| | |
|---|---|
| **Title:** Government response to the consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order 2012. | **Impact Assessment (IA)** |
| **IA No:** DECC0075 | **Date:** 25/07/2012 |
| **Lead department or agency:** Department of Energy and Climate Change (DECC) | **Stage:** Final |
| **Other departments or agencies:** Ofgem | **Source of intervention:** Domestic |
| | **Type of measure:** Primary legislation |
| | **Contact for enquiries:** Samantha.Evens@decc.gsi.gov.uk Brian.Farthing@decc.gsi.gov.uk |

# Summary: Intervention and Options

**RPC Opinion:** N/A

| Cost of Preferred (or more likely) Option | | | | |
|---|---|---|---|---|
| **Total Net Present Value** | **Business Net Present Value** | **Net cost to business per year** (EANCB on 2009 prices) | **In scope of One-In, One-Out?** | **Measure qualifies as** |
| -£1,800m | N/A | N/A | No | N/A |

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

Renewable energy technologies are more expensive than fossil fuel alternatives, this and other non-financial barriers make government intervention necessary to incentivise sufficient investment in renewable electricity generation for the UK to meet its EU 2020 renewable energy targets. The Renewables Obligation (RO) is currently the UK's principal mechanism to incentivise growth in large scale renewable electricity generation. Bands of support under the RO were introduced in 2009, which allowed the RO to offer varied support levels by technology, and reviews of those banding levels were set for every four years. Banding reviews are necessary to help ensure enough large scale renewable electricity generation is deployed to achieve the UK's 2020 targets, this deployment is achieved cost effectively and the scheme meets other objectives, including delivering value for money to electricity consumers.

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

RO bands for the period 1st April 2013 to 31st March 2017 are proposed at levels that should help ensure the RO supports sufficient growth in renewable energy deployment to meet the UK's 2020 renewable energy targets. These recommendations on RO bands should increase the efficiency of the RO, offer value for money to consumers and ensure that the scheme remains within the budgetary constraints as set through the Levy Control Framework (LCF). By incentivising deployment of renewable electricity the RO supports delivery of wider energy and climate change goals to 2050, including reductions in greenhouse gas emission and the increased diversification of energy supply.

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

In October 2011 the Government consulted on different options for setting the RO bands for new stations for the review period from 1st April 2013 to 31st March 2017. This Impact Assessment (IA) considers three options:

(i) Option 1: Do nothing – leave current policy unchanged over the review period (i.e. maintain the current RO bands from 2013 to 2017[1]).

(ii) Option 2: Consultation bands – adopt RO bands over the review period as set out in the Government Consultation published in October 2011.

(iii) Option 3: Response bands – adopt refined RO bands over the review period as set out in the Government Response to the Consultation published alongside this IA in July 2012.

Option 3 is the preferred option. It reflects new evidence gathered during the consultation and adjusts some bands accordingly, with the aim of providing sufficient support for cost-effective renewable technology deployment to achieve the 2020 targets, offering value for money to consumers and staying within the LCF budgetary constraints.

**Will the policy be reviewed?** This is the last scheduled review. DECC will continue to monitor costs and deployment in the usual way.

| | | | | | |
|---|---|---|---|---|---|
| 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** N/A | **< 20** N/A | **Small** N/A | **Medium** N/A | **Large** N/A |
| What is the $CO_2$ equivalent change in greenhouse gas emissions? (Million tonnes $CO_2$ equivalent) | | | **Traded:** -82 | **Non-traded:** | |

1 Unlike for other technologies, "do nothing" would see the offshore wind band reduce from 2 to 1.5 ROCs/MWh from 1 April 2014, in line with the offshore-wind-specific early banding review conducted in 2009.

***I have read the Impact Assessment and I am satisfied that (a) it represents a fair and reasonable view of the expected costs, benefits and impact of the policy, and (b) that the benefits justify the costs.***

Signed by the responsible Minister: Charles Hendry Date: 24.07.12

# Summary: Analysis & Evidence Policy Option 2 Consultation bands

**Description:** the package of bands proposed in the Consultation. Impacts presented relative to the Do Nothing Option 1 (current bands).

**FULL ECONOMIC ASSESSMENT**

| Price Base | PV Base | Time Period | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| 2011/12 | 2012/13 | Years 27 | Low: | High: | Best Estimate: -2,300 |

| COSTS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Cost (Present Value) |
|---|---|---|---|---|
| Low | | | | |
| High | | | | |
| Best Estimate | | | 89 | **4,400** |

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

The monetised costs are increases in overall system generation costs and balancing costs, rounded to two significant figures. There is also a distributional cost to electricity consumers from higher RO support costs.

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

Wider macroeconomic costs of the small increase in retail electricity prices and, any small increase in intermittent generation that could adversely affect the security of supply.

| BENEFITS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Benefit (Present Value) |
|---|---|---|---|---|
| Low | | | | |
| High | | | | |
| Best Estimate | | | 74 | **2,100** |

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

The monetised benefits are the reduction in costs of EU Emissions Trading System Allowance (EUA) purchase to the UK power sector.

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

Bringing forward wave and tidal stream technologies as options for decarbonising the power sector and meeting rising electricity demand; developing renewables industries (note developing one sector of the economy will lead to some displacement and crowding out in other sectors); reducing risk of missing the UK's 2020 renewables target and of incurring potentially unlimited infraction fines; increased security of supply due to reductions in fossil fuel imports. There are likely to be small net air quality benefits, as the air quality benefits of displacing fossil fuel electricity generation outweigh any negative air quality impacts of increasing bioenergy and waste renewable technologies.

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

- Current technology costs and learning rates
- Maximum build rates by technology
- Biomass availability and fuel prices
- Fossil fuel prices
- Hurdle rates

**BUSINESS ASSESSMENT (Option 1)**

| Direct impact on business (Equivalent Annual) £m: | | | In scope of OIOO? | Measure qualifies as |
|---|---|---|---|---|
| **Costs:** N/A | **Benefits:** N/A | **Net:** N/A | No | N/A |

## Summary: Analysis & Evidence — Policy Option 3 Response bands

**Description:** revised bands taking into account new evidence gathered during the Consultation. Impacts presented relative to the Do Nothing Option 1 (current bands).

**FULL ECONOMIC ASSESSMENT**

| Price Base | PV Base | Time Period | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| 2011/12 | 2012/13 | Years 27 | **Low: -4,000** | **High: +2,900** | **Best Estimate: -1,800** |

| COSTS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Cost (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **5,600*** |
| **High** | | | | **-3,500*** |
| **Best Estimate** | | | 67 | **3,700** |

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

The monetised costs are increases in overall system generation costs and balancing costs, rounded to two significant figures. There is also a distributional cost to electricity consumers from higher RO support costs.

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

Wider macroeconomic costs of the small increase in retail electricity prices and any small increase in intermittent generation that could adversely affect the security of supply.

| BENEFITS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Benefit (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **1,600*** |
| **High** | | | | **-600*** |
| **Best Estimate** | | | 69 | **1,900**** |

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

The monetised benefits are the reduction in costs of EUA purchase to the UK power sector. There are small net air quality benefits, as the air quality benefits of displacing fossil fuel electricity generation outweigh any negative air quality impacts of increasing bioenergy and waste renewable technologies.

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

Bringing forward wave and tidal stream technologies as options for the decarbonising the power sector and meeting rising electricity demand; developing renewables industries (note developing one sector of the economy will lead to some displacement and crowding out in other sectors); reducing risk of missing UK's 2020 renewables target and of incurring potentially unlimited infraction fines; increased security of supply due to reductions in fossil fuel imports.

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

Key assumptions, sensitivities and risks relate to: current technology costs and learning rates; Maximum build rates by technology; Biomass availability and fuel prices; Fossil fuel prices; and Hurdle rates.

**BUSINESS ASSESSMENT (Option 2)**

| Direct impact on business (Equivalent Annual) £m: | | | In scope of OIOO? | Measure qualifies as |
|---|---|---|---|---|
| **Costs:** N/A | **Benefits:** N/A | **Net:** N/A | No | N/A |

***The monetised costs and benefits associated with the low net benefit estimate relate to a high fossil fuel price scenario, where both costs and benefits increase compared with current bands. The monetised costs and benefits associated with the high net benefit estimate relate to a low fossil fuel price scenario, where both costs and benefits decrease compared with current bands. Details of these scenarios are presented in Section 5 and Annex D of this IA.

**The benefits in the central case (central fossil fuel prices) are higher than in the low case (high fossil fuel case) owing to the higher increase in renewable deployment (largely ECF and conversions) under proposed bands compared to current bands.

# Evidence Base (for summary sheets)

The evidences base is set out as follows:

# 1. Strategic overview

1. The EU Renewable Energy Directive commits the UK to meeting 15% of its energy needs from renewable sources by 2020. To achieve this, renewable electricity supply from large scale generation will need to increase from around 26TWh in 2010 to around 108TWh (under the central renewables deployment scenario) by 2020, and further deployment of renewable electricity will need to come from smaller-scale generation (<5MW).

2. The Renewables Obligation (RO), introduced in 2002, is currently the Government's main financial policy mechanism for incentivising the deployment of large scale renewable electricity generation in the UK – small scale renewable electricity generation is incentivised through a separate Feed-in-Tariff scheme. Since the introduction of the RO in 2002, there has been a more than trebling in the UK's renewable generation, from 1.8% to 9.4% in 2011.[2] The RO has played an important part in securing reductions in carbon dioxide emissions, alongside other policy measures such as the Climate Change Act 2008.

3. From the RO's introduction in 2002 until 2008/09, all renewable energy technologies received the same band of support at 1 Renewable Obligation Certificate (ROC) per MWh of renewable electricity generated. Different RO bands of support for eligible technologies were set for new stations in the four years from 2009/10 to 2012/13, which sought to remove overcompensation of lower cost technologies and provide incentive for more expensive technologies that had significant deployment potential.

4. The Government Consultation published in October 2011[3] consulted on the levels of banded support for renewable electricity generation for the period 1st April 2013 to 31st March 2017 (except for offshore wind[4] where the RO bands were only considered for 2014/15 to 2016/17), and a number of other matters relating to the draft Renewables Obligation (Amendment) Order 2012 - including grandfathering, the co-firing cap, the bioliquids cap and definitional changes to some bands.

5. The RO will close to new renewables stations from 1st April 2017, whilst maintaining support for existing stations in the scheme out to their respective end dates (of which the latest would be expected in 2037), as part of the Electricity Market Reform. Support for large-scale renewable electricity will be available from around 2014 onwards through the new Feed-in Tariff with Contract-for-Difference scheme (FiT with CfD).

6. The objectives of this banding review are to:
    i. Set cost effective support levels for renewable technologies from 2013/14 to 2016/17;
    ii. Set levels which would keep the UK on track to meet the 2020 target, including interim targets for the two-year periods 2013-2014 and 2015-2016,and our longer term decarbonisation targets;
    iii. Fully take into account all six statutory factors for banding decisions, summarised below:
        (a) the costs (including capital costs) associated with each renewable electricity technology;

2 RO-eligible electricity generation as a proportion of UK electricity sales

3 http://www.decc.gov.uk/en/content/cms/consultations/cons_ro_review/cons_ro_review.aspx

4 An early review of the band for offshore wind was held in 2009, which led to it increasing from 1.5 to 2 ROCs/MWh for new stations up to and including 2013/14, after which it was due, in the absence of other action, to fall back to 1.5 ROCs/MWh.

(b) the income associated with generating electricity from each renewable electricity technology;
(c) the supplies from renewable sources exempted from the climate change Levy (CCL) in relation to generating electricity from each renewable electricity technology;
(d) the desirability of promoting the industries associated with renewables;
(e) impacts on the market for ROCs and on consumers; and
(f) contributions towards achieving European targets, including the interim and final 2020 renewables target.

7. The Coalition Government has made clear its commitment to maintaining a banded RO alongside other support mechanisms that will be introduced through Electricity Market Reform (i.e. FiT with CfD), with the aim of securing a significant increase in investment in renewable electricity generation.

8. In the light of new evidence generated through the Consultation process, this IA sets out the costs and benefits of final decisions on appropriate RO banding support levels for the period 1st April 2013 to 31st March 2017 for all eligible technologies. It should be noted that the assumed bands for large scale solar PV, standard co-firing and co-firing with energy crops will be subject to further consultation.

9. There are a number of related policy issues that are not covered in this IA and are subject to separate consultations, including: proposals to implement a dedicated biomass cap; to bring in further sustainability requirements for biomass; to bring in a new set of monitoring and reporting requirements for the co-firing and conversions bands; to take away support for new sub-5MW solar PV, AD, hydro and onshore installations in Great Britain; to remove the uplift for co-firing with energy crops; and to re-assess the solar PV band in the light of new evidence. These issues are discussed in Annex E.

## 2. Policy Objective / Rationale for intervention

10. The overarching objective of the RO is to facilitate the delivery of the UK's renewable energy targets, as set under the EU Renewable Directive. Government needs to ensure support is available to large-scale renewable electricity technologies, as current renewables costs are higher than their conventional alternatives, and as such they would not be undertaken at the levels required or in the timescales needed in the absence of support. Current bands under the RO do not put the UK on track to meet the renewables targets, therefore further cost effective deployment of large scale renewable electricity is required.

11. In addition to this, there are a number of market failures and other barriers which would lead to too little investment in renewable technologies without government intervention. These include: the negative externalities relating to greenhouse gas (CHG) emissions (i.e. the damage costs of GHG emissions are not factored into investor decision making, although this is being partially addressed by the EU Emissions Trading System, supported by the Carbon Price Floor); positive externalities relating to investment in innovative and emerging technologies; the homogenous nature of electricity as a product (from a consumers' perspective electricity is electricity[5] and is difficult for renewable generators to compete on anything other than price); imperfect information; and, limited access to capital.

[5] Although suppliers may label their electricity and tariffs according to its emissions.

12. RO bands for the period 1st April 2013 to 31st March 2017 are proposed at levels that should help ensure the RO supports sufficient growth in renewable energy deployment to meet the UK's 2020 renewable energy targets. These recommendations on RO bands should increase the efficiency of the RO, offer value for money to consumers and ensure that the scheme remains within the budgetary constraints as set through the Levy Control Framework (LCF). By incentivising deployment of renewable electricity the RO supports delivery of wider energy and climate change goals to 2050, including reductions in greenhouse gas emission and the increased diversification of energy supply.

## 3. Analytical approach

13. This IA sets out the impact on deployment of renewable technologies, and costs and benefits of changes to RO bands, against the counterfactual of continuing with current banding levels. This IA also estimates quantitatively and/or qualitatively as far as possible a number of other impacts, including:

    i) Carbon impacts;

    ii) Security of supply impacts;

    iii) Air quality and other environmental and social impacts; and

    iv) Ensuring compatibility with/ minimising risk of not being on a cost-effective pathway to 80% decarbonisation of the economy by 2050.

14. The analytical approach to assessing the impact of the options considered in this IA is broadly unchanged from the analysis for the RO banding review consultation. Changes to the evidence base are detailed in section 3 A) and Annex A. The analysis is based on a combination of electricity despatch modelling by Pöyry consultants and in-house renewables investment decision modelling described in sections 3 B) to E).

### A) Updated evidence base

15. To inform the IA that accompanied the Consultation published in October 2011, evidence was gathered by Arup, supported by their subcontractors Ernst & Young, on the deployment potential and generation costs of renewable electricity technologies currently or potentially eligible for RO support.[6] Other sources of evidence used included project pipeline data[7] and research commissioned for the CCC's Renewable Energy Review.[8]

16. During the consultation, responses were sought on the evidence collected for all technologies. In particular the National Non-Food Crops Centre collected data from advanced conversion technologies (ACT) developers and recommended ranges for the costs and deployment to be used in this analysis, while the international energy consultants AEA carried out a similar process for renewable combined heat and power (CHP) costs and deployment. DECC worked with coal generators considering biomass conversion/enhanced co-firing to understand costs, technical characteristics and deployment potential.

17. Revised estimates of capital costs, operating costs and certain other parameters for all technologies

[6] Arup (2011) available alongside the consultation document at: http://www.decc.gov.uk/en/content/cms/consultations/cons_ro_review/cons_ro_review.aspx
[7] From the Office for Renewable Energy Deployment, DECC
[8] Mott MacDonald (2011), Costs of Low Carbon Generation Technologies, available at hmccc.s3.amazonaws.com/Renewables%20Review/MML%20final%20report%20for%20CCC%209%20may%202011.pdf

were in the form of a range, generally reflecting the 10th and 90th percentiles of sample data for the pipeline of potential projects (or existing projects where pipeline data was not available). Projections of future costs were determined by learning rates (reflecting learning and economies of scale, market dynamics, etc). Cost data used in modelling the options for this IA are summarised in the annex to the government response. In Annex A of this IA is an explanation of revisions to DECC's cost data since publication of the Consultation IA in November 2011, based on consultation responses and third party information.

18. Since publication of the Consultation IA, all overarching assumptions have been revisited to reflect the latest evidence. These include:
    i. New DECC Fossil Fuel prices[9], which affect the estimates of wholesale electricity prices, and the costs of fossil fuel generation.[10]
    ii. New renewable fuel supply constraints and prices for biomass and waste technologies.[11]
    iii. New DECC electricity demand projections[12]
    iv. New DECC carbon prices for electricity modelling[13]
    v. Heat revenues, i.e. avoided cost of heat – revised following change to fossil fuel prices and carbon prices
    vi. Value of Levy Exemption Certificates (LECs) – post 2023/24 the amount of LECs supplied by renewable generators is estimated to exceed the demand for LECs from firms which pay the full rate of Climate Change Levy (CCL). The price of a LEC will therefore fall to the price paid by firms under a Climate Change Agreement (CCA), i.e. 10% of the full value.[14]
    vii. The conclusions of the government's Bioenergy Strategy[15]

19. Whilst all assumptions have been scrutinised, they are still subject to uncertainty. For example, the range of renewable capital costs which have been submitted as part of the consultation has been used as a proxy for the full range of overall project costs. However, these may over or under-estimate the variation in costs across projects for any particular technology. How costs vary over time is uncertain and to a large extent will depend on global deployment and the rate at which economies of scale can be achieved, technological developments and supply chain market dynamics. Future wholesale electricity prices are uncertain as they depend on many factors including fossil fuel prices and the impact of the changing regulatory framework, inter alia.

## B) Interactions with Electricity Market Reform

20. Full implementation of the Electricity Market Reform (EMR) has been assumed by Pöyry consultants in modelling the impact of RO banding options on the electricity market. This is consistent with the approach taken for the government Consultation and entails the introduction of:

[9] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx
[10] Assumptions on investor expectations of wholesale electricity prices can influence the ROC banding needed significantly, i.e. if lower wholesale electricity prices are assumed, a higher ROC band is needed for the investment to break even. For the central scenario, it is assumed that investors base their decisions on the modelled wholesale electricity prices from Pöyry, but that they have just five years of foresight, after which they assume electricity prices are constant in real terms at the level of the fifth year. In reality, different investors will have different views of future wholesale electricity prices.
[11] Based on AEA (2011), evidence provided in consultation and DECC calculations
[12] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx#2011-projections
[13] http://www.decc.gov.uk/en/content/cms/emissions/valuation/valuation.aspx#
[14] Demand for LECs is derived from two sources: firms which pay the full rate of CCL and firms under CCAs, who only pay 10% of the full cost of the CCL. Once demand for LECs from firms who pay the full rate of the CCL is satiated, the price falls to the avoided cost of the discounted CCL under CCAs.
[15] http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx

i. An Emissions Performance Standard (EPS);
ii. A capacity mechanism;[16]
iii. Carbon Price Floor; and
iv. A system of feed-in tariffs with contract for difference[17] (FiT with CfD) to support low carbon technologies including renewables.

21. After the introduction of the new FiT with CfD (the first contracts are expected in 2014), new renewables developers will have the choice between support under the RO and support under the FiT with CfD, until the closure of the RO to new stations from 1st April 2017. Investment decisions are likely to be aided by financial investment decision (FID) enabling strategies should these be implemented as part of the EMR package. In view of this, it has been assumed for the purpose of this analysis that:

    i. All new renewables stations eligible for the RO and commissioning in 2013/14, 2014/15 and 2015/16 will be supported under the RO (except where they are eligible for small-scale FiTs).
    ii. All new renewables stations eligible for the RO and commissioning in 2016/17 will be supported under the new FiT with CfD scheme, rather than the RO.

22. These are simplifying assumptions and it is not clear at this stage whether individual investors will choose the RO or the FiT with CfD. The switchover point is a modelling simplification. In reality, there is likely to be an overlap period, with some new renewables stations choosing the FiT with CfD in earlier years, and some choosing the RO in 2016/17, if they judge the risk of missing the RO end-date to be insignificant (or if their construction overruns from an intended accreditation date in earlier years).

## C) General modelling approach

23. To analyse the options set out in this IA, DECC commissioned Pöyry to run their Eureca electricity market despatch model and ROCket renewable electricity model. In addition, DECC undertook in-house analysis to act as a cross check and test additional sensitivities.

24. ROCket determines the renewables investment and hence deployment for a given set of RO bands. The range of overall generation costs (i.e. levelised costs) for most technologies is driven by considering the range of capital costs only, keeping all other assumptions on their central values. The range of ROCs required for ACT and Energy from Waste (EfW) plants is driven by both the range of capital costs and gate fees (negative fuel costs), as there is particular uncertainty about the gate fee for these plants. Given the way in which projects in the EfW market compete with each other for waste contracts, the ROCs required for EfW CHP plants have been assessed relative to the economics of power only plants with the same assumption on gate fees.

