consumer bills relative to basecase C. Annual average household electricity bills, after the implementation of Electricity Market Reform, are expected to be, on average, around 2% (£12) higher than they would have been under basecase C over the period 2016-2030. Bills for Non-Domestic consumers and EIIs are also expected to be between 2 and 3% higher.

22. Between 2016 and 2020 average annual electricity bills are estimated to be marginally higher under EMR, than they otherwise would have been, with annual household electricity bills around £4 (1%) higher. In the early 2020's the costs of EMR increase, with average annual domestic electricity bills £15 (3%) higher under EMR in comparison to the basecase. EMRs bill impacts peak in 2025, before declining. In 2030 the modelling suggests annual domestic electricity bills could be £8 (1%) higher under EMR in comparison to what they would have been under a basecase which does not reach the same level of decarbonisation.

Basecase D – Decarbonisation with the Renewables Obligation (RO)

23. Basecase D meets the decarbonisation ambition through the RO instrument alone. As Nuclear or CCS technologies cannot be incentivised through this instrument, decarbonisation is achieved in this scenario through investment in renewable technology alone (and through the RO instrument). This section presents the NPV and prices and bills analysis of EMR relative to this basecase.

Cost Benefit Analysis (CBA)

24. Relative to decarbonising through the RO alone, EMR results in a large increase in net welfare of around £29bn (up to 2030). Reflecting the relatively similar carbon emission profiles of the two scenarios, carbon costs are broadly similar under EMR and this

basecase. Capital costs are around £24bn lower up to 2030 reflecting both the efficiency of delivering renewable investment through EMR, rather than the RO, but also the capital cost benefits of meeting the 2030 ambition through a combination of renewable, nuclear and CCS technology, rather than renewables alone.

Table 20: Change in Net Welfare (NPV) - CfDs with Capacity Market compared to basecase D

		NPV, £m (Real 2012)		
		2012 to 2030	2012 to 2040	2012 to 2049
Net Welfare	Value of carbon savings	-1,600	2,200	4,200
	Generation cost savings	6,200	19,000	31,000
	Capital cost savings	24,000	38,000	38,000
	Unserved energy savings	26	1,700	3,000
	Cost of Interconnector energy saved	-300	140	1,000
	Change in Net Welfare	**29,000**	**60,000**	**76,000**