25. Eureca is used to estimate non-renewable investment decisions, short-run despatch decisions for all technologies and how total supply meets demand overall and the resulting wholesale prices. The modelling approach involves iteration between the two models, with wholesale electricity prices from the Eureca model driving investor decisions in the ROCket model, which then influences electricity prices. Because of the relatively high level of uncertainty on the future deployment of biomass conversion and enhanced co-firing (ECF), a more detailed analysis was also used to look at the possible impact of different banding levels on the deployment of these two technologies and hence costs.

[16] Assumed to be implemented if capacity margins are expected drop below 10%.
[17] For full details, see the Energy Bill (2012), available at: http://www.decc.gov.uk/en/content/cms/legislation/energybill2012/energybill2012.aspx

26. Alongside Pöyry modelling, DECC developed an in-house discounted cashflow model to determine the range of ROCs required for each technology for each year until 2016/17 – this analysis is presented at Annex F. The in-house analysis was used to cross check the results from the Pöyry modelling, explore further sensitivities and help choose the banding options for Pöyry to model according to the objectives set out in section 3. D) below.

## D) Approach used for selecting the banding options for each technology

27. DECC's in-house analysis determined a range of ROCs required by each technology. From this range bands were chosen (for each technology in each year of the banding review period) to model in ROCket/Eureca and, ultimately, to set the bands for the options in this IA. To ensure the schemes objectives are met, as set out in section 1, the following principles were followed when selecting the bands for each technology:

    i. To reduce costs to consumers the bands incentivised more of the relatively cheaper technologies and less of the relatively expensive technologies.
    ii. Proposed bands are never above the top of the ranges of ROCs required to ensure that costs to the economy and consumers are not higher than necessary.
    iii. Technologies with significant large-scale deployment potential were incentivised so that the expected trajectory remains on track to meet large-scale electricity's contribution to interim and 2020 renewables targets, while ensuring a range of technologies are incentivised.
    iv. Technologies which have strategic long-term value for 2020 and beyond, and/or where is it particularly desirable to promote the industries associated with the technologies, were allocated more support than a strict minimising cost approach up to 2020 (this applies to offshore wind, ACTs, wave and tidal technologies).
    v. Bands were selected to ensure coal to biomass conversions and enhanced co-firing are incentivised at a level consistent with helping security of electricity supply, more detail on the modelling approach for these technologies is given in Annex C.
    vi. To limit costs to consumers, bands were selected to ensure expected RO spend was less than the total RO budget for the four years of the Levy Control Framework (LCF) and that expected overspends in individual years did not exceed the 20% allowed flexibility on the overall LCF budget.

## E) Modelling approaches for biomass conversions and Enhanced Co-Firing (ECF)

28. The responses to the Banding Review consultation indicated there was more potential for biomass conversions and ECF during the banding review period, than indicated by Arup's analysis on technical potential for the RO consultation. Given this uncertainty and the large potential impact of this technology on RO spending and renewable electricity deployment, potential uptake was analysed in detail. In common with the approach taken for all technologies, DECC undertook Pöyry modelling and in-house modelling of conversions and ECF investment decisions. In addition to this, a "bottom-up" view based on a combination of modelling, together with technical and market intelligence, was generated to underpin the central results set out in section 5. below. Full details for these technologies are presented in Annex C.

# 4. Description of options considered

29. This section explores the options considered as part of the Government Response to the consultation on the RO banding review. There are a number of related policy issues that are not covered in this IA and are subject to separate consultations (see Annex E).

***Option 1 – Do nothing (Current bands)***

30. This option retains the bands which are currently offered through the RO, as shown in the second column of Table 1 below. It also retains the cap on co-firing at 12.5% of all ROCs that suppliers can submit in a given year.

***Option 2 – Consultation bands***

31. This option reflects the bandings as proposed in the Consultation. In particular, it removes the cap on co-firing; introduced two new bands of ECF and conversion; increases support for wave and tidal stream to 5 ROCs/MWh (subject to a 30MW project cap); cuts support for hydro and EfW to 0.5 ROCs/MWh; reduces support for onshore wind to 0.9 ROCs/MWh; and reduces support for everything at the 2 ROCs level, including offshore wind, to 1.9 in 2015/16 and 1.8 in 2016/17.

***Option 3 – Response bands***

32. Following assessment of new evidence received through the Consultation and updated analysis, the following changes to the Consultation bands have been announced in the Government Response:

- **Standard co-firing (SCF), enhanced co-firing (ECF) and conversion:**

  I. To redefine SCF, ECF and conversion as burning a percentage of biomass fuel in a boiler /unit as opposed to the percentage of biomass fuel burnt in the whole (former) fossil fuel power station, with bands increasing gradually as a greater percentage of biomass is burned in each unit as follows:

     - SCF (Up to 50% biomass) at 0.3 ROCs/MWh in 2013/14 and 2014/15 rising to 0.5ROCs/MWh for the rest of the period – this proposal will be the subject of a further consultation
     - Mid-range co-firing (50% to up to 85% biomass) at 0.6 ROCs/MWh
     - High-range co-firing (85% to up to 100% biomass) at 0.7 ROCs/MWh in 2013/14, rising to 0.9 ROCs/MWh from 2014/15
     - Conversion (100% biomass) at 1.0 ROC/MWh

  II. Proposed new monitoring and reporting requirements for biomass conversions and ECF will be the subject of a new consultation. See section 9 of the government response.

  III. Bioliquids will not be an eligible fuel for the mid-range co-firing and high-range co-firing bands.

  IV. There will be no additional support for mid-range co-firing with energy crops, high-range co-firing with energy crops or conversion with energy crops bands.

  V. There will be additional support for mid-range co-firing with CHP, high-range co-firing with CHP and conversion with CHP bands.[18] Extra support for CHP may incentivise heat

[18] These extra bands are not expected to result in significant extra deployment, as neither the evidence available for the consultation or the

offtake on these technologies where there is a heat demand, allowing greater efficiency and carbon savings.

- **Solar PV.** Evidence by PB Power[19] collected for the FiTs Consultation demonstrated that estimates of the cost of solar PV had fallen dramatically. In response to this evidence, the Government will consult on proposals for reduced ROC support for solar PV generating stations which accredit or add additional capacity on or after 1 April 2013;
- **Energy from Waste CHP:** EfW CHP will be supported at a higher level (1 ROC/MWh) than that proposed in the consultation. New cost evidence was used and an investment decision was assessed against a counterfactual of building a power-only plant, which is a more appropriate basis than no investment at all. This new analysis indicated more support was required.
- **Advanced Conversion Technologies[20]:** analysis of data from the ACT call for evidence indicated that the costs of most 'standard' (steam cycle) plants had been underestimated for the consultation, with a range of ROCs required from 0 to 7.7[21]. The new evidence suggests that the ROCs required to incentivise all of the technical potential for both 'standard' and 'advanced' (gas engine) is above 2 ROCs/MWh, although much of it can be brought on at 2 ROCs. In order to encourage the development of a reasonable level of both standard and advanced ACT, the Government response has announced that all new accreditations and additional capacity added in 2013/14 and 2014/15 will receive 2 ROCs/MWh, reducing to 1.9 ROCs/MWh in 2015/16 and 1.8 ROCs/MWh in 2016/17.
- **Hydro:** in order to incentivise more deployment of this cost-effective technology, support has been increased from the consultation proposal of 0.5 ROCs/MWh to 0.7 ROCs/MWh for new accreditations and additional capacity added in the banding review period (1 April 2013 to 31 March 2017). Following consultation responses, and further discussions with developers, the generic cost and potential assumptions for hydro above 5MW were revised, and individual pipeline project data analysed - these individual results are commercially confidential.
- **Landfill gas:** an additional 0.1 ROCs/MWh will be available to incentivise waste heat to power units as evidence was provided of the additional efficiency gain and hence additional generation of adding 'waste heat to power' units onto landfill gas installations. Whilst no costs were provided to suggest landfill recovery required support from open sites, consultation responses indicated that there was new landfill gas potential from closed sites no longer accepting waste, and that there were additional costs associated with closed sites, which are expected to require 0.2 ROCs/MWh to proceed. Given the cost-effectiveness of landfill gas recovery, support is now proposed at 0.2 ROCs/MWh for landfill gas generation from closed sites.

33. Table 1 below shows the banding level for each technology under all three options considered in this IA. Options relating to scheme design decisions other than banding levels (i.e. grandfathering, technology definitions and caps), and their impacts, are described separately in the government response and Annex E to this IA.

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evidence gathered through the consultation indicated any potential for these technologies with CHP.

19 http://www.decc.gov.uk/en/content/cms/meeting_energy/Renewable_ener/feedin_tariff/feedin_tariff.aspx

20 In Table 1 these are labelled as standard and advanced gasification and pyrolysis.

21 2014/15 ROC range.

**Table 1: Technology banding option packages considered for new build from 2013-17, bandings in ROCs/MWh of renewable electricity supplied**

| Technology | Option 1: Current bands/do nothing | Option 2: Consultation bands | Option 3: Response bands |
|---|---|---|---|
| **Wave** | 5 in Scotland, 2 in rest of UK | 5 up to a 30MW project cap. 2 above the cap | |
| **Tidal stream** | 3 in Scotland, 2 in rest of UK | 5 up to a 30MW project cap. 2 above the cap | |
| **Solar PV** | 2.0 | 2.0 in 2013/14 and 2014/15, 1.9 in 2015/16 and 1.8 in 2016/17 | Proposals subject to further consultation |
| **Onshore wind** | 1.0 | 0.9 except small-scale in N.I.[22] | |
| **Offshore wind** | 2 to 2013/14; 1.5 2014/15 onwards[23] | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |
| **Hydro** | 1.0 | 0.5 | 0.7 except small-scale in N.I. |
| **Standard co-firing of biomass** | 0.5 | 0.5 (defined as less than 15% co-firing of whole station) | 0.3 in 2013/14 and 2014/15; 0.5 in 2015/16 and 2016/17 (defined as 0-49% co-firing in a unit) – proposals subject to further consultation |
| **Enhanced co-firing of biomass** | Eligible for co-firing of biomass, 0.5 | 1.0 (ECF defined as biomass 15% or more of whole station) | 0.6 (50-84% cofiring) 0.7 (85-99% cofiring), rising to 0.9 in 2014/15 (percentages of units) |
| **Biomass conversion** | Eligible for dedicated biomass, 1.5 | 1.0 (conversion defined as biomass 100% of whole station) | 1.0 (conversion defined as biomass 100% of a unit) |
| **Biomass conversion with CHP** | Eligible for dedicated biomass with CHP, 2 | Conversion defined as biomass 100% of whole station | 1.5 or 1 plus RHI in 2013/14 and 2014/15; 1 plus RHI from 2015/16 (biomass 100% of a unit) |
| **Biomass conversion using energy crops** | Eligible for dedicated energy crops, 2 | Conversion defined as biomass 100% of whole station | 1 (biomass 100% of a unit) – no separate band to biomass conversion |
| **Biomass conversion using energy crops with CHP** | Eligible for dedicated energy crops with CHP, 2 | Conversion defined as biomass 100% of whole station | 1.5 or 1 plus RHI in 2013/14 and 2014/15; 1 plus RHI from 2015/16 (biomass 100% of a unit) |
| **Dedicated biomass** | 1.5 | 1.5 in 2013/14, 2014/15 and 2015/16; 1.4 in 2016/17 | |
| **Dedicated biomass with CHP** | 2.0 | 2.0 or 1.5 plus RHI in 2013/14 and 2014/15; 1.5 plus RHI in 2015/16; and 1.4 plus RHI in 2016/17 | |

[22] Higher rates of support are available for such installations in Northern Ireland, which does not currently operate a small-scale FIT scheme. The Government will shortly consult on proposals to exclude from the RO new solar PV, AD, hydro and onshore wind installations at or below 5 MW that are currently eligible for support under either the RO or FITs scheme.

[23] Unlike for other technologies, “do nothing” would see the offshore wind band reduce from 2 to 1.5 ROCs/MWh from 1 April 2014, in line with the offshore-wind-specific banding review conducted in 2009

| Technology | Option 1: Current bands/do nothing | Option 2: Consultation bands | Option 3: Response bands |
|---|---|---|---|
| **Dedicated energy crops** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |
| **Dedicated energy crops with CHP** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |
| **Co-firing of biomass with CHP** | 1.0 | 1 (defined as less than 15% co-firing of whole station) | 0.5 ROC uplift in addition to prevailing ROC support available to SCF until 31 March 2015 |
| **Co-firing of energy crops** | 1.0 | | Proposals subject to further consultation |
| **Enhanced co-firing of biomass with CHP** | Eligible for co-firing of biomass with CHP, 1 | Defined as less than 15% co-firing of whole station | 1.1 or 0.6 plus RHI in 2013/14 and 2014/15; 0.6 plus RHI from 2015/16 (50-84% co-firing in a unit);<br>1.2 or 0.7 plus RHI in 2013/14; 1.4 or 0.9 plus RHI in 2014/15; 0.9 plus RHI from 2015/16 (85-99% co-firing in a unit) |
| **Co-firing of energy crops with CHP** | 1.5 | | Proposals subject to further consultation |
| **Energy from waste with CHP** | 1.0 | 0.5 | 1.0 |
| **Standard gasification, standard pyrolysis** | 1.0 | 0.5 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 |
| **Advanced gasification, advanced pyrolysis** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |
| **Landfill gas** | 0.25 | 0 | 0 for open landfill sites, 0.2 for closed sites. 0.1 for new Waste Heat to Power at open and closed sites. |
| **Sewage gas** | 0.5 | | |
| **AD** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 except small-scale in Northern Ireland |
| **Geopressure** | 1.0 | | |
| **Geothermal** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |
| **Tidal impoundment – barrage or lagoon** | 2.0 | 2.0 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 | |

# 5. Impacts of options considered

34. This section sets out the impact of Option 2 and Option 3 of the Government response to the consultation on the RO banding review in terms of:

A) Renewable electricity deployment and the generation mix
B) Total power sector generation costs (excluding carbon allowance purchases)
C) Carbon allowance purchase costs
D) System balancing costs
E) Air quality impacts
F) Net monetised impacts (B + C + D + E)
G) Non-monetised impacts
H) Distributional impacts

## A) Renewable electricity deployment and the generation mix

35. Annex B gives full details of the capacity and generation mix under current bands, as well as the new build supported by the RO under Options 2 and 3 considered over the banding review period from 2013/14 to 2016/17.[24] Table 2 and 3 below summarise this information for the main technologies.

**Table 2: Modelled new build capacity under different options, MW**

| | | New build under the RO during the 2013-17 Banding Review period, supported under the RO*** | | |
|---|---|---|---|---|
| **Modelled Capacity (MW)** | **Total deployment by 2012/13** | **Option 1 Current bands** | **Option 2 Consultation bands** | **Option 3 Response bands** |
| Biomass conversion and enhanced co-firing | 1,200 | 1,500 | 3,200 | 3,200 |
| Onshore wind (>5MW)* | 7,000 | 2,800 | 2,600 | 2,600 |
| Offshore wind | 3,600** | 0 | 530 | 530 |
| Dedicated biomass >50MW | 50 | 78 | 78 | 78 |
| Dedicated biomass <50MW | 340 | 170 | 170 | 170 |
| Tidal stream | 2 | 0 | 23 | 23 |
| Wave | 1 | 0 | 0 | 0 |
| Other**** | 3,400 | 980 | 960 | 710 |
| **Total 'large-scale'**** | **16,000** | **5,500** | **7,600** | **7,300** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; results rounded to two significant figures.
* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.
**For offshore wind this is total deployment by 2013/14 as the band is already set for 2013/14.
*** For offshore wind this only includes capacity built in 2014/15 and 2015/16.
****Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind supported by FiTs in Great Britain. Other includes large scale >5 MW PV. Bands for large scale PV will be subject to further consultation in the near future. Large scale PV costs and deployment are indicative at this stage

[24] This includes renewables new build commissioning from 2013/14 to 2015/16. In 2016/17, new build is assumed to be supported by CfDs.

**Table 3: Modelled generation from new build capacity under different options, GWh per year**

| Modelled annual generation (GWh per year) | Annual generation from capacity built by 31/3/2012 | Annual generation in 2016/17 from new build supported under the RO during the Banding Review period (2013/14 - 2016/17):*** | | |
|---|---|---|---|---|
| | | Option 1 Current bands | Option 2 Consultation bands | Option 3 Response bands |
| Biomass conversion and enhanced co-firing | 6,800 | 8,300 | 18,400 | 18,400 |
| Onshore wind (>5MW)* | 17,000 | 6,800 | 6,400 | 6,400 |
| Offshore wind | 11,000** | 0 | 1,600 | 1,600 |
| Dedicated biomass >50MW | 400 | 610 | 610 | 610 |
| Dedicated biomass <50MW | 2,600 | 1,400 | 1,400 | 1,400 |
| Tidal stream | 8 | 0 | 80 | 80 |
| Wave | 3 | 0 | 0 | 0 |
| Other**** | 17,000 | 4,100 | 3,900 | 3,900 |
| **Total 'large-scale'**** | **55,000** | **21,000** | **32,000** | **32,000** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; results rounded to two significant figures

* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.

** For offshore wind this is generation from capacity built by 2013/14 as the band is already set for 2013/14.

*** For offshore wind this only includes generation from capacity build in 2014/15 and 2015/16.

****Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Other includes large scale PV. Bands for large scale PV will be subject to further consultation in the near future. Large scale PV costs and deployment are indicative at this stage.

36. As discussed in section 3. B), the simplifying assumption has been made that new stations with the choice between the RO and FiT with CfD will choose the RO up until 31st March 2016, and the FiT with CfD thereafter. This implies that the RO bandings will influence build over the first three years of the banding review period, which is presented in the tables above (though in reality it may be that some new build still occurs under the RO in 2016/17 and some build modelled as being under the RO before that is actually supported by the FiT with CfD).

37. Total modelled large-scale renewable electricity generation, towards the renewable target in 2016/17 is around 68TWh under Option 1 and around 79TWh[25] under Options 2 and 3, net of decommissioning but excluding new build from CfDs. Total generation in 2016/17 for each of the options is not the sum of existing generation and new build generation in Table 3, as decommissioning of some renewable plants has not been accounted for in this table and generation from standard co-firing is estimated to be slightly higher in 2012/13 than in 2016/17.

38. These tables are based on the results of modelling by Pöyry consultants coupled with DECC bottom up analysis for ECF and conversions; as with any modelling the outputs are based on input assumptions and therefore subject to uncertainty. Note ECF includes both the mid-range and high-range co-firing bands.

39. **Option 2 (Consultation bands):** increases renewables capacity by around 2.1GW and renewables generation by around 11TWh by 2016/17 compared to Option 1, to reach around 79TWh/y large-scale renewable electricity in total (net of decommissioning, and excluding new build under CfDs). This section outlines how each technology contributes towards total modelled capacity and generation.

[25] Generation is around 79.5TWh in the modelling for options 2 and 3, the difference between generation under option 1 and options 2 and 3 when rounded is closer to 11TWh that 12TWh. The difference in generation between options 2 and 3 is negligible, only around 40GWh.

40. Option 2 reduces support for biomass conversion (from 1.5 to 1 ROCs/MWh), but at the same time increases support for enhanced co-firing (ECF) compared to current bands. DECC's bottom-up assessment assumes one or two plants shift from full conversion to ECF. In total, 1.7GW of ECF capacity delivering around 10 additional TWh/y of generation is brought on under Option 2.

41. Support for onshore wind is reduced from 1 to 0.9 ROCs/MWh. New build onshore wind over the banding review period under the RO falls from 2.8GW to 2.6GW [26], compared to current bands. Generation from new build falls from 6.8TWh/y to 6.4TWh/y compared to current bands.

42. The band for offshore wind is increased compared to the bands that would be in place in the absence of this banding review, remaining at 2 ROCs in 2014/15 and reducing to 1.9 in 2015/16 and 1.8 in 2016/17, as opposed to 1.5 in those years (which was the previously-announced position, following the offshore-wind-specific banding review in 2009). New build offshore wind capacity in 2014/15 and 2015/16[27] increases, relative to a band of 1.5 ROCs, by around 530MW, delivering around 1.6TWh/y of additional generation.[28]

43. The band for dedicated biomass remains at 1.5 ROCs/MWh in line with current bands for the first three years of the banding review period, reducing to 1.4 in 2016/17. Modelled capacity for plant size less than 50MW is 170MW and for plant size above 50MW is around 78MW by 2015/16. New build dedicated biomass capacity remains the same as under current bands, with almost 250MW of capacity deployed by 2016/17. However, market assessment indicates that there could be scope for more deployment potential by 2016/17. This it is likely to be restricted by a combination of project economics, feedstock constraints and a cap on dedicated biomass within the RO, for which there will be a new consultation.

44. Support for tidal stream is increased from 2 ROCs/MWh to 5 ROCs/MWh (3 to 5 in the case of Scotland) which, in combination with assumed 25% grants[29], brings on around 23MW of modelled capacity by 2015/16. DECC believe this to be a conservative estimate; more might come forward if the costs or required returns are lower than assumed, but it is expected that tidal stream deployment will remain relatively modest under the RO, in the tens rather than multiple hundreds of MWs by 1st April 2017.

45. Support for wave is increased from 2 ROCs/MWh to 5 ROCs/MWh becoming equal to the banding support in Scotland, where wave is already eligible for 5. Modelling results show support at 5 ROCs/MWh with a 25% capital grant is not sufficient, given current cost assumptions, to bring on any wave deployment between 2013/14 and 2015/16. However, the bottom of the range of ROCs required is only 5.3 ROCs/MWh in 2015/16, so with a little more cost reduction, or a lower required return, there may be some wave deployment in that year. The modelling indicates that 5 ROCs/MWh would be sufficient to incentivise some wave deployment in 2016/17, but this is assumed to be supported by the FiT with CfD.

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26 According to Pöyry modelling. DECC's in-house modelling suggests a fall of 250MW. The cost-benefit analysis below uses the Pöyry results.
27 The offshore wind band for 2013/14 is already committed and so not considered in this analysis.
28 As explained in section 2B, a simplifying assumption used in the modelling is that all new build generation in 2016/17 chooses the new FiTs with CfD.
29 Wave and tidal schemes may be eligible for a grant of up to 25% under the Marine Energy Array Demonstrator (MEAD) scheme. In modelling the banding options for these technologies we have assumed projects receive the full grant, to avoid overcompensation under the RO. This does not pre-judge the levels that may be available under MEAD or other support mechanisms.

46. Option 2 reduces the bands for standard ACT from 1.0 to 0.5, EfW CHP from 1.0 to 0.5 and large-scale hydro (<5MW) from 1.0 to 0.5. This reduces standard ACT deployment by 36MW, or over 80% (resulting from the use of new cost data from stakeholders provided in the call for evidence). DECC assessed the ROCs required for EfW CHP in-house, on the basis of the relativity between the economics of EfW power only and EfW CHP and looked at individual project data for pipeline hydro plants. This indicates that the reduction in EfW CHP and large-scale hydro bands to 0.5 would reduce deployment by around 220MW (100%) and 16MW (around 70%) respectively.[30]

47. **Option 3 (Response bands):** increases renewables capacity by around 1.8GW compared to current bands (0.3GW less than under Option 2) and renewables generation by around 11TWh by 2016/17, the same as Option 2, to reach around 79TWh/y large-scale renewable electricity in total (net of decommissioning, excluding new build under CfDs).

48. Modelled deployment for Option 3 is the same as for Option 2, except with regard to ECF, standard ACT, landfill gas and SCF. DECC's bottom-up assessment for ECF shows 1.5GW of new build in 2013/14 under Option 2 is delayed to 2014/15 under Option 3 (when the band rises for 85-99% from 0.7 to 0.9 ROCs/MWh). Standard ACT new build in Option 3 (with ROCs/MWh of 2 in 2013/14 and 2014/15, 1.9 in 2015/16 and 1.8 in 2016/17) reaches around 43MW in the Pöyry modelling from 2013/14 to 2015/16, compared to around 7MW under Consultation bands (0.5 ROCs). Landfill gas from closed sites is increased to 0.2 ROCs/MWh and from waste to heat power to 0.1 ROCs/MWh, which brings on around 12MW of new capacity, compared to around 11MW with no support in option 2 (Consultation bands). Under the bands set out in Option 3, generation from SCF is expected to reduce in the first two years of the banding review period compared to Option 2, but contribute the same amount of renewable generation towards the renewables targets in 2015/16 and 2016/17 as in Option 2. The SCF banding support will be subject to a further consultation, as will assumed support levels for large scale solar PV.

49. DECC assessed the ROCs required for EfW CHP in-house on the basis of the relativity between the economics of EfW power only and EfW CHP; and looked at individual project data for pipeline hydro plants. This in-house analysis indicates that 1.0 ROC/MWh would bring on around 40%, but not all of the EfW CHP potential. For large-scale hydro, the in-house analysis indicated that 0.7 ROCs/MWh would bring on almost all of the available potential.

50. Table 4 below shows non-renewable generation over time for Option 3, and the change relative to Option 1. In the first few years, the main difference relates to a reduction in coal generation, with the gap first filled by CCGT generation, whilst converting coal plant are offline, and then biomass (and a little coal again in the case of ECF) once they are online again. CCGT falls below current bands from 2016/17 onwards as more renewables generation comes online and displaces it. The future generation mix is very uncertain, especially post-2020, and these results should be treated as purely illustrative further into the future.

[30] Note that the deployment estimates in Tables 2 and 3 and the cost-benefit analysis results are based on the Pöyry modelling, which used a counterfactual of no investment at all ( as opposed to power-only investment) for EfW CHP and which used generic hydro plant data. They do not fully reflect the bottom up estimates generated by DECC through its ROCs required analysis set out in Annex F.

**Table 4: Great Britain non-renewable generation in TWh under Option 3 Response bands, and change relative to Option 1 Current Bands**

| | 2013/14 | | 2014/15 | | 2015/16 | | 2016/17 | | | 2020/21 | | 2025/26 | | 2030/31 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TWh** | **•** | **TWh** | **•** | **TWh** | **•** | **TWh** | **•** | | **TWh** | **•** | **TWh** | **•** | **TWh** | **•** |
| **CCGT** | 73 | 6 | 66 | 10 | 57 | 3 | 86 | -2 | | 81 | -6 | 43 | -11 | 34 | 1 |
| **CCS Coal and Gas** | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | | 9 | 0 | 9 | 0 | 18 | 0 |
| **Non-renewable CHP** | 25 | 0 | 25 | 1 | 25 | 0 | 27 | 0 | | 30 | 0 | 31 | -2 | 31 | -1 |
| **Coal** | 112 | -1 | 117 | -10 | 110 | -12 | 68 | -10 | | 37 | -5 | 4 | 2 | 0 | 0 |
| **OCGT** | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | | 1 | 0 | 0 | 0 | 0 | 0 |
| **Nuclear** | 66 | 0 | 61 | 0 | 61 | 0 | 61 | 0 | | 44 | 0 | 97 | 0 | 114 | 0 |
| **Oil** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total non-renewable generation in GB** | 277 | 5 | 271 | 1 | 256 | -9 | 245 | -12 | | 203 | -11 | 184 | -11 | 198 | 1 |

Source: modelling by Pöyry consultants and DECC calculations to nearest TWh

## B) Total power sector generation costs (excluding carbon allowance purchases)

51. Total generation costs (defined as capital costs, finance costs[31], operating costs and fuel costs) increase under Options 2 and 3, compared to Option 1. Options 2 and 3 bring on more enhanced co-firing, offshore wind and tidal stream, whilst reducing deployment of onshore wind. Both options increase deployment of large scale electricity overall, putting the UK on track to meet large-scale renewable electricity's share of the renewable energy targets. The significant net increase in renewables build increases renewable generation costs, whilst the reduction in coal and later gas generation reduces non-renewables generation costs. The renewable technologies generation costs are higher than those of coal and gas, and so total generation costs increase as a result of the changes in bands.

52. The slightly lower increase in discounted total generation costs under Option 3 compared to Option 2 is primarily due to the delay in bringing on additional ECF from 2013/14 to 2014/15 (under consultation bands ECF gets 1.0 ROC/MWh from 2013/14 onwards whilst under the response bands 85-99% ECF gets 0.7 ROCs/MWh in 2013/14 and 0.9 in 2014/15 onwards). This also reflects lower costs associated with SCF under Option 3, where low range co-firing (defined as 0-49% biomass co-firing in a unit) receives banded support of 0.3 ROCs/MWh in 2013/14 and 2014/15 rising to 0.5ROCs/MWh for the rest of the period, compared with banded support of 0.5 ROCs/MWh over the entire review period for less than 15% co-firing of a whole station under Option 2.

**Table 5: Total power sector generation costs to 2040 under different banding options (discounted 2011/12 prices; £bn)**

| **£billion** | **Option 1 Current bands (absolute)** | **Option 2 Consultation bands – relative to current bands** | **Option 3 Response bands – relative to current bands** |
|---|---|---|---|
| Renewable | 260 | +11.9 | +10.9 |
| Non-Renewable | 310 | -7.7 | -7.3 |
| **Total** | **570** | **+4.3** | **+3.6** |

Source: modelling by Pöyry consultants and DECC calculations

## C) Carbon allowance purchase costs

53. The reduction in coal and gas generation under Option 2 leads to a reduction in total grid $CO_2$ emissions by around 92Mt to 2040, compared to current bands. Option 3 (Response bands) leads to a reduction of around 82Mt to 2040, compared to current bands.

54. The UK power sector is part of the EU Emissions Trading System (EU-ETS). This means that any reductions in UK power sector greenhouse gas emissions will be offset by increases (or foregone reductions) elsewhere in the EU-ETS. However, there is a benefit to the UK from such emissions reductions in terms of avoided carbon allowance (known as EUAs) purchase costs. The emissions reductions (offset by increase elsewhere) under Options 2 and 3 are valued at the DECC central traded carbon appraisal values[32] and amount to around £2.1bn and £1.9bn, respectively, of EUA purchase cost savings, compared to current bands.

[31] Finance costs are taken into account by annuitising capital costs at the assumed hurdle rates over a 15-year period.
[32] Which can be found on DECC's website here: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

**Table 6: EUA purchase costs to 2040 under different options, discounted 2011/12 prices (£bn)**

| £billion | Option 1 Current bands - absolute | Option 2 Consultation bands – change relative to current bands | Option 3 Response bands – change relative to current bands |
|---|---|---|---|
| Total | 37 | -2.1 | -1.9 |

Source: modelling by Pöyry consultants and DECC calculations

## D) System balancing costs

55. System balancing costs tend to rise with increased amounts of intermittent generation on the system. Under Options 2 and 3 system balancing costs are estimated to rise by around £0.1bn, compared to under current bands.

**Table 7: System balancing costs to 2040 different options, discounted 2011/12 prices (£bn)**

| £billion | Option 1 Current bands - absolute | Option 2 Consultation bands – change relative to current bands | Option 3 Response bands – change relative to current bands |
|---|---|---|---|
| Total | 24 | +0.1 | +0.1 |

Source: modelling by Pöyry consultants and DECC calculations

## E) Air quality impacts

56. DEFRA has modelled the impact on air quality of Option 3 (Response bands) against the impact of Option 1 (Current bands), under three fossil fuel price scenarios. For this assessment, annual renewables and non-renewable generation to 2039/40 under each scenario was converted into air quality emissions and combined with impact factors[33] from the UK Integrated Assessment Model. The impacts on air quality have been assessed and quantified using the agreed methodology of the Inter-Departmental Group on the Costs and Benefits of Air Quality[34].

57. DEFRA's analysis found that in all three fossil fuel price scenarios, Option 3 (Response bands) reduce the impact of air pollution on human health compared to current bands, and that the impact is greatest (i.e. the benefit for human health is highest) in the central fossil fuel price scenario. Under this scenario, the central monetised estimate from improved air quality is a present value of £66m.

**Table 8: Air quality impacts, discounted 2011/12 prices (£m)**

| | Air quality cost sensitivities (+ve implies a benefit) | | |
|---|---|---|---|
| **Scenario** | **Low** | **Central** | **High** |
| Low fossil fuel price | £7 | £9 | £10 |
| Central fossil fuel price | £53 | £66 | £75 |
| High fossil fuel price | £39 | £48 | £54 |

58. The benefits presented in Table 8 do not increase, as one would expect, in line with the fossil fuel price scenarios. *Relative* fossil fuel prices change in each scenario, affecting the mix of coal and gas generation which renewable technologies would displace. For example, if the fossil fuel price scenario resulted in relatively less coal than gas generation, uptake of renewables, on average,

[33] Impact factors represent the relationship between emissions and a number of environmental metrics reflecting impacts on human health and ecosystem damage.
[34] More information on this methodology can be found here http://www.defra.gov.uk/environment/quality/air/air-quality/economic/

would lead to relatively lower reductions in air quality emissions, and therefore the air quality benefits would also be lower.

59. In addition, the benefits presented above only include the impact on human health, not the impact on ecosystems or the natural environment. Poor air quality can have a negative impact on ecosystems. At present there is not sufficient evidence to monetise these impacts.

### F) Net monetised impacts (B + C + D + E) and sensitivity analysis

60. The monetised generation cost, carbon credit purchase cost, balancing cost and air quality impacts (all discounted at the social discount rate[35]), are summed below to give the net present value of the change in policy at -£2.3bn for Option 2 consultation bands and -£1.8bn for Option 3. The NPVs are driven primarily by the increases in total generation costs caused by bringing on more renewables generation in place of cheaper conversion generation.

**Table 9: Social monetised impacts of banding changes, £bn discounted in 2011/12 prices**

| **Option •** | **Option 2** | | **Option 3** | |
|---|---|---|---|---|
| **Impact on •** | **Benefits (+)** | **Costs (-)** | **Benefits (+)** | **Costs (-)** |
| Total power sector generation costs [reduction = social benefit (+); increase = social cost (-)] | | -4.3 | | -3.6 |
| Carbon credit purchase costs [reduction = social benefit (+); increase = social cost (-)] | +2.1 | | +1.9 | |
| Balancing costs [reduction = social benefit (+); increase = social cost (-)] | | -0.1 | | -0.1 |
| **NPV excluding air quality impacts** | **-2.3** | | **-1.8** | |
| Air quality impacts | Not calculated | | +0.06 | |
| **NPV including air quality impacts** | Not calculated | | **-1.75** | |

-Source: modelling by Pöyry consultants and DECC calculations

61. Sensitivity analysis has been undertaken for Option 3, including;
    - Fossil fuel price sensitivities[36]
    - Assuming new build in 2016/17 is all supported by the RO rather than by CfDs
    - Biomass conversions and enhanced co-firing

62. Full details are provided in Annex D, Table 10 and 11 below summarise the results of the sensitivity analysis scenarios on NPV, capacity and generation mix for Option 3. Annex D presents alternative approaches to sensitivity analysis and looks at other potential scenarios for biomass conversion, as well as the capacity and generation impacts should all new installations come on under the RO rather than FiTs with CfD in 2016/17.

[35] Assumed to be 3.5%
[36] High and low fossil fuel price projections can be found on DECC's website here: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx

**Table 10: Sensitivity Analysis of social monetised impacts of banding changes (£bn discounted in 2011/12 prices)**

| Option 3 (relative to Option 1) | NPV excluding air quality impacts |
|---|---|
| Central Scenario | -1.8 |
| High fossil fuel price scenario | -4.0 |
| Low fossil fuel price scenario | 2.9 |

**Table 11: Net new capacity and modelled generation under the RO during the 2013-17 Banding Review Period**[37]

| Scenario | Capacity (MW) | Generation (MWh/year) |
|---|---|---|
| Central Scenario | 7,300 | 32,000 |
| High fossil fuel price scenario | 8,500 | 38,000 |
| Low fossil fuel price scenario | 2,000 | 8,800 |
| All capacity under RO (not FiT with CfDs) to 2016/17 | 9,300 | 39,000 |

## G) Non-monetised impacts

63. It should be noted that the monetised costs and benefits above do not include several potentially significant impacts. There are a number of positive non-monetised impacts such as; lower future costs of decarbonisation, reduced risk of missing the 2020 renewables target and related fines, and greater foreign direct investment (FDI) in turbine manufacturing. In addition, negative non-monetised impacts include the macroeconomic costs of higher electricity bills and increased risk of intermittent generation.

64. This section describes these non monetised impacts in more detail, in the following order:
    - Security of supply impacts
    - Impacts on other industries competing for biomass resource
    - Wider environmental and social impacts
    - Risk of missing 2020 renewables target
    - Macroeconomic impacts
    - Lifecycle greenhouse gas emissions

**Security of supply impacts**

65. Options 2 and 3 reduce reliance on imported fossil fuels relative to the do nothing option, but at the same time by increasing the amount of intermittent generation, these options may increase the small probabilities of brown-outs or even black-outs. However, it is assumed here that these small amounts of extra intermittent generation will be accommodated on the grid with an increase in other kinds of balancing services – back-up generation, interconnection, storage and/or demand-side response. System balancing costs are included in the monetised costs and discussed in section 5. D).

[37] Further detail is provided in Annex B and D

**Impacts on other industries competing for biomass resource**

66. Continuing support for biomass-related electricity technologies could impact on other sectors that use the same fuel sources, such as the wood products industry (e.g. for furniture and construction material) and the pulp and paper industry. A report commissioned for the Bioenergy Strategy used lifecycle analysis to quantify the carbon balances associated with different forest management approaches and uses of forest wood[38], and therefore enabled us to compare the carbon impacts of using wood and energy crops in energy versus other uses. The scenarios analysed included: using harvested wood for bioenergy (heat or electricity); choosing alternative uses (such as construction products); or leaving the forest unharvested or unmanaged. The analysis indicated that, in the context of wider decarbonisation of the economy, wood products can be an important store of carbon. Therefore, to achieve optimal GHG scenarios woody biomass should be used for the production of both material products and for bioenergy uses, with re-use and recycling wherever possible. Given the important role of wood products as a store of carbon, we have considered the potential competition for resources between the wood products industry and woody biomass for energy use in further detail.

67. The bioresource supply scenarios used as a constraint in the modelling of the RO Banding Review scenarios were derived from the scenarios developed for the Bioenergy Strategy, and which were based on AEA Technology analysis[39]. The Bioenergy Strategy Analytical Annex includes a full explanation of AEA assumptions, and how the bioresource supply scenarios were derived for the low risk bioenergy pathway analysis[40]. Although isolating the potential impact of the RO on the wood products industry is extremely difficult given the potential impact of other policies and market drivers on the demand of the relevant feedstocks, in order to reflect the finite nature of the feedstocks for biomass and their competing uses, AEA considered the extent of competing uses, e.g. use of agricultural land for food and feed or wood for timber, pulp, paper, and panel board, etc, and whether or not this competition was price dependent. Only those resources where competition was considered to be price dependent (i.e. potentially available to the bioenergy sector at higher prices) or where no significant competition existed, were viewed as potentially available to the bioenergy sector. For example, it was assumed that half the unconstrained potential estimated from UK sawmill residue would be available to the energy sector due to competition from the wood panelling industry. However, it is recognised that the wood products industry and the energy sector could compete for the same fuel source, and the impact of this competition on prices and availability of resource is difficult to forecast, given the uncertainty around future demand from non-energy sectors and the impact of increasing demand for bioresources from the energy sector. For further information on the current market for wood in the UK see Appendix 1 in the Bioenergy Strategy Analytical Annex.

68. In addition, two modifications were made to the Bioenergy Strategy bioresource supply scenarios (derived from AEA modelling) in the work which underpins this IA: first, to take account of the impact of sustainability standards in the RO[41]; and secondly, to include the updated estimates on the potential supply of residual waste, based on consultation responses and analysis used for the Defra Waste Review 2011. The review looked at scenarios of total potential waste resource available consistent with Government ambition, rather than a realistic forecast of what feedstock may be available. These modifications lead to lower supply scenarios in total than those assumed in the

[38] Forest Research and North Energy Associates, Carbon impacts of using biomass in bioenergy and other sectors: Forests, 2012
[39] AEA: 2010 UK and global bioenergy resource. http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx
[40] Section 1, Bioenergy Strategy: analytical annex, 2012
http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx
[41] AEA estimates apply RED sustainability standards to biofuels, and assume all biomass is produced from existing forest or abandoned agricultural land, but do not include specific sustainability standards for solid biomass given that the RED does not mandate for this. Sustainability standards applied are consistent with a 60% threshold compared to the EU average (712 kgCO2/MWh) which is the current reporting standard under the RO.

Bioenergy Strategy analysis.

69. Based on the latest Forest Commissions estimates, approximately 10.3 Million green tonnes (Mgt) of UK virgin wood was delivered in 2011, of this total wood panelling consumed approximately 30% (1.4 Mgt of virgin wood and 1.8 of sawmill products). The energy sector accounted for approximately 15% of this total in 2011, an increase from 5% in 2007[42]. For further information on the current market for wood in the UK, including analysis on prices, see the Government Bioenergy Strategy and supporting documents.

70. The current forecast for woody biomass use from the heat[43] and power sector in 2016/17 is approximately 17 million oven dried tonnes (Modt), of this 15 Modt is from the power sector based on the latest RO Banding Review proposals and associated projections. This demand could be met by a number of different feedstocks (both within the UK and imported), such as wood, agricultural residues and (UK) waste wood. Smaller scale power generators are more likely use domestic feedstocks: of the total 15 Modt forecast in 2016/17, approximately 3 Modt is expected to be used by smaller scale generators. Assuming 50% of woody biomass feedstocks for heat come from the domestic markets (as larger generators likely to source from international markets) total forecast demand of domestic fuels for heat could be in the region of 1 Modt in 2016. Therefore, in total the forecast domestic bioresource use from the power and heat sector is approximately 5 Modt (including 10% of large scale power generation). Table 12 below summarises the total forecast woody biomass use from heat and power sector in 2016/17.

**Table 12: Breakdown of total forecast woody biomass use from heat and power in 2016/17 (Modt)**

| | **2016/17** |
|---|---|
| Large scale biomass | 12 |
| Small scale biomass | 3 |
| CHP | 1 |
| Heat | 2 |
| Total | 17 |

Note: Figures may not sum due to rounding.