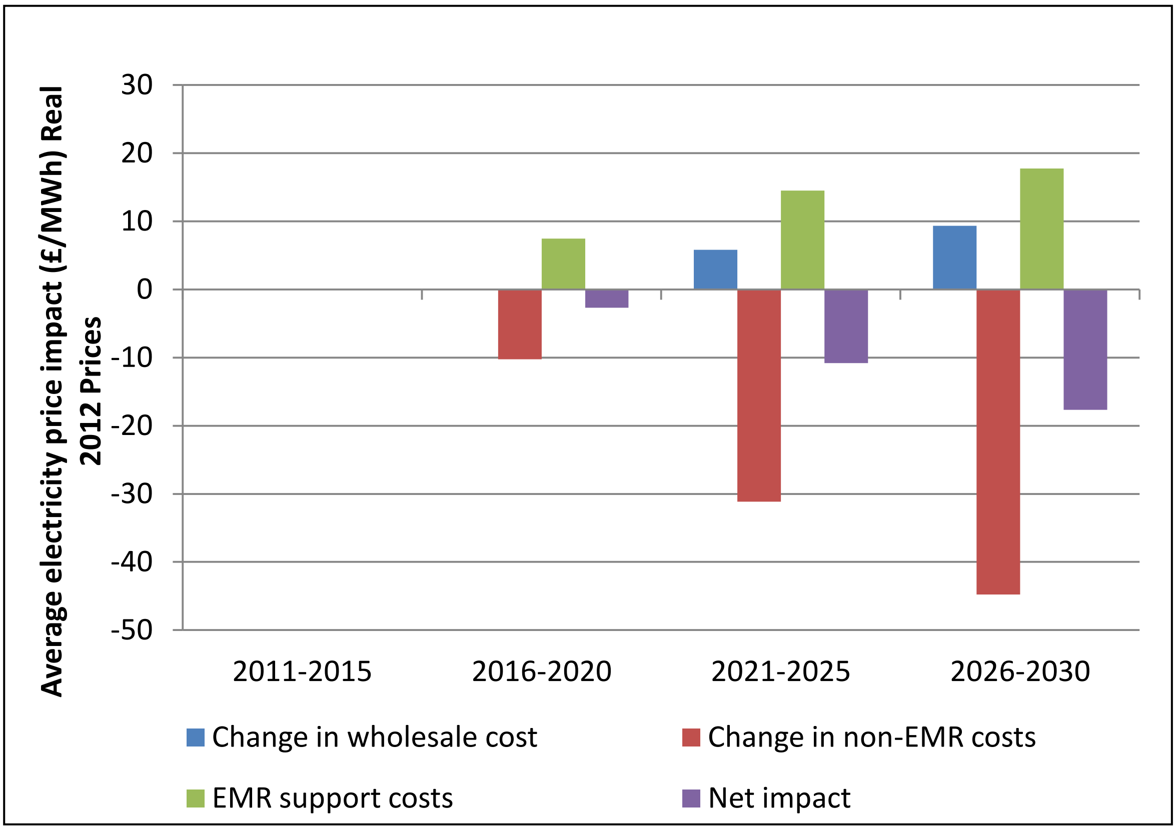
Source: DECC modelling

25. Assessed over a longer time frame EMR generates larger positive net-welfare benefits when assessed up to 2040 and 2049. Assessed up to 2049 the lower generation and capital costs realised under EMR could lead to an improvement in net welfare of around £76bn. In addition, by 2040 the benefits of the capacity market are illustrated through lower unserved energy costs, which by 2049 could be worth around £3bn.

Price and Bills Analysis

26. Chart 12 presents the average impact of EMR on domestic retail prices relative to this basecase. Over the period 2016-2030 average prices could be around 5% lower under EMR in comparison to what they would be under basecase D. In the period 2026-2030 prices are around 8% lower under EMR, compared to what they would be under basecase D. Relative to this basecase EMR would in fact increase wholesale prices (a reflection of the decarbonisation ambition being achieved through increased renewable investment alone). However, this wholesale price impact (and the cost of EMR support costs) is offset by the reduction in non-EMR support costs (reflecting the cost of supporting renewable investment through the RO in the basecase).

Chart 12: Net Impact of EMR on Domestic Electricity prices (relative to RO basecase)



Source: DECC modelling

27. Table 21 presents the impact of EMR on consumer electricity bills relative to a basecase D. All consumers would enjoy lower electricity bills under EMR compared to what they would be if the decarbonisation ambition were met through the RO. Under EMR, domestic consumer bills could be 5% lower on average, over the period 2016-2030, compared to what they would be under basecase D. The largest reductions would be realised over the period 2026-2030, when bills could be 8% lower. The impact on average bills for businesses and energy intensive industries will be similar.

Table 21: Bill impacts relative to basecase D

Real 2012 prices	Bill under basecase £	Change in bill as a result of EMR, £ (%)	Bill under basecase, £	Change in bill as a result of EMR, £ (%)	Bill under basecase, £	Change in bill as a result of EMR, £ (%)
	Domestic, (£)		Non-Domestic (with CRC), (£ 000's) (rounded)		EII, (£ 000's) (rounded)	
2011-2015	580	-	1,150	-	8,340	-
2016-2020	619	-£8 (-1%)	1,400	-£20 (-2%)	11,030	-£220 (-2%)
2021-2025	644	-£33 (-5%)	1,560	-£90 (-5%)	12,910	-£840 (-6%)
2026-2030	751	-£60 (-8%)	1,740	-£180 (-10%)	14,420	-£1,640 (-11%)
2016-2030	**671**	**-£34 (-5%)**	**1,560**	**-£90 (-6%)**	**12,780**	**-£890 (-7%)**

Source: DECC modelling