71. The supply scenarios used to constrain the RO modelling assume between 17 and 28 Modt of total available woody biomass in 2016/17, of this 9 - 11 Modt are from UK sources, and between 8 and 17 Modt are from imports. The large majority of the feedstock demand for electricity generation is expected to come from >50MW generators which will source their supplies through imports (90%) due to the need for volume certainty and long term contracts (7-15 years). It should be remembered that the supply assumptions used for the RO modelling are entered as a constraint, not a forecast of what bioresource we consider to be actually available in the future. Table 13 below summarises the 2016/17 woody biomass supply constraint used for RO analysis.

**Table 13: Woody biomass supply constraint used for RO analysis (Modt in 2016/17)**

| | **2016/17** |
|---|---|
| UK woody biomass | 9 - 11 |
| Imported woody biomass | 8 - 17 |
| Total | 17 - 28 |

Note: Figures may not sum due to rounding.

72. At an aggregate level (i.e. sum of feedstocks), the forecast bioresource use implied by the deployment under the new RO Bands does not breach the central bioresource supply constraint, this

[42] Forestry Statistics 2011 http://www.forestry.gov.uk/pdf/trprod12.pdf/$FILE/trprod12.pdf

[43] Forecast woody biomass use for the heat sector in 2016 is based on illustrative DECC analysis for the RHI, and is subject to change.

is shown in Table 14 below. To note, these supply figures do not include domestic or imported bioliquid supply.

**Table 14: Comparing power sector forecast bioresource use and supply constraint used for RO analysis (Modt 2013/14 to 2016/17)**

| Modt | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Forecast bioresource use (existing bands) | 17 | 19 | 22 | 25 |
| Forecast bioresource use (new bands) | 14 | 18 | 25 | 29 |
| Supply constraint (central) | 38 | 38 | 38 | 40 |
| Supply constraint (high) | 48 | 51 | 54 | 60 |

73. The analysis above suggests that UK resources should be sufficient to meet both energy and wood products demand for woody biomass. However, it recognises that the future demand for wood from other sectors and future supply is extremely difficult to predict and that for the upper end of the potential domestic supplies to materialise prices will have to rise. Although analysis of historic evidence suggests that movements in domestic prices appear to be correlated to international prices of wood, rather than domestic demand for co-firing generation[44], it is recognised that the full impact of the RO (and other renewable policies) on the demand and prices for these feedstocks is very difficult to estimateat this stage. DECC will work closely with the wood products industry and biomass electricity generators to ensure robust monitoring measures are in place for biomass feedstocks to provide early warning of supply risks from the electricity sector.

74. For further analysis of the potential impacts of UK bioenergy policies on other sectors of the economy see the Government's Bioenergy Strategy and supporting documents.

**Wider environmental and social impacts**

**i. Land use**

75. The forecast bioresource use in the power sector implied by the expected biomass deployment under Option 3 revised proposals has been assessed for its potential impact on land use. Energy to land conversion factors, developed by the Forestry Commission for the Bioenergy Strategy 2012, have been used to convert from projected estimates of energy demand by feedstock to hectares of land required, adjusted for potential improvements in productivity.

76. It is estimated that between 54-60k hectares of land were utilised in 2011, around 60%[45] of which used for arable crops (OSR[46]) to produce bioliquids and the remainder for woody energy crops such as miscanthus and short rotation coppice (SRC). By 2030 total land use is expected to rise to between 91-113k hectares with around 80% of this used to grow woody energy crops. Table 15 illustrates the potential land use requirement under Option 3 revised proposals.

[44] http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx

[45] This estimate assumes all of the bioliquid used for electricity generation in 2011 are derived from arable crops, which is considered to be an upper estimate of the impact on land use. The latest figures from OfGEM biomass sustainability report (http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=318&refer=Sustainability/Environment/RenewablObl/FuelledStations) indicate that fuels derived from arable crops which are not wastes or residues made up less than 1% (by mass) of bioliquid feedstocks used between April 2010 and April 2011.

[46] Used Cooking Oil is another potential feedstock suggesting that these estimates may be overestimates. However, analysis for the Bio-Energy Strategy suggests this feedstock would be most cost effectively used as a transport fuel.

**Table 15: Total land use impact of Renewables Obligation, kha**

| Summary | 2011/12 | 2015/16 | 2020/21 | 2025/26 | 2030/31 |
|---|---|---|---|---|---|
| Energy Crops (low) | 21 | 24 | 109 | 88 | 73 |
| Energy Crops (high) | 23 | 26 | 129 | 113 | 91 |
| Arable Crops (low) | 33 | 31 | 67 | 49 | 18 |
| Arable Crops (high) | 37 | 37 | 79 | 61 | 22 |
| Total (low) | 54 | 55 | 176 | 137 | 91 |
| Total (high) | 60 | 63 | 208 | 174 | 113 |

77. The split between domestic and imported feedstocks is highly uncertain and will depend upon prices, the development of supply chains within the UK and overcoming barriers around establishment. Our best assessment at this stage, based upon supply modelling, is that domestic UK feedstocks could represent around 20% of total energy crops in early years (c5k hectares), and around 10% by 2020 and beyond (c12k hectares). For context, in 2011 plantings of woody energy crops were around 11k hectares in England.

78. The marginal impacts on land use of Option 3 compared to Option 1 is set out below. This shows that the proposed amendments will not lead to a change in the potential use of arable crops for bioliquids, but that more land is likely to be used to grow woody energy crops for biomass combustion (in later years).

**Table 16: Marginal land use impact of proposed amendments to Renewables Obligation, kha**

| Summary | 2011/12 | 2015/16 | 2020/21 | 2025/26 | 2030/31 |
|---|---|---|---|---|---|
| Energy Crops (low) | 0 | -5 | 69 | 58 | 54 |
| Energy Crops (high) | 0 | -6 | 82 | 73 | 67 |
| Arable Crops (low) | 0 | 0 | 0 | 0 | 0 |
| Arable Crops (high) | 0 | 0 | 0 | 0 | 0 |
| Total (low) | 0 | -5 | 69 | 58 | 54 |
| Total (high) | 0 | -6 | 82 | 73 | 67 |

### ii. Food security

79. The Bioenergy Strategy 2012 set out the principles by which Government should act to ensure the sustainability of bioenergy feedstocks, as well as a level of ambition consistent with those principles. The estimates in this analysis are consistent with the principles set out in the Strategy and the overall level of ambition it set taking account of food security needs.

80. To date, land used to grow woody energy crops in the UK has tended to be lower-quality, marginal or idle land which is generally unsuitable for food production. However, we should continue to monitor patterns of agricultural land use carefully, to identify changes that happen as a result of, for example, changing commodity prices, and determine whether there is a shift in the way in which different types of land are being used for food or energy production.

### iii. Wider Environment (biodiversity, water demand)

81. Demand for bioenergy can present risks for biodiversity and ecosystems through loss of semi-natural and natural habitats (such as forest clearance), intensification of agricultural production and the potential introduction of non-native invasive species. There is, therefore, a potential tension with the Government’s commitment to halt and reverse biodiversity loss and ecosystem degradation both domestically and internationally, particularly the issue of potentially increasing water stress.

82. On the other hand, a number of reports show that perennial energy crops, such as short rotation coppice and miscanthus if cultivated in the right place and in the right way, can be better for biodiversity and water quality than arable crops such as wheat and maize. There will also be benefits if energy demand leads to unmanaged forests being brought back into sensitive management. The precise impacts depend on the previous nature of the land, the nature and location of the new crops and their management, for example by avoiding large swathes of monoculture.

83. Risks can be reduced and benefits increased by: taking steps to create additional feedstock supply in appropriate ways, thus reducing the pressure for agricultural expansion into natural habitats; applying standards and safeguards effectively to exclude biomass from unsustainable sources; monitoring impacts and undertaking periodic reviews of policies and measures to ensure bioenergy expansion proceeds at a sustainable pace.

84. For further information on potential wider environmental impacts from bioenergy feedstock cultivation see DECC Carbon Plan analytical annex[47], and the NNFCC report on energy crop potential which discusses biodiversity issues[48].

**Risk of missing 2020 renewables target**

85. Options 2 and 3 reduce the risk of missing the 2020 renewables energy target by incentivising offshore wind deployment in the UK, that wouldn't be incentivised under current bands. Analysis of expected subsequent cost reductions and technical potential suggests that offshore wind deployment forms part of a cost-effective mix for reaching the 2020 target. Continuing deployment of offshore wind also enables a strategic option for post-2020 power decarbonisation and sector expansion.

86. The impacts relating to enabling an option for future UK marine deployment are not monetised. Options 2 and 3 reduce the risks of not being able to achieve decarbonisation and expansion of the power sector required to 2030 and 2050 to meet the carbon budgets. It does this by creating two more low-carbon technology options, wave and tidal stream, for the generation mix. Their potential is uncertain, but they could eventually reach around 27GW in 2050.[49] Marine technologies' outputs are expected to be more predictable than that of wind generation, which is expected to imply lower balancing costs - this potential impact on balancing costs has not been monetised.

87. Marine technologies in the long term may also prove relatively expensive overall and not a cost-effective part of the future low-carbon mix. Future relative technology costs are very uncertain. No attempt is made here to monetise their option value. Whether future marine deployment turned out to have a net benefit would depend on many uncertain factors, including the speed of cost reductions in wave and tidal stream technologies, the availability and cost of alternative low-carbon technologies and the system balancing costs relating to the intermittency of wave and tidal stream compared to wind.

**Macroeconomic impacts**

88. Other important impacts which are not monetised include the wider macroeconomic impacts of changes in retail electricity prices. Slightly higher electricity bills (than would otherwise have been in place – i.e. lower rises in bills) mean higher costs to industry and less real income for consumers. However, the increases in bills from these proposals (set out in section H below) are expected to be

[47] Page 184. http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/carbon-plan/3749-carbon-plan-annex-b-dec-2011.pdf
[48] http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/bio-energy/5138-domestic-energy-crops-potential-and-constraints-r.pdf
[49] According to Ernst & Young (2010), *Costs of and financial support for wave, tidal stream and tidal range technologies*. Their total wave and tidal stream deployment range in 2050 is 9-43GW.

relatively small when compared to the absolute bill impact of the RO under Option 1.

89. Options 2 and 3 also imply an increased likelihood of attracting FDI, for example in offshore wind turbine manufacturing, which is expected to be associated with positive spillover effects. Growth in industries related to renewable electricity as a result of these proposals could also affect propensity to imports and exports. That growth will be balanced by displacement of resources (capital and labour) from other sectors. Overall, the GDP impacts of incentivising renewable electricity deployment are unclear.

### Lifecycle greenhouse gas emissions

90. The analysis of carbon emissions above looked at the CO2 emissions from the UK power sector associated with the burning of fossil fuels and valued these at the central DECC EU-ETS traded sector appraisal carbon prices. An assessment has also been made of the full lifecycle greenhouse gas emissions associated with all the UK power sector generation, including not only the emissions from burning fossil, biomass and waste fuels, but also the emissions associated with fuel transportation, construction of power stations and in the case of waste technologies, avoided greenhouse gas emissions from waste going to landfill.

91. Table 17 below shows the full lifecycle emissions associated with the projected UK power sector generation under Option 1 (current bands) and the preferred Option 3 (Response bands). Overall the estimated difference in full lifecycle emissions due to changing bands to the preferred Option 3 comes to a reduction of 87Mt compared to Option 1.

**Table 17: Full lifecycle greenhouse gas emissions impacts**

| | Option 1 Current bands - absolute | Option 3 Response bands – change relative to current bands |
|---|---|---|
| **Mt $CO_2$ equivalent** | 2,313 | -93 |

92. Note that it has not been possible to estimate the time profile of these emissions savings in the same way as for the CO2 savings from avoided burning of fossil fuels above, and therefore the full lifecycle impact has not been monetised. The estimated full lifecycle greenhouse gas emissions impact at 93Mt is higher than the estimated CO2 savings from avoided burning of fossil fuels at 82Mt.

## H) Distributional impacts

93. Changing RO bands can change levels of renewables deployment, and hence the levels of RO costs falling on consumers; wholesale prices (impacting on retail prices) can be reduced on average when more wind is on the system; and system balancing costs increase with more intermittent generation.

### RO support costs

94. The changes in bands in the different options have a number of impacts on electricity consumers. Table 18 below shows how Options 2 and 3 reduce the level of RO support costs in the first few years, owing to the reduction in rents by reducing bands, and incentivising the more cost-effective renewable technologies. However, these options bring on more renewable generation in the last two years of the banding review period and in subsequent years, raising RO support costs in these years. The PV of lifetime increases to RO support costs is £2.3bn in Option 2 and £1.5bn in Option 3.

**Table 18: RO support costs to 2039/40 (2011/12 prices, £m)**

| | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|---|
| Current bands | 1,400 | 1,900 | 2,900 | 3,100 | 3,200 | 3,300 |
| Impact of Option 2 Consultation Bands | - | - | -160 | -64 | 110 | 230 |
| Impact of Option 3 Revised Proposals | - | - | -390 | -320 | 67 | 180 |

Source: modelling by Pöyry consultants and DECC calculations; Estimates rounded to two significant figures

### Wholesale price impacts

95. By bringing on slightly more wind generation, on average over the modelling lifetime to 2039/40, Option 3 revised proposals reduces wholesale prices relative to the current bands. The net present value to consumers of these lower wholesale prices is a benefit of around £260m in PV terms.[50] Option 2 Consultation Bands is assumed to deliver the same wholesale prices as Option 3, and hence the same benefit relative to current bands.

### Net impact on consumers (including balancing costs)

96. The net impact on consumers relative to current bands, comes to an increase in costs to consumers of around £2.2bn in NPV terms under Option 2, and around £1.3bn under Option 3. These net impacts include wholesale cost of electricity savings and balancing costs.

**Table 19: Lifetime impact on consumers of banding options compared to maintaining current bands (2011/12 prices, £m) - negative indicates a net cost and positive indicates a net benefit**

| | Option 2 relative to Option 1 | Option 3 relative to Option 1 |
|---|---|---|
| **Total impact on consumers** | -2,200 | -1,300 |

Source: modelling by Pöyry consultants and DECC calculations; estimates rounded to two significant figures

### Bill impacts

97. Costs to consumers increase by around £2.2bn in NPV terms under Option 2 and around £1.3bn under Option 3 relative to Option 1. Under both options there is a small reduction in average annual bills in the first few years, then as more renewable generation comes through in later years, the RO support costs and balancing costs push up bills, generally more than the (generally later) reduction in wholesale prices pushes bills down. The average annual bill impact from 2012 to 2030 of the change in bands on households, medium-sized non-domestic users and energy-intensive users is set out in Table 20 below. Under the preferred Option 3, electricity bills are increased by a modest average over the period of 0.1-0.2% compared to current bands.

**Table 20: Impact of changing RO bands to Option 3 (Response bands), on average annual electricity bills 2012-2030 (£2010 prices)**

| | Average household | Medium-sized non-domestic user | Large energy-intensive user |
|---|---|---|---|
| **Average annual electricity bill impact** | £0.7 (0.1%) | £3,000 (0.2%) | £20,000 (0.2%) |

Notes: Medium sized non domestic user impact is rounded to the nearest £1,000. Based on the mid-point of Eurostat "medium industrial user" consumption band. Large energy intensive user impact is rounded to the nearest £10,000. Based on a user consuming 100,000mwh pa. The estimate is before energy efficiency savings.

98. In terms of absolute contribution to household bills, revised bands under Option 3 are projected to lead to a total impact from the RO of around £53 to the average household's annual electricity bill by

[50] This reduction in wholesale prices occurs mainly post-2020. In the Pöyry modelling there is an increase in wholesale prices under Revised Proposals relative to Current Bands up to 2015/16, which is due to coal plant coming offline for 12 months to adapt ready for enhanced co-firing and conversions. It is likely that conversions and ECF will not require plant to be offline for so long and that a lot of the work may take place over period when coal plant do not tend to generate so much. i.e. the summer months. Given these uncertainties, DECC have excluded this increase in wholesale prices from the analysis.

2016/17, based on estimated average household annual electricity bills and household electricity demand *before* the impact of energy efficiency policies. Table 21 below shows the contribution to household bills of current bands and Option 3 based on estimated household electricity demand before and after the impact of energy efficiency policies. Energy efficiency policies are expected to lead to significant reductions in household electricity demand, whilst business and public sector demand are projected to rise, shifting some of the RO cost burden from household to business and the public sector.[51]

**Table 21: Absolute contribution to average household electricity bills of RO support costs under current bands and the preferred option (£2011/12 prices)**

| Basis: | | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|
| Household electricity demand before policies | Current bands | 44 | 47 | 49 | 50 |
| | Option 3 Response bands | 38 | 42 | 50 | 53 |
| Household electricity demand after policies | Current bands | 36 | 37 | 37 | 37 |
| | Option 3 Response bands | 31 | 33 | 38 | 39 |

Source: modelling by Pöyry consultants and DECC calculations; Estimates rounded to nearest £1.

### Producer surplus

99. In reducing the bands where analysis suggests that this would have a zero or low impact on deployment, Option 2 consultation bands and Option 3 revised proposals are likely to reduce producer surplus by an estimated £1.2bn over the modelling lifetime to 2039/40. This producer surplus, also known as rents, is defined simply as the sum of positive cashflow NPVs (discounting at the hurdle rates) for renewables plant.

## 6. Wider impacts

### Equality

100. This policy has no significant bearing on protected characteristics, including age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

### Environmental Issues

101. The greenhouse gas emissions impacts and non-greenhouse gas air quality impacts are covered in section 5G. The proposed banding options lead to carbon savings within the UK power sector, but these will be offset by increases in emissions elsewhere within the capped EU-ETS traded emissions sector. There will therefore be no net impact on greenhouse gas emissions.

102. The RO provides the Government's support scheme for renewables electricity generation. It incentivises investment in renewables projects which help to move the UK away from fossil fuel dependency towards a low carbon economy with consequential carbon savings from displaced fossil fuel generation.

103. Individual projects supported under the RO that are deemed to have the potential to cause significant adverse impacts are required to undertake an Environmental Impact Assessment

[51] Unlike the overall analysis of consumer costs, table 21 does not take into account the (relatively small) indirect effects of the RO on household electricity bills through reducing wholesale prices and increasing balancing costs.

(Directive 85/337/EEC) as part of the planning process.

104. Any future deployment of renewable and low carbon energy infrastructure will be subject to all relevant environmental legislation and controls, and aims to contribute to government policy objectives that enhance the natural environment .

**Rural proofing**

105. A large proportion of renewable energy is produced in rural areas and affects businesses involved in the growth (of biomass) and generation of renewable energy and rural communities living in the vicinity of new developments. Increasing the proportion of energy from renewable sources will mean more renewable energy developments in rural areas.

106. Whilst there has been no separate or explicit assessment of the needs of rural areas, the RO banding review proposals are set within this wider policy context and the Government's overall reforms of the planning system. Separate planning legislation exists to ensure that the environmental and social impacts of renewable energy developments, and the views of those living near to installations, are fully taken into account.

107. Development of RO policy has been subject to extensive consultation. This has included business interests within the renewables sector and consumer interests. It has also included relevant rural business groups but has not specifically sought to engage rural community groups in particular. Nevertheless, consultation responses that have been taken into account in formulating final decisions on the RO Banding Review were received from community/rural groups including: Campaign to Protect Rural England; Scottish Natural Heritage; Cambrian Mountains Society; Country Land & Business Association; Royal Society for the Protection of Birds, Friends of the Earth; and numerous local rural campaign groups.

**Sustainable Development**

108. The RO is aimed at increasing the deployment of renewable electricity generation in order to move the UK away from fossil fuel dependency towards a low carbon economy in preparation for a future when supplies of gas and oil will become tighter and more expensive. From 1 April 2011, under the Renewables Obligation, electricity generators over 50kW are required to report annually on their performance against sustainability criteria for biomass feedstocks they use. This criteria includes a minimum 60% (285.12 kgCO2eq/MWh) Greenhouse Gas lifecycle emission saving for electricity generation using solid biomass or biogas relative to fossil fuel, and general restrictions on the use of materials sourced from land with high biodiversity or carbon stock value such as primary forest, protected areas, wetland and peatland. The sustainability criteria apply to the use of imported as well as domestic biomass and biogas for electricity generation but do not apply to waste or biomass wholly derived from waste. Generators are required to report annually to Ofgem on their performance against these criteria, which will help inform future Government policy on sustainable use of biomass for electricity generation.

109. Following a two year transition period, the intention is from April 2013, generators of 1MWe capacity and above will be required to meet the sustainability criteria in order to receive support under RO.

110. The Government will consult shortly on a new trajectory of biomass fuel sustainability requirements to 2020.

## Competition

111. The RO is a market-based instrument that operates in a competitive market for electricity. It is open to all participants in renewable generation. The way in which the RO recycles money from the buy-out fund should act as a positive incentive to competition between suppliers, and reduce barriers to entry for renewable electricity generators.

## Small Firms

112. The major impact of the RO on the large majority of small business is likely to come from increased costs of electricity which, while affecting all electricity consumers, are likely to represent a larger proportion of income for smaller companies, as they are less likely to have their own generation compared to – particularly - larger industrial users with heavy electricity requirements.

113. The majority of smaller businesses involved in renewables generation are likely to seek support under FiTs, as the simplicity and income-certainty of FiTs makes them better suited to small business needs. Small businesses involved in licensed electricity supply should not experience any additional burdens from the proposals.

114. The Government will consult shortly on support for new small-scale solar PV, AD, hydro and wind generation under the RO in Great Britain.

## 7. Summary and preferred option with description of implementation plan

115. The preferred option is Option 3 (Response bands). It delivers 32TWh/y of additional generation from new build over the 2013-17 banding review period towards the 2020 renewables target, compared to 21TWh/y under Option 1 (current bands). Under central assumptions, this achieves the 'large-scale'[52] renewable electricity deployment required to meet the UK's interim and 2020 renewable energy targets under the EU Renewable Energy Directive.

116. Option 3 also increases the efficiency of the RO, delivering a lower average cost per MWh of renewables for the electricity consumers who bear the cost of the RO. It does this by focussing on the more cost-effective technologies and reducing excess profits to renewables developers. The latter is achieved through reducing support in technologies such as hydro above 5MW (sub-5 MW hydro is supported by FiTs) and biomass conversion, but without reducing renewables deployment.

117. The Government's expectation is that renewables support will reduce as the costs of renewable technologies fall. The proposed RO banding for offshore wind, which represents one of the more expensive technologies required to meet the 2020 renewables target, is reduced from 2.0 in 2013/14 and 2014/15 to 1.9 ROCs/MWh in 2015/16 and to 1.8 ROCs/MWh in 2016/17 as offshore wind costs are projected to fall. The banding for all other technologies beginning at 2 ROCs/MWh are proposed to fall likewise (with the exception of wave and tidal stream). Complementary policies will help bring down renewable generation costs, such as innovation support programmes, support for the development of new large-scale coastal manufacturing facilities and a joint HMG-business taskforce.

118. Table 922 below summarises the costs and benefits of Option 2 (Consultation bands) and Option 3 (Response bands) compared to Option 1 (Current bands).

**Table 22: Social monetised impacts of banding changes, £bn discounted in 2011/12 prices**

| **Option •** | **Option 2** | | **Option 3** | |
|---|---|---|---|---|
| **Impact on •** | **Benefits (+)** | **Costs (-)** | **Benefits (+)** | **Costs (-)** |
| Total power sector generation costs [reduction = social benefit (+); increase = social cost (-)] | | -4.3 | | -3.6 |
| Carbon credit purchase costs [reduction = social benefit (+); increase = social cost (-)] | +2.1 | | +1.9 | |
| Balancing costs [reduction = social benefit (+); increase = social cost (-)] | | -0.1 | | -0.1 |
| **NPV excluding air quality impacts** | **-2.3** | | **-1.8** | |
| Air quality impacts | Not calculated | | +0.06 | |
| **NPV including air quality impacts** | Not calculated | | **-1.75** | |

Source: modelling by Pöyry consultants and DECC calculations

52 'Large-scale' renewable electricity is defined as all UK renewable electricity except that in Great Britain from stations with an installed capacity below 5MW in AD, solar PV, wind and hydro technologies, i.e. except that electricity which is eligible for support under the small-scale FITs scheme.

119. The preferred Option 3 is more affordable to consumers compared to Option 1 (Current bands) and Option 2 (Consultation bands), allowing the RO to stay within its Levy Control Framework budget over the four years of 2011/12 to 2014/15. Under central assumptions Option 3 is expected to deliver the large-scale renewable electricity share of the overall renewable energy interim targets, on the way to the 2020 renewable energy target.

**Implementation**

120. The RO is administered and enforced by Ofgem, who report annually on their administration of the RO and conduct regular audits in relation to compliance with the RO.

121. DECC is responsible for monitoring the impact of the RO on the development of renewable energy and collects detailed information on growth in renewable energy generation and projects under development.

# Annex A - Details of key assumptions

## A) Updates to key assumptions since Consultation Impact Assessment

122. As in the Consultation document, Arup research provided estimates of current costs of renewable electricity technologies through access to proprietary information, use of external reports, and consultation with renewable developers. Arup also made projections of future generation costs, based on their assumed learning rates (cost reductions with increased deployment reflecting technological learning, economies of scale etc.), global deployment projections from the IEA Blue Map scenarios and future prices of key cost drivers such as labour and industrial commodities.

123. Arup also gathered information on maximum deployment potential, in the form of annual new build rates for each technology. Low, medium and high estimates of these annual build rates were developed to reflect varying levels of non-financial barriers to deployment, such as planning, supply chain and grid constraints. The Arup estimates of generation costs and deployment potential were used to create annual stepped supply curves for each technology.[53] The high version of the annual maximum build rates was used for these, reflecting the high level of ambition the Government has to tackle non-financial barriers to renewables deployment, as detailed in the Renewables Roadmap.[54] Development of the supply chain, grid extensions and planning success will be just as important as providing the right financial incentives in achieving the 2020 renewables target.

124. Some cost, deployment and technical data has been revised since the analysis for the consultation impact assessment, in line with consultation responses and some technical updates. The primary changes that have been made are:

a. Load factors for **onshore wind >5MW** have been reduced across all regions following the inclusion of the latest year's data into the long run average**.** Maximum technical potential increased slightly and region split revised in light of revised project pipeline data.
b. Central and high cost estimates for **onshore <5MW** have been revised upwards in light of new evidence from consultation and analysis for the Feed-in-Tariff scheme.
c. Operating costs have been revised downwards by 15% for **offshore wind R2** following consultation evidence**.** At consultation, it was assumed 100% of the revenues accrue to the project, consultation evidence suggested some farms would secure PPAs, and therefore receive a discount on the revenues, the new assumption is that projects can only secure 95% of the full value of revenues on average across all projects. In addition, maximum build rates have been revised downwards in light of new pipeline data.
d. The capital cost range for **Dedicated biomass (both sizes)** was widened and the maximum build rate assumptions have been change based on consultation evidence and project pipeline data, respectively.
e. The fuel cost assumption for **Dedicated biomass >50MW** was revised downwards as it is now assumed they can source a higher proportion of woodchip.
f. The data for **Dedicated biomass CHP** has been substantially revised following the CHP call for evidence, a revised view of the technical potential based on the deployment pipeline, and heat revenues have been adjusted to take account of revised fossil fuel and carbon price

[53] As Arup's medium cost estimates represent the median, the supply curves take into account cost skewedness. If the median equals the mid-point of the low to high range, then the distribution is fairly even, while a median above (below) the mid-point implies costs are more skewed towards the higher (lower) end. Therefore, our supply curve, which assumes five cost tranches (low, low/medium/, medium, medium/high, high), each with 20% of the available potential, assumes more deployment potential at lower costs, if costs are skewed towards the low side, while it assumes more deployment potential at higher costs, if costs are skewed towards the high side.

[54] DECC (2011), UK Renewable Energy Roadmap, available at www.decc.gov.uk/assets/decc/11/meeting-energy-demand/renewable-energy/2167-uk-renewable-energy-roadmap.pdf

assumptions and reduced by 20% to better reflect the discount which CHP generators received on their heat output.

g. The cost, deployment and technical data for **Advanced Conversion Technology** plants was substantially revised following the call for evidence, which was compiled by NNFCC. The gate fee assumption was revised downwards to reflect both the greater fuel refining required and the increased competition for waste from the rest of the EU.
h. Capital costs and operating costs for **Biomass conversion and enhanced co-firing** plants were unchanged from the consultation, but biomass prices were adjusted downwards slightly in line with Dedicated biomass >50MW.

**Table A 1: Assumed Feedstock Prices for Solid Biomass and Waste Plant**

| £/MWh(e) fuel input basis (NVC) | Lowest | Low | Central | High | Highest |
|---|---|---|---|---|---|
| Dedicated biomass <50MW, CoCHP | 7 | 9 | 12 | 15 | 18 |
| Dedicated biomass >50MW, biomass CHP | 19 | 21 | 23 | 24 | 26 |
| Standard co-firing, conversions, ECF | 25 | 26 | 28 | 31 | 33 |
| UK energy crops | 13 | 19 | 25 | 27 | 29 |
| ACT (assumed gate fee) | -8 | -6 | -5 | -3 | -1 |
| EfW (assumed gate fee) | -26 | -25 | -23 | -21 | -19 |

Source: Internal analysis based on AEA (2011) and WRAP gate fee report (2011)

**Table A 2: Assumed feedstock prices for bioliquid plant**

| | **Current** | **2020** | | | **2030** | | |
|---|---|---|---|---|---|---|---|
| **£/MWh input** | | **Low** | **Central** | **High** | **Low** | **Central** | **Very High** |
| **Biodiesel** | 75 | 48 | 69 | 73 | 48 | 69 | 73 |
| **Bioethanol** | 58 | 50 | 54 | 58 | 43 | 47 | 83 |

Source: AEA (2011)

**Table A 3: Assumed hurdle rates at different financial close dates[55], with hurdle rates from 2010-16 assuming support under the RO and from 2017 onwards assuming support under the new FIT with CfD**

| | 2010-16 | 2017-18 | 2020-25 | 2026-30 |
|---|---|---|---|---|
| Onshore wind | 9.6% | 8.6% | 8.6% | 8.6% |
| Offshore wind | 11.6% | 10.5% | 10.5% | 8.6% |
| Offshore wind R3 | 13.2% | 12.3% | 12.3% | 10.9% |
| Geothermal | 22.7% | 21.2% | 21.2% | 15.3% |
| PV | 7.5% | 7.0% | 7.0% | 7.0% |
| Biomass | 12.7% | 11.9% | 11.9% | 10.9% |
| Bioliquid | 12.7% | 11.8% | 11.8% | 10.6% |
| EfW | 11.9% | 11.1% | 11.1% | 11.1% |
| AD | 13.2% | 13.2% | 12.3% | 11.1% |
| ACT | 12.7% | 11.8% | 11.8% | 10.6% |
| Landfill gas | 9.6% | 9.6% | 8.6% | 8.6% |
| Sewage gas | 9.6% | 8.6% | 8.6% | 8.6% |
| Hydro | 7.5% | 7.0% | 7.0% | 7.0% |
| Wave | 8.0% | 8.0% | 12.8% | 12.3% |
| Tidal stream | 13.2% | 12.3% | 12.3% | 11.1% |
| Tidal barrage | 7.5% | 7.0% | 7.0% | 7.0% |

Source: DECC assumptions, based on Arup (2011), Oxera (2011) and Redpoint (2010)

125. The heat produced by CHP stations has a value which influences their project economics. This value may be through sale of the heat in the form of steam to a nearby buyer, or if the heat is used on-site, through avoiding the costs of generating the heat by other means. The latter costs are also relevant to the buyer, as if they were not buying the heat, they would have to generate it by other means (or find an alternative seller).

126. Heat revenues have been calculated using the avoided cost of heat generation approach. This is based on gas boiler costs of £30/kW capex and £0.2/kW/y opex from AEA/Nera (2009)[56], DECC gas fuel price assumptions and DECC carbon price assumptions (where the installation would be large enough to be in the EU-ETS).

127. The values of heat revenues per MWh of electricity, will depend on the heat to power ratios of the CHP stations, as provided by Arup. The results vary significantly, as shown in the table below. Heat revenues are included in levelised costs with a negative sign.

55 For CHP, a 1% increase in the hurdle rates in assumed to reflect the increased difficulties in finding and retaining a heat customer for the life of the generation asset.
56 AEA/Nera (2009) *UK Supply Curve for Renewable Heat,* available at www.rhincentive.co.uk/library/regulation/0907Heat_Supply_Curve.pdf

**Table A 4: Heat revenues**

| Technology | Levelised heat revenue, £/MWh of electrical output (£2010/11 prices) |
|---|---|
| Energy from waste with CHP | £18 |
| Geothermal with CHP | £86 |
| Dedicated bioliquids with CHP | £13 |
| ACT with CHP | £23 |
| Dedicated biomass with CHP | £50 |
| Anaerobic Digestion CHP | £21 |

*Marine revenues*

128. It is possible that early wave and tidal stream arrays may be in receipt of grant funding, subject to state aids approval. DECC has recently announced a £20m marine funding programme. For the purposes of modelling, the following simplifying assumptions were made:

- Grants are made to demonstration projects in addition to ROC bandings, subject to not exceeding state aid limits on maximum percentage of total investment costs.
- Grants were limited to bringing on half of the available tidal stream and wave potential in individual years.

*Small-scale electricity in feed-in tariff technologies (AD, solar PV, hydro and wind)*

129. In the modelling, new installations with less than 5MW of installed capacity in these technologies are assumed to be supported under feed-in tariffs (FiTs) rather than the RO. This is a simplification: whilst microgeneration (<50kW) is only supported by FiTs, installations between 50kW and 5MW have the choice between RO and FiT support. FiTs have generally given more generous support than the RO up to now, reflecting higher generation costs at lower capacities. However, some installations with the choice are likely to continue to accredit under the RO, for example if financial institutions are more familiar with the RO mechanism.

*Fossil fuel prices*

130. The analysis uses the latest available finalised DECC fossil fuel price projections published in October 2011[57].

*Co-firing, enhanced co-firing and biomass conversions*

131. In the Pöyry modelling, the decision to enhance co-fire or convert a station fully is modelled on a unit-by-unit basis. If a unit is economic to convert under the bandings in the scenario, then it does so fully for as long as it is economic to do so. Standard co-firing is assumed to be 20% co-firing of a coal plant, where it is economic under the bandings in the scenario being modelled.

132. The choice between burning coal and burning biomass for each coal/co-firing plant is made in the model according to which alternative gives the highest NPV of cashflows (discounting at the hurdle rate).

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[57] Available at: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx

*Wholesale price income*

133. As set out in the Evidence Base, it was assumed that plants receive the wholesale prices endogenously modelled by Pöyry consultants, and investment decisions are made with five-year foresight (from the point of the main financial investment decision – assumed to be just before construction begins) of rising wholesale prices (which rise due to the carbon price floor and rising gas prices). Thereafter wholesale prices are assumed by investors to be flat at the level of the fifth year. This market failure – information failure in a lack of certainty for investors about rising wholesale prices – means that ROC levels have to be set higher than in a world of perfect information about future wholesale prices, to achieve the same level of deployment.

134. The table below sets out the wholesale prices under Option 3 with central, low and high fossil fuel prices. The underlying fossil fuel prices have been updated since those used in the consultation.

**Table A 5:Wholesale prices under Option 3 (£2011/12)**

| | GB wholesale electricity price | | |
|---|---|---|---|
| | **Central fossil fuel prices** | **Low fossil fuel prices** | **High fossil fuel prices** |
| **2011/12** | 60 | 57 | 61 |
| **2012/13** | 63 | 48 | 68 |
| **2013/14** | 68 | 42 | 72 |
| **2014/15** | 73 | 43 | 75 |
| **2015/16** | 73 | 44 | 76 |
| **2016/17** | 75 | 45 | 80 |
| **2017/18** | 73 | 46 | 82 |
| **2018/19** | 70 | 46 | 85 |
| **2019/20** | 71 | 49 | 86 |
| **2020/21** | 72 | 50 | 88 |
| **2021/22** | 74 | 52 | 91 |
| **2022/23** | 74 | 53 | 93 |
| **2023/24** | 75 | 55 | 93 |
| **2024/25** | 76 | 57 | 97 |
| **2025/26** | 76 | 59 | 94 |
| **2026/27** | 73 | 61 | 91 |
| **2027/28** | 77 | 62 | 95 |
| **2028/29** | 74 | 61 | 89 |
| **2029/30** | 74 | 59 | 83 |
| **2030/31** | 75 | 57 | 76 |

Source: Pöyry

# Annex B - Renewables capacity and generation mix details

**Table B 1: Renewables capacity mix under different banding options, MW**

| All large-scale* (non-FiTs) capacity | Total deployment by 2012/13 | New build under the RO during the 2013-17 Banding Review period, MW*** Option 1 Current bands | Option 2 Consultation bands | Option 3 Response bands |
|---|---|---|---|---|
| **Enhanced co-firing and conversions** | 1,200 | 1,500 | 3,200 | 3,200 |
| **Onshore wind** | 7,000 | 2,800 | 2,600 | 2,600 |
| **Offshore wind** | 3,600** | 0 | 530 | 530 |
| **Dedicated biomass >50MW** | 50 | 78 | 78 | 78 |
| **Dedicated biomass <50MW** | 340 | 170 | 170 | 170 |
| **Biomass CHP** | 33 | 80 | 80 | 80 |
| **PV** | 50 | 470 | 470 | *Reconsulting* |
| **Energy from waste power only** | 290 | 120 | 140 | 140 |
| **Energy from waste CHP** | 28 | 220 | 220 | 220 |
| **ACT standard and CHP** | 7 | 43 | 7 | 43 |
| **ACT advanced** | 2 | 0 | 0 | 0 |
| **Sewage gas** | 210 | 11 | 11 | 11 |
| **AD** | 37 | 2 | 2 | 2 |
| **Hydro** | 1,700 | 8 | 8 | 8 |
| **Tidal stream** | 2 | 0 | 23 | 23 |
| **Wave** | 1 | 0 | 0 | 0 |
| **Bioliquids** | 51 | 0 | 0 | 0 |
| **Co-firing with CHP** | 0 | 0 | 0 | 0 |
| **Geothermal** | 10 | 10 | 8 | 8 |
| **Landfill gas** | 1,100 | 13 | 11 | 12 |
| **TOTAL** | 19,823 | 5,500 | 7,600 | 7,300 |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures

*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.
** Includes capacity built in 2013/14, as the band is already set for 2013/14.
*** For offshore wind this only includes new build in 2014/15 and 2015/16

**Table B 2: Renewables generation mix under different banding options (GWh)**

| Modelled large-scale*annual generation (GWh per year) | Generation from capacity built by 31/3/2012 | Generation from net new build under the RO during the 2013-17 Banding Review period:*** | | |
|---|---|---|---|---|
| | | Option 1 current bands | Option 2 Consultation bands | Option 3 Response bands |
| Enhanced co-firing and conversions | 6,800 | 8,300 | 18,400 | 18,400 |
| Onshore wind | 17,100 | 6,800 | 6,400 | 6,400 |
| Offshore wind | 11,000** | 0 | 1,600 | 1,600 |
| Dedicated biomass >50MW | 400 | 610 | 610 | 610 |
| Dedicated biomass <50MW | 2,600 | 1,400 | 1,400 | 1,400 |
| Biomass CHP | 220 | 530 | 530 | 530 |
| PV | 48 | 440 | 440 | *Re-consulting* |
| Energy from waste power only | 1,700 | 890 | 1,000 | 1,000 |
| Energy from waste CHP | 200 | 1,700 | 1,700 | 1,700 |
| ACT standard and CHP | 40 | 260 | 39 | 260 |
| ACT advanced | 9 | 0 | 0 | 0 |
| Sewage gas | 630 | 52 | 52 | 52 |
| AD | 170 | 10 | 10 | 10 |
| Hydro | 4,900 | 28 | 28 | 28 |
| Tidal stream | 8 | 0 | 80 | 80 |
| Wave | 3 | 0 | 0 | 0 |
| Bioliquids | 150 | 0 | 0 | 0 |
| Co-firing with CHP | 0 | 0 | 0 | 0 |
| Geothermal | 0 | 80 | 64 | 64 |
| Landfill gas | 5,900 | 93 | 75 | 85 |
| Standard co-firing | 3,200 | N/A | N/A | N/A |
| TOTAL | 55,000 | 21,000 | 32,000 | 32,000 |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures
*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.
** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.
*** For offshore wind this includes only generation from new build in 2014/15 and 2015/16

**Table B 3: Renewables capacity mix under high fossil fuel prices, MW**

| All large-scale* (non-FiTs) capacity | Total deployment by 2012/13 | | New build under the RO during the 2013-17 Banding Review period, MW:*** Option 1 Current bands | | Option 3 Response bands | |
|---|---|---|---|---|---|---|
| | High FF | Difference from central FF | High FF | Difference from central FF | High FF | Difference from central FF |
| **Biomass conversion and enhanced co-firing** | 1,200 | *0* | 2,400 | *970* | 3,700 | *510* |
| **Onshore wind (>5MW)** | 7,100 | *48* | 3,200 | *400* | 2,800 | *220* |
| **Offshore wind** | 3,600** | *0* | 200 | *200* | 740 | *200* |
| **Dedicated biomass >50MW** | 50 | *0* | 140 | *61* | 160 | *78* |
| **Dedicated biomass <50MW** | 340 | *3* | 230 | *55* | 230 | *55* |
| **Biomass CHP** | 33 | *0* | 80 | *0* | 80 | *0* |
| **PV** | 53 | *0* | 470 | *0* | 280 | *96* |
| **Energy from waste power only** | 290 | *1* | 140 | *17* | 140 | *0* |
| **Energy from waste CHP** | 28 | *0* | 260 | *40* | 260 | *40* |
| **ACT standard and CHP** | 7 | *0* | 43 | *0* | 46 | *4* |
| **ACT advanced** | 2 | *0* | 0 | *0* | 0 | *0* |
| **Sewage gas** | 210 | *1* | 11 | *0* | 11 | *0* |
| **AD** | 37 | *0* | 2 | *0* | 2 | *0* |
| **Hydro** | 1,700 | *6* | 20 | *12* | 8 | *0* |
| **Tidal stream** | 2 | *0* | 0 | *0* | 23 | *0* |
| **Wave** | 1 | *0* | 0 | *0* | 0 | *0* |
| **Bioliquids** | 51 | *0* | 0 | *0* | 0 | *0* |
| **Co-firing with CHP** | 0 | *0* | 0 | *0* | 0 | *0* |
| **Geothermal** | 0 | *0* | 10 | *0* | 10 | *2* |
| **Landfill gas** | 1,100 | *1* | 12 | *-1* | 12 | *0* |
| **TOTAL** | **16,000** | ***61*** | **7,300** | ***1,800*** | **8,500** | ***1,200*** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures

*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.

** Includes capacity built in 2013/14, as the band is already set for 2013/14.

*** For offshore wind this only includes new build in 2014/15 and 2015/16

**Table B 4: Renewables generation mix under high fossil fuel prices (GWh)**

| Modelled annual generation (GWh per year) from large-scale* renewable capacity | Generation from capacity built by 31/3/2012 | Generation from net new build under the RO during the 2013-17 Banding Review period:*** | | | |
|---|---|---|---|---|---|
| | | Option 1 Current bands | | Option 3 Response bands | |
| | High FF | High FF | Difference from central FF | High FF | Difference from central FF |
| **Enhanced co-firing and conversions** | 6,800 | 14,000 | *5,500* | 21,000 | *2,900* |
| **Onshore wind** | 17,000 | 7,800 | *990* | 6,800 | *480* |
| **Offshore wind** | 11,000** | 620 | *620* | 2,300 | *620* |
| **Dedicated biomass >50MW** | 400 | 1,100 | *480* | 1,200 | *610* |
| **Dedicated biomass <50MW** | 2,700 | 1,800 | *430* | 1,800 | *430* |
| **Biomass CHP** | 220 | 530 | *0* | 530 | *0* |
| **PV** | 48 | 440 | *0* | 260 | *91* |
| **Energy from waste power only** | 1,700 | 1,000 | *120* | 1,000 | *0* |
| **Energy from waste CHP** | 200 | 2,000 | *300* | 2,000 | *300* |
| **ACT standard and CHP** | 40 | 260 | *0* | 280 | *22* |
| **ACT advanced** | 9 | 0 | *0* | 0 | *0* |
| **Sewage gas** | 640 | 52 | *0* | 52 | *0* |
| **AD** | 170 | 10 | *0* | 10 | *0* |
| **Hydro** | 4,900 | 66 | *38* | 28 | *0* |
| **Tidal stream** | 8 | 0 | *0* | 80 | *0* |
| **Wave** | 3 | 0 | *0* | 0 | *0* |
| **Bioliquids** | 150 | 0 | *0* | 0 | *0* |
| **Co-firing with CHP** | 0 | 0 | *0* | 0 | *0* |
| **Geothermal** | 0 | 80 | *0* | 80 | *16* |
| **Landfill gas** | 5,900 | 93 | *0* | 93 | *9* |
| **Standard co-firing** | 4,000 | N/A | N/A | N/A | N/A |
| **TOTAL** | **56,000** | **30,000** | ***8,500*** | **38,000** | ***5,500*** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures
*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.
** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.
*** For offshore wind this includes only generation from new build in 2014/15 and 2015/16

**Table B 5: Renewables capacity mix under low fossil fuel prices, MW**

| All large-scale* (non-FiTs) capacity | Total deployment by 2012/13 | | New build under the RO during the 2013-17 Banding Review period, MW:*** Option 1 Current bands | | Option 3 Response bands | |
|---|---|---|---|---|---|---|
| | low FF | Difference from central FF | Low FF | Difference from central FF | low FF | Difference from central FF |
| **Biomass conversion and enhanced co-firing** | 750 | *-450* | 1,200 | *-220* | 770 | *-2,400* |
| **Onshore wind (>5MW)** | 6,800 | *-220* | 1,000 | *-1,800* | 880 | *-1,700* |
| **Offshore wind** | 3,600** | *0* | 0 | *0* | 0 | *-530* |
| **Dedicated biomass >50MW** | 50 | *0* | 0 | *-78* | 0 | *-78* |
| **Dedicated biomass <50MW** | 300 | *-36* | 2 | *-170* | 2 | *-170* |
| **Biomass CHP** | 33 | *0* | 80 | *0* | 80 | *0* |
| **PV** | 40 | *-13* | 320 | *-150* | 10 | *-170* |
| **Energy from waste power only** | 280 | *-9* | 20 | *-110* | 20 | *-120* |
| **Energy from waste CHP** | 21 | *-7* | 180 | *-40* | 180 | *-40* |
| **ACT standard and CHP** | 1 | *-6* | 7 | *-36* | 7 | *-36* |
| **ACT advanced** | 2 | *0* | 0 | *0* | 0 | *0* |
| **Sewage gas** | 200 | *-5* | 2 | *-9* | 2 | *-9* |
| **AD** | 37 | *0* | 2 | *0* | 2 | *0* |
| **Hydro** | 1,700 | *0* | 8 | *0* | 1 | *-6* |
| **Tidal stream** | 2 | *0* | 0 | *0* | 15 | *-8* |
| **Wave** | 1 | *0* | 0 | *0* | 0 | *0* |
| **Bioliquids** | 51 | *0* | 0 | *0* | 0 | *0* |
| **Co-firing with CHP** | 0 | *0* | 0 | *0* | 0 | *0* |
| **Geothermal** | 0 | *0* | 8 | *-2* | 8 | *0* |
| **Landfill gas** | 1,100 | *-2* | 12 | *-1* | 12 | *0* |
| **TOTAL** | **15,000** | *-740* | **2,900** | *-2,600* | **2,000** | ***-5,300*** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures

*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.

** Includes capacity built in 2013/14, as the band is already set for 2013/14.

*** For offshore wind this only includes new build in 2014/15 and 2015/16

**Table B 6: Renewables generation mix under low fossil fuel prices (GWh)**

| Modelled annual generation (GWh per year) from large-scale* renewable capacity | Generation from capacity built by 31/3/2012 | Generation from net new build under the RO during the 2013-17 Banding Review period:*** | | | |
|---|---|---|---|---|---|
| | | Option 1 Current bands | | Option Response bands | |
| | Low FF | Low FF | Difference from central FF | Low FF | Difference from central FF |
| **Enhanced co-firing and conversions** | 4,300 | 7,000 | *-1,300* | 4,400 | *-14,000* |
| **Onshore wind** | 17,000 | 2,600 | *-4,200* | 2,200 | *-4,200* |
| **Offshore wind** | 11,000** | 0 | *0* | 0 | *-1,600* |
| **Dedicated biomass >50MW** | 400 | 0 | *-610* | 0 | *-610* |
| **Dedicated biomass <50MW** | 2,400 | 16 | *-1,400* | 16 | *-1,400* |
| **Biomass CHP** | 220 | 530 | *0* | 530 | *0* |
| **PV** | 36 | 300 | *-140* | 8 | *-160* |
| **Energy from waste power only** | 1,700 | 110 | *-780* | 110 | *-900* |
| **Energy from waste CHP** | 140 | 1,400 | *-300* | 1,400 | *-300* |
| **ACT standard and CHP** | 6 | 39 | *-220* | 39 | *-220* |
| **ACT advanced** | 9 | 0 | *0* | 0 | *0* |
| **Sewage gas** | 610 | 12 | *-41* | 12 | *-41* |
| **AD** | 170 | 10 | *0* | 10 | *0* |
| **Hydro** | 4,900 | 28 | *0* | 4 | *-24* |
| **Tidal stream** | 8 | 0 | *0* | 51 | *-28* |
| **Wave** | 3 | 0 | *0* | 0 | *0* |
| **Bioliquids** | 150 | 0 | *0* | 0 | *0* |
| **Co-firing with CHP** | 0 | 0 | *0* | 0 | *0* |
| **Geothermal** | 0 | 64 | *-16* | 64 | *0* |
| **Landfill gas** | 5,900 | 54 | *-39* | 37 | *-47* |
| **Standard co-firing** | 450 | N/A | N/A | N/A | N/A |
| **TOTAL** | **48,000** | **12,000** | ***-9,000*** | **8,800** | ***-24,000*** |

Source: modelling by Pöyry consultants; DECC bottom-up conversions/ECF assessment; Results rounded to two significant figures

*Note 'large-scale' renewables are defined as all UK renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain. Bands for large scale solar PV will be subject to further consultation. Large scale PV costs and deployment are indicative at this stage.

** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.

*** For offshore wind this includes only generation from new build in 2014/15 and 2015/16

## Annex C - Modelling approaches for biomass conversions and Enhanced Co-Firing

135. In the lead consultation option, standard co-firing was defined as burning 0-14% biomass fuel in a whole (former) fossil fuel power station, with enhanced co-firing defined as burning 15-99% biomass fuel. In light of evidence submitted as part of the consultation and additional technical advice, it became clear that total ECF/conversion costs reflected their percentage of biomass fuel input to the boiler/unit they were burnt in, more than the percentage they represent of the whole station's biomass fuel input. The basis of the definitions has therefore been switched to a per unit basis in the Government response. Whilst the capital costs follow a roughly linear profile from 20% of a unit upwards (roughly constant capex per kW of biomass with increasing percentages of biomass), the proportionate reductions of efficiency and capacity on a generation asset increase the closer the unit gets to burning 100% biomass and fuel costs per MWh can increase too. Furthermore, there is a policy objective to encourage higher proportions of biomass burn to increase decarbonisation and to achieve a higher degree of 'lock-in' for (former) fossil fuel plant to biomass. The revised proposals therefore increase the bands in a step-wise fashion as a greater percentage of biomass is burned in the unit (by creating a mid-range co-firing band for co-firing between 50-84% in a unit, and a high-range co-firing band for co-firing between 85-99% in a unit).[58]

136. There is an affordability constraint in the form of the Levy Control Framework (LCF). Whilst conversions and enhanced co-firing represent some of the most cost-effective renewable technologies, they also represent the majority of expected new RO spend from 2013-17. Analysis suggests control of ECF and/or conversions costs is necessary to stay within the LCF. The band for high-range co-firing is therefore set at a lower level (0.7 ROCs/MWh) in 2013/14 to remain within the LCF for that year, before increasing to 0.9 ROCs/MWh in 2014/15 for the rest of the period to further incentivise deployment. The band for low range co-firing is proposed at a lower level (0.3 ROCs/MWh) in 2013/14 and 2014/15 before increasing to 0.5ROCs/MWh for the rest of the period – this proposal will be the subject of a new consultation.

137. New biomass conversions are not expected to pose the same degree of budgetary risk as ECF under the LCF, and the policy objective is to incentivise higher percentages of biomass burn. Conversions provide both higher levels of renewable output and more certain renewable output towards renewable targets than ECF. However, conversions, like ECF, still represent a significant risk on the one hand to renewables targets if deployment is too low; and on the other to affordability for consumers if deployment is too high. It is proposed that both will therefore be subject to the new monitoring and reporting requirements, on which a separate consultation will be published shortly.

138. In line with the evidence provided in consultation, each approach examines the conversion of individual generation units, rather than the plant as a whole. This is consistent with the revised proposed definitions for enhanced co-firing and conversions set out in the Government Response to consultation. Enhanced co-firing is defined as burning 50% or more biomass in a boiler. The proportion of biomass burned in each unit may vary according the relative prices of biomass and coal throughout the year. Owing to the difficulty of forecasting short-term movements in relative prices throughout the year, this has not been modelled. Instead, relative biomass-coal prices were assumed to vary annually. The analysis assumes a constant amount of biomass will be burned *per generation*

[58] In general when ECF is referred to in the results below, it covers mid-range and high-range co-firing. The analysis found that only high-range co-firing is expected to occur at the proposed rates.

*unit*, in every year, irrespective of the other uncertainties set out earlier.

139. Owing to the relatively small number of potential conversions/ECF and the commercial confidentiality of the data provided, results are not presented in this IA for individual plants but they have been aggregated. In addition, given that it is difficult to recreate the economics of the investment decision faced by coal generators accurately for every individual case, the results have been aggregated to average out non-systematic errors.

140. As was the case for other technologies, assumptions were supplied to Pöyry and inputted into DECC's in-house renewables investment model on the costs, technical characteristics and deployment potential of biomass conversions and ECF plants. Three plants were modelled individually, based on data collected for, and during, the consultation. Other potential projects used average values for costs and technical characteristics. Evidence collected as part of the consultation was used to produce deployment potential scenarios.

### A) Pöyry modelling

141. With respect to biomass conversions and ECF, Pöyry were instructed to investigate the impact of current bands and revised proposals under two scenarios:

- central assumptions with a biomass fuel availability constraint; and
- high biomass conversions/ECF deployment potential with no biomass fuel constraint.

Relaxing the biomass fuel supply constraint was chosen as a sensitivity because availability of sustainable biomass is a key uncertainty which will directly affect how much biomass generation is possible.

### B) DECC In-house modelling

142. Each potential candidate for conversion or ECF was modelled separately. First, it was important to determine how economic the plant was in continuing to burn coal, and for how long. Owing to changes in fossil fuel, carbon and electricity prices over time, some plants cease to be economic before others e.g. for having a lower efficiency. When determining the minimum level of RO support to incentivise a conversion/ECF, the profitability must be identical to that when the plant burns coal. When discounting cashflows, a higher discount rate (11.6%) is used in the biomass case, than the coal case (7.5%), reflecting the risk of switching to a new fuel and the impacts that could have on the existing boilers, and the relative immaturity of the biomass fuel supply chain.

143. The in-house model then estimates which plants will decide to convert/ECF based on a comparison of the estimated ROCs required and the ROC support under the scenario being modelled. The methodology is similar to that used for the Pöyry ROCket modelling, but there is no biomass constraint modelled in any of the scenarios.

### C) Bottom-up scenarios

144. It is important to recognise that although the evidence has been assessed in detail, substantial uncertainties remain with the modelling assumptions which have been made in relation to these two technologies of enhanced co-firing and conversions. For example, a 10% rise in the price of biomass is estimated to result in investors requiring an additional 0.25 ROCs per MWh. The sensitivity analysis presented in Annex D attempts to illustrate some of this uncertainty, but outcomes outside these ranges are still possible.

145. The results for ECF and conversions. from the modelling analysis did not reflect the market intelligence and judgement of likely deployment by DECC. It was therefore decided to construct bottom-up deployment scenarios, informed by the modelling evidence above, by consultation evidence and by market intelligence. These scenarios set out estimated deployment at different ROC banding levels. Additional factors which have been considered were:

- Geographical factors which may influence price and therefore likelihood of an investment going ahead
- Time required to develop the feedstock supply chain, and competition for resource with other biomass generators
- Ownership of other plants - if a company owns multiple plants it is likely to decide on a priority order rather than multiple simultaneous conversions

146. A number of scenarios were provided to Pöyry and 'forced-on' in the modelling results presented in this IA. All other technologies have been modelled by Pöyry using their ROCket and Eureca models, following the process set out in section 3.

# Annex D – Sensitivity Analysis

## A) Biomass conversions and enhanced co-firing

147. As set out in Annex C, the uptake of biomass conversions and ECF plants were explored using three different modelling approaches: Pöyry modelling, in-house analysis and bottom-up.

148. All three approaches used "central" and "high" estimates of biomass conversions/ECF potential. The impact of these scenarios on uptake in response to the banding options was explored using the different modelling approaches. The 'central' potential contained generation units which were more likely to convert/ECF based on consultation evidence indicating well-developed plans. The 'high' potential also contained units which were more speculative, but nevertheless showed potential to convert/ECF in the future.

149. Table D1 sets out the capacity and generation in 2016/17, under the three different modelling methodologies set out in Annex C. For each methodology, a number of scenarios are presented, which vary the potential, fossil fuel prices and banding scenario.

150. Pöyry modelling (consultation bands and revised proposals):
    - Central potential – uptake estimated under the central set of assumptions, set out in Annex A.
    - No fuel constraint and high potential – This sensitivity removes the biomass fuel supply constraint and uses the high estimate of biomass conversions and ECF potential

151. In-house model (consultation bands and revised proposals):
    - Central uptake potential – under low, central and high fossil fuel price assumptions
    - High deployment potential – under central fossil fuel price assumptions

152. Bottom-up (consultation bands, current bands and revised proposals):
    - Current bands and revised proposals used the central estimate of potential, under low, central and high fossil fuel prices
    - Consultation bands used the central estimate of potential, under central fossil fuel prices.

**Table D 1: Biomass conversion/ECF results**

| Model approach | Banding scenario | Potential assumption | Fossil fuel price assumption | Generation in 2016/17 |
|---|---|---|---|---|
| | | | | TWh |
| Pöyry modelling | Current bands | Central | Central | 5.8 |
| | Consultation bands | Central | | 16 |
| | | High, plus no fuel constraint | | 15 |
| | 0.9 ROCs/MWh for conversion and ECF | Central | | 11 |
| In-house model | Consultation bands | Central | Central | 5.1 |
| | | | Low | 5.1 |
| | | | High | 12 |
| | | High | Central | 10 |
| | Response bands | Central | Central | 5.1 |
| | | | Low | 0.0 |
| | | | High | 5.1 |
| | | High | Central | 5.1 |
| Bottom-up assessment | Current bands | Central | Low | 7.0 |
| | | | Central | 8.3 |
| | | | High | 14 |
| | Response bands | | Low | 4.4 |
| | | | Central | 18 |
| | | | High | 21 |
| | Consultation proposals | | Central | 18 |

Source: Pöyry modelling, DECC modelling and DECC calculations, rounded to two significant figures.

153. DECC examined the results of the Pöyry and in-house modelling, which showed ECF and conversions deployment ranging from 0-16 TWh/y by 2016/17, depending on banding levels and other assumptions, alongside industry intelligence and expert judgement, and believe it is likely on a central view that deployment would be higher than the modelling indicates. This DECC view is the 'bottom-up assessment' set out above which was 'forced on' in the main Pöyry modelling results above. However, there is very considerable uncertainty surrounding the level of ECF and conversions deployment, given the variability of relative coal to biomass fuel prices, and uncertainty about the levels of available biomass amongst other factors, as illustrated by the range of estimates in the table above.

### B) Fossil fuel price sensitivities

### High fossil fuel prices

154. This section outlines renewable deployment, monetised costs and benefits and distributional impacts under a high fossil fuel price scenario

Renewable deployment

155. Tables D2 and D3 summarise the capacity and generation mix in a world of high fossil fuel prices[59] for current bands and the new-build supported by the RO under new banding levels over the 2013-17 banding review period. Generally, owing to renewable technologies becoming more cost-competitive under high fossil fuel prices, more renewable capacity is built over the Banding Review period in both current bands and new bands when compared to central fossil fuel price scenarios.

**Table D 2: Modelled new build capacity under different options, MW**

| **Modelled Capacity (MW)** | **Total deployment by 2012/13** | | **New build under the RO during the 2013-17 Banding Review period:****** | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Option 1 Current bands** | | **Option 1 Current bands** | | **Option 3 Response bands** | |
| **Fossil fuel price** | **High** | **N/A** | **High** | **N/A** | **High** | **N/A** |
| | | **Difference from central FF** | | **Difference from central FF** | | **Difference from central FF** |
| Biomass conversion and ECF | 1,200 | *0* | 2,400 | *970* | 3,700 | *510* |
| Onshore wind (>5MW)* | 7,100 | *48* | 3,200 | *400* | 2,800 | *220* |
| Offshore wind | 3,600*** | *0* | 200 | *200* | 740 | *200* |
| Dedicated biomass >50MW | 50 | *0* | 140 | *61* | 160 | *78* |
| Dedicated biomass <50MW | 340 | *3* | 230 | *55* | 230 | *55* |
| Tidal stream | 3 | *0* | 0 | *0* | 23 | *0* |
| Wave | 1 | *0* | 0 | *0* | 0 | *0* |
| Other** | 3,400 | *10* | 1,100 | *68* | 850 | *140* |
| **Total 'large-scale'**** | **16,000** | ***61*** | **7,300** | ***1,800*** | **8,500** | ***1,200*** |

* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.
**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind supported by FiTs in Great Britain.
*** Includes new build in 2013/14
**** For offshore wind includes only new build in 2014/15 and 2015/16

156. Under high fossil fuel prices, new proposed bands brings on around 1.3GW of ECF and conversion capacity that does not come on under current bands (as there is no separate band for enhanced co-firing and the standard co-firing rate is not enough to bring on any enhanced capacity), delivering an additional 7 TWh/y of generation towards the 2020 renewables target.

157. Under high fossil fuel prices, new proposals lead to generation from onshore wind new build of around 6.8TWh, a reduction of 1 TWh from current bands. This compares with a reduction of 0.5TWh under central fossil fuel prices.

158. Under high fossil fuel prices total large-scale renewables new build increases by 1.2GW under new proposed bands compared to central fossil fuel prices. This equates to an increase in generation towards the 2020 renewables target of 8TWh.

[59] High fossil fuel price assumptions (as central and low) are the latest DECC projections, published October 2011.

**Table D 3: Modelled generation from new build capacity under different options, GWh per year**[60]

| Modelled Generation (GWh) | Total deployment by 2012/13 | | New build under the RO during the 2013-17 Banding Review period:**** | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Option 1 Current bands** | | **Option 1 Current bands** | | **Option 3 Response bands** | |
| **Fossil fuel price** | **High** | **N/A** | **High** | **N/A** | **High** | **N/A** |
| | | **Difference from central FF** | | **Difference from central FF** | | **Difference from central FF** |
| Biomass conversion and ECF | 6,800 | *0* | 14,000 | *5,500* | 21,000 | *2,900* |
| Onshore wind (>5MW)* | 17,000 | *120* | 7,800 | *990* | 6,800 | *480* |
| Offshore wind | 11,000*** | *0* | 620 | *620* | 2,300 | *620* |
| Dedicated biomass >50MW | 400 | *0* | 1,100 | *480* | 1,200 | *610* |
| Dedicated biomass <50MW | 2,700 | *24* | 1,800 | *430* | 1,800 | *430* |
| Tidal stream | 8 | *0* | 0 | *0* | 80 | - |
| Wave | 3 | *0* | 0 | *0* | 0 | - |
| Other** | 14,000 | *840* | 4,500 | *460* | 4,300 | *440* |
| **Total 'large-scale'**** | **52,000** | ***980*** | **30,000** | ***8,500*** | **38,000** | ***5,500*** |

* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.
**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind supported by FiTs in Great Britain.
*** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.
**** For offshore wind this includes only generation from new build in 2014/15 and 2015/16.

Monetised costs and benefits

159. Under new proposals, renewable generation costs are £7.9bn higher while non-renewable generation costs are £2.4bn lower than under current bands. This compares to £10.9bn higher renewable generation costs and £7.3bn lower non-renewable generation costs than under current bands in the scenario with central fossil fuel prices. The increase in renewable generation compared to current bands is lower under the high fossil fuel price scenario, than in the central scenario, driven mainly by the difference in the impact on ECF and biomass conversions – this result comes from our bottom up modelling of ECF and conversions and the economics of different plant under fossil fuel scenarios (see table D1). Under high fossil fuel prices the level of ECF/ conversion reaches the technical constraint on total conversions – which restricts the total increase in deployment under this scenario. This leads to a lower increase in renewable generation costs (from proposed bands compared to current bands) in the high fossil fuel case than the central case. The reduction in non-renewable generation costs are significantly lower in the high fossil fuel scenario than in the central scenario – leading to a higher overall increase in costs of £5.5bn in the high fossil fuel price scenario.

160. Under high FF prices, new proposed bands produces 56Mt fewer $CO_2$ emissions and hence £1.6bn lower carbon credit purchase costs than under current bands. This compares to 82Mt less $CO_2$ emissions and £1.9bn lower carbon credit purchase costs under new bands than under current bands in a world with central fossil fuel prices. This smaller impact on $CO_2$ in the high fossil fuel case is as a result of the lower increase in renewable generation than under the central case.

161. Balancing costs are slightly higher under high fossil fuel price assumptions compared to current bands. This is a smaller impact than in the central fossil fuel price scenario, where proposed bands

[60] Note that the generation figures include 12 months of generation from the new build during 2015/16, which is assumed to start generating halfway through 2015/16. The sum of the generation from capacity built by 1/4/13 and the generation built under the RO banding review period is therefore greater than total renewable generation in 2015/16, but lower than total renewable generation in 2016/17. In this latter year, it is assumed there is new build of renewables under the FiT with CfD.

lead to £100m increase in balancing cost compared to current bands.

162. The table below summarises the monetised impacts. Note, the signing below (unlike in the tables above) is positive for a benefits and negative for a cost. Table D4 shows that the total impact of new bands under high fossil fuel prices is a £5.5bn increase in costs and a £1.6bn increase in benefits, as compared to current bandings in a high fossil fuel price scenario. Option 3 in a high fossil fuel price world imposes a larger net present cost of £4bn due to more renewables being deployed.

**Table D 4: Monetised costs and benefits to 2039/40 summary, NPV (£bn 2011/12 prices)**

| | **Option 3 (High FF) relative to Option 1 (High FF)** |
|---|---|
| Generation costs | -£5.5bn |
| EUA purchase | +£1.6bn |
| Balancing costs | -£0.05bn |
| **Total impact** | **-£4.0bn** |

Estimates rounded to two significant figures

Distributional impacts

163. Under high fossil fuel prices, Option 3 refined proposals reduce the cost of the RO. The lifetime (to the end of the RO in 2037) reduction in RO costs from Option 3 refined proposals comes to a PV of £370m (£2011/12 prices), relative to current bands under high fossil fuel prices. This compares to an increase in RO costs under central fossil fuel prices of £1.5bn. RO costs overall are higher in a high fossil fuel price world due to more renewable generation coming on and hence more ROCs being issued; renewables generation goes up due to high fossil fuel prices more under current bands than under Option 3 refined proposals as set out above.

**Table D 5: RO support costs under high fossil fuel prices (£m 2011/12 prices, undiscounted)**

| | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|---|
| Current bands (high FF) | 1,400 | 1,900 | 2,900 | 3,300 | 3,700 | 3,900 |
| Impact of Option 3 Response bands (high FF) | - | - | -420 | -450 | -140 | 0 |

164. Under high fossil fuel prices, Option 3 refined proposals reduces wholesale prices relative to the current bands. The net present value to consumers of these lower wholesale prices is a benefit of around £430m in NPV terms. This compares to around a benefit of £260m in NPV terms under central fossil fuel prices.

165. Under high fossil fuel prices, the net impact on consumers relative to current bands, covering RO support costs, wholesale price impacts and balancing costs, comes to comes to a net benefit of around £91m in NPV terms for Option 3 refined proposals. This compares to a £1.4bn net cost under central fossil fuel prices.

**Low fossil fuel prices**

166. This section outlines renewable deployment, monetised costs and benefits and distributional impacts under a low fossil fuel price scenario

Renewable deployment

167. Tables D6 and D7 summarise the capacity and generation mix in a world of low fossil fuel prices[61] for current bands and the new-build supported by the RO under new proposed bands over the 2013-17 banding review period. Generally, due to renewable technologies becoming less cost-competitive under low fossil fuel prices, significantly less renewable capacity is being built over the period in either current bands or Option 3 refined proposals when compared to central fossil fuel price scenarios.

**Table D 6: Modelled new build capacity under different options, MW**

| **Modelled Capacity (MW)** | **Total deployment by 2012/13** | | **New build under the RO during the 2013-17 Banding Review period:****** | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Option 1 Current bands** | | **Option 1 Current bands** | | **Option 3 Response bands** | |
| **Fossil fuel price** | **Low** | **N/A** | **Low** | **N/A** | **Low** | **N/A** |
| | | **Difference from central FF** | | **Difference from central FF** | | **Difference from central FF** |
| Biomass conversion and ECF | 750 | *-450* | 1,200 | *-220* | 770 | *-2,400* |
| Onshore wind (>5MW)* | 6,800 | *-220* | 1,000 | *-1,800* | 880 | *-1,700* |
| Offshore wind | 3,600*** | *0* | 0 | *0* | 0 | *-530* |
| Dedicated biomass >50MW | 50 | *0* | 0 | *-78* | 0 | *-78* |
| Dedicated biomass <50MW | 300 | *-36* | 2 | *-170* | 2 | *-170* |
| Tidal stream | 3 | *0* | 0 | *0* | 15 | *-8* |
| Wave | 1 | *0* | 0 | *0* | 0 | *0* |
| Other** | 3,400 | *-42* | 640 | *-350* | 320 | *-390* |
| **Total 'large-scale'**** | **15,000** | ***-740*** | **2,900** | ***-2,600*** | **2,000** | ***-5,300*** |

Source: Pöyry modelling and DECC calculations; all figures rounded to two significant figures.
* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.
**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain.
*** Includes new build in 2013/14
**** For offshore wind includes only new build in 2014/15 and 2015/16

168. Total capacity of all technologies in 2015/16 is 5.3GW lower under low fossil fuel prices than under central fossil fuel prices for Option 3 refined proposals and generation is 24TWh/y lower by 2016/17.

169. For Option 3 refined proposals, under central fossil fuel price assumptions there are 3.2GW of ECF and conversion capacity deployed delivering 18TWh/y by 2016/17, compared to 2.4GW under low fossil fuel prices delivering 14TWh/y. Under central fossil fuel prices, offshore wind new build also increases under Option 3 by 530MW compared to current bands, while under low fossil fuel prices no additional offshore is coming on under Option 3 compared to current bands.

170. Under low fossil fuel prices, there is around 160MW less onshore wind deployed during the banding review period at the proposed 0.9 ROCs under Option 3, compared to the current band of 1 ROC and 0.4TWh/y less of generation by 2016/17. Around 1.7GW less onshore wind is built under Option 3 with low as opposed to central fossil fuel prices giving 4.2TWh/y less generation by 2016/17.

[61] High fossil fuel price assumptions (as central and low) are the latest DECC projections, first published May 2009.

**Table D 7: Modelled generation from new build capacity under different options, GWh per year**[62]

| Modelled Generation (GWh) | Total deployment by 2012/13 | | New build under the RO during the 2013-17 Banding Review period:**** | | | |
|---|---|---|---|---|---|---|
| **Scenario** | **Option 1 Current bands** | | **Option 1 Current bands** | | **Option 3 Response bands** | |
| **Fossil fuel price** | **Low** | **N/A** | **Low** | **N/A** | **Low** | **N/A** |
| | | **Difference from central FF** | | **Difference from central FF** | | **Difference from central FF** |
| Biomass conversion and ECF | 4,300 | *-2,600* | 7,000 | *-1,300* | 4,400 | *-14,000* |
| Onshore wind (>5MW)* | 17,000 | *-510* | 2,600 | *-4,200* | 2,200 | *-4,200* |
| Offshore wind | 11,000*** | *0* | 0 | *0* | 0 | *-1,600* |
| Dedicated biomass >50MW | 400 | *0* | 0 | *-610* | 0 | *-610* |
| Dedicated biomass <50MW | 2,400 | *-280* | 16 | *-1,400* | 16 | *-1,400* |
| Tidal stream | 8 | *0* | 0 | *0* | 51 | *-28* |
| Wave | 3 | *0* | 0 | *0* | 0 | *0* |
| Other** | 14,000 | *-3,000* | 2,500 | *-1,500* | 2,200 | *-1,700* |
| **Total 'large-scale'**** | **48,000** | ***-6,300*** | **12,000** | ***-9,000*** | **8,800** | ***-24,000*** |

Source: Pöyry modelling and DECC calculations; all figures are rounded to two significant figures.
* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.
**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain.
*** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.
**** For offshore wind this includes only generation from new build in 2014/15 and 2015/16.

171. The net impact of Option 3 refined proposals in a low fossil fuel price world is to reduce renewables new build by around 0.9GW compared to current bands and to reduce renewables generation towards the 2020 renewables target by around 3.4TWh/y.

172. In comparison, under central fossil fuel prices, renewable new build increases by 1.8GW compared to current bands under Option 3 refined proposals and renewables generation towards the 2020 renewables target increases by 11TWh/y. So under low fossil fuel prices, the contribution of new build under the new bands is greatly reduced, with deployment higher under current bands.

<u>Monetised costs and benefits</u>

173. Under the preferred Option 3 refined proposals in a low fossil fuel prices world, renewable generation costs are £4.0bn lower than under current bands while non-renewable generation costs are £640m higher. This compares to £11bn higher renewable generation costs and £7.5bn lower non-renewable generation costs than under current bands in the scenario with central fossil fuel prices.

174. Option 3 refined proposals is associated with a relatively small increase of 24Mt in $CO_2$ emissions in the power sector to 2040 and hence £600m higher EUA (carbon credit) purchase costs than under current bands. (offset by higher emissions elsewhere within the EU-ETS). This compares to 82Mt less $CO_2$ emissions and £1.9bn lower carbon credit purchase costs under Option 3 than under current bands in a world with central fossil fuel prices.

[62] Note that the generation figures include 12 months of generation from the new build during 2015/16, which is assumed to start generating halfway through 2015/16. The sum of the generation from capacity built by 1/4/13 and the generation built under the RO banding review period is therefore greater than total renewable generation in 2015/16, but lower than total renewable generation in 2016/17. In this latter year, it is assumed there is new build of renewables under the FIT with CfD.

175. Balancing costs are £85m lower in Option 3 than under current bands with low fossil fuel price assumptions due to there being less onshore wind in the system. This compares to £94m higher balancing costs than under current bands with central fossil fuel prices.

176. The table below summarises the monetised impacts. Note, the signing below is positive for a benefits and negative for a cost. It shows that the total impact of Option 3 refined proposals under low fossil fuel prices is a £3.4bn reduction in costs and a £0.6bn reduction in benefits, as compared to current bandings in a low fossil fuel price scenario. This compares to a £1.6bn increase in costs under central fossil fuel prices.

**Table D 8: Monetised costs and benefits to 2039/40 summary, NPV (2011/12 prices)**

| | **Option 3 (Low FF) relative to option 1 (Low FF)** |
|---|---|
| Generation costs | +£3.4bn |
| EUA purchase | -£0.6bn |
| Balancing costs | +£0.1bn |
| **Total impact** | **+£2.9bn** |

Source: Pöyry modelling and DECC calculations; all figuresare rounded to two significant figures

Distributional impacts

177. Under low fossil fuel prices, Option 3 refined proposals reduces the cost of the RO. The lifetime (to the end of the RO in 2037) reduction in RO costs from Option 3 comes to an NPV of £3.7bn (£2011/12 prices), relative to current bands under low fossil fuel prices. This compares to an increase in RO costs under central fossil fuel prices of £1.5bn. RO costs are lower in a low instead of central fossil fuel price world due to less renewable generation coming on and hence less ROCs being issued.

**Table D 9: RO support costs under low fossil fuel prices (£m 2011/12 prices, undiscounted)**

| | 2011/12 | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|---|
| Current bands | 1,400 | 1,900 | 2,600 | 2,700 | 2,700 | 2,700 |
| Impact of Option 3 Revised Proposals | - | - | -200 | -360 | -340 | -340 |

Source: Pöyry modelling and DECC calculations; all figures are rounded to two significant figures.

178. Under low fossil fuel prices, Option 3 refined proposals increases wholesale prices relative to the current bands. The net present value to consumers of these higher wholesale prices is a cost of around £1.8bn in NPV terms. This compares to a benefit to consumers of around £260m in NPV terms under central fossil fuel prices.

179. Under high fossil fuel prices, the net impact on consumers relative to current bands, covering RO support costs, wholesale price impacts and balancing costs, comes to comes to a net benefit of around £1.8m in NPV terms for Option 3 refined proposals. This compares to a £1.4bn net cost under central fossil fuel prices.

### C) Assuming new build in 2016/17 is all supported by the RO rather than by CfDs

180. Under the Electricity Market Reform (EMR), the RO is due to close to new capacity from 1st April 2017. Between the introduction of the new support mechanism under the EMR (known as the CfD) and 31st March 2017, new large-scale renewable capacity in eligible technologies will have a choice between support under the RO and support under the CfD. Under the central assumptions set out above, all the capacity built up to and including 2015/16 is assumed to choose the RO, and capacity

in 2016/17 is assumed to choose the CfD, due to the greater revenue stability it offers alongside avoiding the risk of missing the RO cut-off date in the event of construction delay. This sensitivity looks at new capacity in 2016/17 choosing the RO, with all other assumptions as for the preferred Option 3 refined proposals.

181. Tables D10 and D11 below shows that new build under the RO increases by around 2GW under this sensitivity, compared to under central assumptions, delivering around 7TWh more generation under the RO.

**Table D 10: Modelled new build capacity under the RO with new build switching from the RO to CfD support from 2016/17 or from 2017/18, for Option 3 (Response bands)**

| Modelled Capacity (MW) | Total deployment by 2012/13 | New build under the RO during the 2013-17 Banding Review period**** | |
|---|---|---|---|
| | | RO supports new build 2013/14 to 2015/16 | RO supports new build 2013/14 to 2016/17 |
| Biomass conversion and enhanced co-firing | 1,200 | 3,200 | 3,900 |
| Onshore wind (>5MW)* | 7,000 | 2,600 | 3,200 |
| Offshore wind | 3,600*** | 530 | 960 |
| Dedicated biomass >50MW | 50 | 78 | 78 |
| Dedicated biomass <50MW | 340 | 170 | 230 |
| Tidal stream | 2 | 23 | 31 |
| Wave | 1 | 0 | 0 |
| Other** | 3,400 | 710 | 930 |
| **Total 'large-scale'**** | **16,000** | **7,300** | **9,300** |

Source: Pöyry modelling and DECC calculations; all figures are rounded to two significant figures

* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.

**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain.

*** Includes new build in 2013/14; **** For offshore wind includes only new build in 2014/15 and 2015/16

**Table D 11: Modelled generation from new build capacity under the RO with new build switching from the RO to CfD support from 2016/17 or from 2017/18**

| Modelled annual generation (GWh per year) | Generation from capacity built by 31/3/2012 | Generation from net new build under the RO during the 2013-17 Banding Review period:**** | |
|---|---|---|---|
| | | RO supports new build 2013/14 to 2015/16 | RO supports new build 2013/14 to 2016/17 |
| Biomass conversion and enhanced co-firing | 6,800 | 18,400 | 22,000 |
| Onshore wind (>5MW)* | 17,000 | 6,400 | 7,800 |
| Offshore wind | 11,000*** | 1,600 | 3,000 |
| Dedicated biomass >50MW | 400 | 610 | 610 |
| Dedicated biomass <50MW | 26,00 | 1,400 | 1,800 |
| Tidal stream | 8 | 80 | 110 |
| Wave | 3 | 0 | 0 |
| Other** | 17,000 | 3,900 | 4,600 |
| **Total 'large-scale'**** | **55,000** | **32,000** | **39,000** |

Source: Pöyry modelling and DECC calculations; all figures are rounded to two significant figures

* Onshore wind (>5MW) includes onshore wind <5MW in Northern Ireland.

**Note 'large-scale' are renewables defined as all renewable electricity except for <5MW AD, PV, hydro and wind in Great Britain.

*** This includes generation from capacity built by 2013/14, as the offshore wind band for 2013/14 has already been set.

**** For offshore wind this includes only generation from new build in 2014/15 and 2015/16.

182. The extra renewable generation brought on in this sensitivity increases RO costs in 2016/17 by £220m and in 2017/18 by £430m (discounted £2011/12 prices).

## Annex E – Other banding review decisions (i.e. excluding banding)

### A) Grandfathering

183. Grandfathering is a firm policy intention to fix the RO banding level for generating capacity for the whole 20 years of its support under the RO (subject to the 2037 end date of the RO). In July 2010, the Government declared its intention to change the grandfathering policy for biomass generation, and stated its intention to grandfather support for biomass and AD and EFW, but not to grandfather support for bioliquids in the RO. The impact assessment published in July 2010 estimated the impact of grandfathering for plant that generated prior to April 2013.[63]

184. The banding review consultation sets out the approach to grandfathering ROC levels for plant accrediting post April 2013. The policy intention post 2013 is to maintain the current position for dedicated biomass, AD and energy from waste from CHP - to grandfather new accreditations from 1st April 2013 to 31st March 2017 at the support levels prevailing at the time of accreditation - and to make the following changes:

1) Creation of two new bands: for biomass conversion; and for mid-range co-firing bands as from 1 April 2013 and the high-range co-firing band as from 1 April 2014, which will be grandfathered at their new rates.

2) Grandfather bioliquids for dedicated plants and conversions at the rates prevailing at the time of their accreditation, but introduce a cap on bioliquids equivalent to around 2 TWh/y.

3) Grandfather the 'energy crops uplift' for dedicated biomass with energy crops and the 'CHP uplift' at the levels prevailing at the time of accreditation. This means maintaining the differential between grandfathering dedicated energy crops and dedicated biomass with CHP at the full banding level prevailing at the time of accreditation. For dedicated biomass with CHP, this level is proposed to be 2 ROCs/MWh to 2014/15, and for dedicated energy crops 2 ROCs/MWh to 2014/15, 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17.[64] The Government has decided to consult on removing the energy crop uplift for standard co-firing and so grandfathering policy will not apply to the uplift for those stations.

185. The revised proposals in the Government Response maintain these grandfathering policies in terms of grandfathering at the rate prevailing at the time of accreditation, but with the following exceptions. Grandfathering policy will not apply to bioliquids when they are used for co-firing. Furthermore, grandfathering policy will not apply to the energy crop uplift for co-firing, as there will be a consultation on removing the energy crop uplift for those stations. However, there will be a consultation on proposals for the energy crop uplift to continue for a limited period of time for standard co-firers that currently use energy crops.

186. A further exception to these grandfathering decisions is low-range co-firing. Low-range co-firing requires minimal additional capital expenditure to coal generation, especially compared with the capital expenditure for other renewable technologies. Co-firing generators can switch between coal and biomass (up to around 10%) fuel sources in response to changing relative fuel prices and are

[63] See : http://www.decc.gov.uk/assets/decc/consultations/rhi/256-impact-assessment.pdf.
[64] Note that it is proposed to close combined heat and power bands to new accreditations from 1st 2015 (i.e. remove the uplift), and to provide support to CHP technologies thereafter through a combination of RO support and RHI support.

more likely to do so than ECF and full conversions. Future relative coal and biomass prices are extremely uncertain, and hence it is not thought appropriate to set the level of ROC support for the full period of up to 20 years.

187. In analysis of costs and benefits above, biomass technologies have been modelled as being grandfathered in both the counterfactual, and under proposed new bands. The impact on costs and benefits are therefore those associated with the new banding levels. Biomass conversion and enhanced co-firing have been modelled in the counterfactual as being captured by the current dedicated biomass and co-firing bands. The new bands for conversion and enhanced co-firing are assumed to be grandfathered. The costs of this change are included in the overall cost of the lead scenario.

**Grandfathering Bioliquids**

188. Bespoke analysis of the Restats database and the Ofgem sustainability report for 2009/2010[65] indicates that in 2010, generation using bioliquids is estimated at 125GWh of electricity generation. This is in a mix of dedicated biomass and co-firing, and it is expected that, under current proposals, and with levels of support grandfathered for dedicated bioliquids, these levels of generation would continue. It is further expected that in the absence of grandfathering few new dedicated bioliquid projects could secure finance, and therefore grandfathering is assumed to increase the level of generation from bioliquids.

189. Under the revised bioliquid cost assumptions and the proposed ROC levels, the modelling does not assume additional deployment of electricity from bioliquids, and it can therefore be assumed that impact of grandfathering ROCs for dedicated bioliquids will be small. Nonetheless it is anticipated that the increased certainty offered by the policy could have the impact of bringing forward the small amount of low cost bioliquid deployment identified. The total supported generation from bioliquids would, however, be capped at the equivalent of around 2TWh/y.

**Grandfathering the Energy crops uplift**

190. Government's current policy is to not grandfather where the support level covers primarily a fuel cost. Grandfathering the energy crop uplift therefore represents a departure from current policy. The reasons for doing so are:

- the need to increase the total biomass resource available for energy use to 2020 and beyond. Energy crops are one of the few sources of biomass that the UK can grow and expand production;
- to minimise the impacts of bio-electricity on other biomass (wood) using industries;
- to achieve the security of supply benefits of having a diversity of indigenous biomass sources and supply chains; and
- to create new opportunities for UK farmers.

191. In 2010, energy crops were used to generate 60GWh of electricity. Uptake of the uplift since 2009 has been slow. This is in part due to the fact that perennial energy crops take a minimum of three years to establish and grow, but will crop for up to 10 years. There has also been a reluctance on the part of growers and energy suppliers to engage in long term contracts without financial surety.

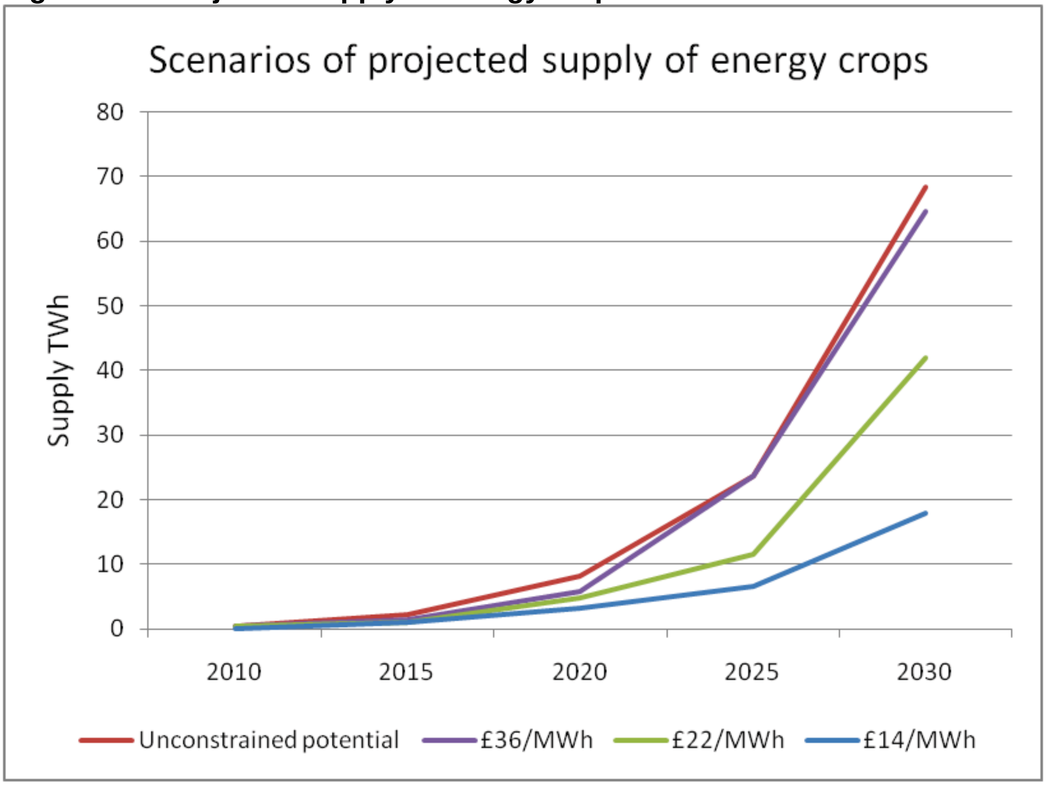
192. Analysis by AEA of future potential global biomass resource indicated that, assuming the use of

[65] OfGem (2011), Annual Sustainability Report 2010-11, available at www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/FuelledStations/Documents1/Annual%20Sustainability%20Report%202010-11.pdf

marginal land and increasing yields and that global food demands are met first, the growth of energy crops in the UK could provide primary energy equivalent to an additional 5TWh in 2020 and up to 50 TWh in 2030 (see Figure 2 below). Grandfathering would therefore protect existing UK investment and set the framework for an increase in the use of energy crops over the medium to longer term.

193. As noted above, the Government intends to re-consult on the band for co-firing with energy crops.

**Figure D 1: Projected supply of energy crops in different scenarios.**




Note: The unconstrained potential is the same at all price points. The scenarios showing supply at different prices assume no market or other constraints are overcome. The AEA study showed that supply will vary according to how the market is able to overcome these barriers.

### B) Definitional changes to energy crops bands

194. The energy crop uplift was introduced in 2009 to encourage the planting within the UK of perennial crops such as Miscanthus and short rotation coppice species such as willow and poplar so as to increase the available biomass resource which does not directly impact on food prices or divert food to energy use. The Government Response sets out the decision to redefine those energy crops which will be eligible for the uplift since concerns have been raised by some non-governmental organisations (NGOs) that the existing definition could allow a wider variety of crops than originally intended, including food crops, to benefit. Continuing with the current definition could therefore lead to unintended consequences. The Government proposes to close this loophole so as to prevent crops from being subsidised which are (a) not perennial or (b) which are food crops and which (c) do not require additional support in order develop the supply chain. This can be done by one of two ways:

i. Restrict the definition to perennial energy crops only through exclusion
ii. Restrict the definition to named energy crops through a positive list

195. Restricting the definition to “perennial energy crops only” risks inclusion of perennial food crops such as palm oil, unless it is defined such a manner so as to exclude any crop which could also be

used as a food crop. Ensuring a legally water-tight exclusion of such crops from the definition will be difficult. Restricting the definition to named energy crops risks excluding valuable crops unless the list is reviewed regularly or made less species specific. However, it is easier to legally define. On balance, the latter is easier to understand and enforce and less open to legal challenge on interpretation.

196. Currently there are no energy crops which do not meet the proposed revised definition claiming ROCs. Changes to the definition of energy crops are therefore not expected to result in economic loss to energy crop producers or energy suppliers.

**C) Definitional changes to gasification and pyrolysis bands**

197. The Government considered whether to introduce the proposed standard 'steam cycle' and advanced 'gas engine' definitions from the consultation. Analysis by the NNFCC, based on energy balance information provided, showed that on average steam cycle processes are less efficient than gas engine processes even taking into account the parasitic load required (although the Government recognises the issues in measuring efficiency fairly across different processes).

198. Based on project information, it is also clear that several plants currently using steam cycle generation can reach high efficiencies and be considered innovative, as well as deliver a wider range of low carbon energy outputs beyond power generation. The Government therefore believes that, based on both cost data and policy aims, there is not a strong rationale for continuing with the proposed differentiation of standard and advanced under the RO.

**D) Bioliquids cap**

199. The Government Response sets out the decision to support the use of bioliquids in dedicated biomass, CHP, co-firing and conversion, subject to an overall cap on bioliquids in the RO. This was to limit the risk that that grandfathered support for bioliquids could lead to a high proportion of bioliquids electricity generation, which would draw in bioliquid sources from other priority sectors – and could cause a 'lock in' of feedstock. The proposals to limit both the level of support and the level of deployment of bioliquids greatly reduce the risks associated with grandfathering existing and planned generation.

200. Although the proposal did not differentiate support for bioliquids from other biomass sources, consultation responses exposed a risk that a wider range of bioliquid feedstocks could be used in co-firing than originally anticipated if the support level increased above 0.5ROCs. A high deployment of bioliquids in co-firing may negatively affect those who rely on contracts with vertically integrated companies to secure sales of bioliquid ROCs. We therefore intend to limit support for bioliquids in co-firing to 0.5ROCs, regardless of the proportion of bioliquid used.

201. In relation to the Renewables Obligation, a cap of 4% of the total number of ROCs is likely to prevent obligated suppliers from receiving support for bioliquid electricity generation that exceeds 2TWh of bioliquid electricity generation within a year. It is important to note that setting a cap alone does not guarantee transport biofuels will not be diverted into electricity production, but lowers the risk of market pull from other sectors.

202. Analysis by AEA[66] and E4Tech[67] shows that there is likely to be a constrained supply of sustainable biofuel to 2020. Table E 1 shows illustrative ranges for electricity generation from sustainable feedstocks in 2020 (based on DECC analysis, using E4Tech and NNFCC data):

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[66] AEA (2011), *UK and Global Bioenergy Resource – Final Report,* available at www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/Energy%20mix/Renewable%20energy/policy/1464-aea-2010-uk-and-global-bioenergy-report.pdf

[67] E4Tech (2010), *Biomass prices in the heat and electricity sectors in the UK,* available at

**Table E 1: Electricity generation from sustainable feedstocks in 2020**

| Bioliquid | Electricity generated in 2020 (TWh) |
|---|---|
| Transport fuel | 0 – 0.032 |
| Non-transport fuel | 2.0 – 2.5 |

203. The theoretical deployment potential for bioliquids, estimated by NNFCC[68], is much higher than that forecast above. These are given in Table E 2, which shows the technical deployment rates with no constraints applied to take into account the support level or availability/ price of feedstock:

**Table E 2: Theoretical potential for bioliquids in 2020**

| Scenario | Electricity generation (TWh) |
|---|---|
| Low | 4.7 |
| Medium | 7.7 |
| High | 12.9 |

204. A cap of around 2TWh in 2020 therefore corresponds to the lower estimate of non-transport bioliquids in 2020. This corresponds with the OfGem sustainability reports[69] which shows that the primary bioliquid feedstocks used under the RO for electricity generation were of a type not suitable for transport use and were used primarily in co-firing and dedicated bioliquid generation. The intention is not for the cap to limit the current use or projects about to come on stream, and it is expected that, assuming no further growth, the current level of deployment would still be apparent in 2020.

205. Consultation responses highlight the risks that a cap may have on certain suppliers to secure finance and sell ROCs at their full value. We consider that an exemption from the cap for CHP accredited stations under 1MW and micro generators will increase investor confidence in these sectors, but is unlikely to lead to a high level of bioliquid use in the RO.

### E) The co-firing cap

206. Currently the RO includes a cap for biomass co-firing of 12.5%. This means that licensed suppliers are restricted to producing only 12.5% of their overall obligation from co-firing of regular biomass ROCs. It is proposed to remove the co-firing cap from 2013/14 onwards to allow more generation from this cost-effective renewable technology.

207. Historically, the total ROCs presented by suppliers did not reach the 12.5% cap, due to a combination of (a) either lack of attractiveness due to high biomass prices in comparison to coal; and/or (b) the cap itself sending a restricting signal to the market and so limiting uptake. For 2011/12 the total Renewables Obligation is set at around 38m ROCs, implying a maximum of 4.7m ROCs would be available for co-firing.

208. The modelling finds that at central assumptions the cap does not restrict standard co-firing generation, as much of the potential standard co-firing generation is not economic relative to burning

www.rhincentive.co.uk/library/regulation/100201Biomass_prices.pdf

[68] Evaluation of Bioliquid Feedstocks & Heat, Elec. & CHP Technologies, NNFCC 11-016, www.nnfcc.co.uk/tools/evaluation-of-bioliquid-feedstocks-and-heat-electricity-and-chp-technologies-nnfcc-11-016

[69] Sustainability Report on biomass fuelled generating stations for 2009/10 obligation period, OfGem, http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=248&refer=Sustainability/Environment/RenewablObl/FuelledStations
Sustainability Report on biomass fuelled generating stations for 2009/10 obligation period, OfGem
http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=318&refer=Sustainability/Environment/RenewablObl/FuelledStations

coal. While there is no evidence to date, the cap could constrain co-firing in the future. Removing the co-firing cap would remove this uncertainty. Given its cost-effectiveness, this could reduce the overall cost of the RO in comparison to more expensive technologies.

209. While removing the co-firing cap might be beneficial for the overall cost of the RO, there is a risk of under-predicting the amount of co-firing when setting the obligation level each year due to added uncertainty. Under-predicting the amount of co-firing might result in significantly reduced ROC prices, which in turn results in reduced investor confidence.

## Annex F – In-house ROCs required analysis

**Table F 1: ROCs required for investment for each technology in each year based on DECC in-house analysis and rationales for proposed bands**

| | | Country | Cost tranche | 2013/14 | 2014/15 | 2015/16 | 2016/17 | Rationale for bands |
|---|---|---|---|---|---|---|---|---|
| Wind | **Onshore >5MW** | E&W | Low | 0.5 | 0.4 | 0.4 | 0.5 | No changes are proposed to the consultation proposals Incentivises the more cost-effective onshore deployment. |
| | | | Low-medium | 0.7 | 0.7 | 0.7 | 0.7 | |
| | | | Medium | 1.0 | 0.9 | 1.0 | 1.0 | |
| | | | Medium-high | 1.3 | 1.2 | 1.2 | 1.3 | |
| | | | High | 1.5 | 1.5 | 1.5 | 1.5 | |
| | **Onshore >5MW** | Scotland | Low | 0.2 | 0.2 | 0.2 | 0.2 | |
| | | | Low-medium | 0.5 | 0.4 | 0.4 | 0.5 | |
| | | | Medium | 0.7 | 0.6 | 0.7 | 0.7 | |
| | | | Medium-high | 0.9 | 0.9 | 0.9 | 0.9 | |
| | | | High | 1.2 | 1.1 | 1.1 | 1.2 | |
| | **Offshore Round 2** | UK | Low | 2.0 | 1.8 | 1.4 | 1.5 | No changes are proposed to the consultation proposals. Analysis shows that if offshore wind is to make a cost-effective contribution to the 2020 target it is necessary to encourage some deployment over the banding review period. |
| | | | Low-medium | 2.3 | 2.0 | 1.7 | 1.7 | |
| | | | Medium | 2.5 | 2.3 | 1.9 | 1.9 | |
| | | | Medium-high | 2.8 | 2.6 | 2.1 | 2.1 | |
| | | | High | 3.1 | 2.8 | 2.4 | 2.4 | |
| | **Offshore Round 3** | UK | Low | 2.6 | 2.5 | 2.5 | 2.5 | |
| | | | Low-medium | 2.9 | 2.8 | 2.8 | 2.8 | |
| | | | Medium | 3.2 | 3.1 | 3.1 | 3.1 | |
| | | | Medium-high | 3.6 | 3.6 | 3.5 | 3.5 | |
| | | | High | 4.0 | 4.0 | 3.9 | 3.9 | |
| Biomass | **Biomass conversion and Enhanced Co-firing** | UK | | 0.3 | 1.1 | 0.8 | | 1.0 is judged enough to bring on biomass conversions which are cost-effective and provide more certainty towards renewables target than enhanced co-firing. ECF is set lower due to lower hurdle rates and RO budgetary risks. |
| | | | Range from modelling many individual plants/boilers | | | | | |
| | | | Modelling judged likely to underestimate deployment. | | | | | |
| | | | | | | | | |
| | | | | 1.2 | 1.2 | 1.2 | | |
| | **Dedicated biomass <50MW** | UK | Low | 1.1 | 1.1 | 1.1 | 1.2 | Our aim is to bring forward only the most cost and carbon-effective plants which can contribute in the short to medium term to GHG reduction and to avoid lock-in of biomass to uses which are sub-optimal in the long term. We therefore propose keeping ROC |
| | | | Low-medium | 1.4 | 1.4 | 1.4 | 1.4 | |
| | | | Medium | 1.7 | 1.6 | 1.7 | 1.7 | |
| | | | Medium-high | 2.1 | 2.0 | 2.1 | 2.1 | |
| | | | High | 2.5 | 2.4 | 2.4 | 2.5 | |
| | **Dedicated biomass >50MW** | UK | Low | 1.5 | 1.5 | 1.4 | 1.5 | |
| | | | Low-medium | 1.6 | 1.6 | 1.6 | 1.6 | |
| | | | Medium | 1.7 | 1.7 | 1.7 | 1.7 | |

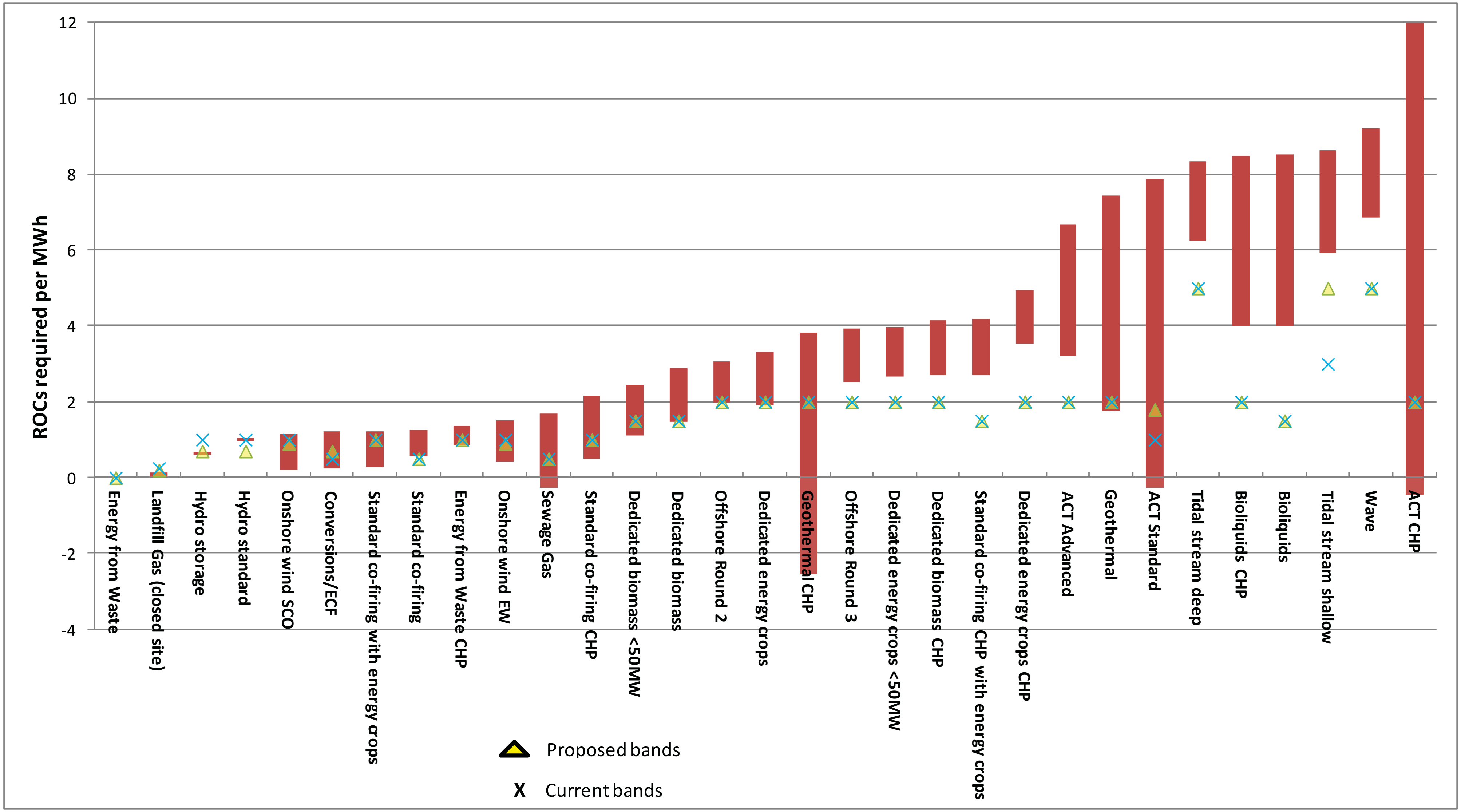
| | Country | Cost tranche | 2013/14 | 2014/15 | 2015/16 | 2016/17 | Rationale for bands |
|---|---|---|---|---|---|---|---|
| | | Medium-high | 2.3 | 2.3 | 2.2 | 2.3 | support at 1.5 ROC, degressing to 1.4 ROC from 1 April 2016, subject to a cap around the equivalent of 800-1000MW (subject to consultation). |
| | | High | 2.9 | 2.9 | 2.8 | 2.9 | |
| **Dedicated biomass <50MW with Energy Crops** | UK | Low | 2.7 | 2.6 | 2.7 | 2.7 | |
| | | Low-medium | 3.0 | 2.9 | 2.9 | 3.0 | |
| | | Medium | 3.2 | 3.2 | 3.2 | 3.3 | |
| | | Medium-high | 3.6 | 3.6 | 3.6 | 3.6 | |
| | | High | 4.0 | 3.9 | 4.0 | 4.0 | |
| **Dedicated biomass >50MW with Energy Crops** | UK | Low | 2.0 | 1.9 | 1.9 | 1.9 | |
| | | Low-medium | 2.1 | 2.0 | 2.0 | 2.1 | |
| | | Medium | 2.2 | 2.2 | 2.1 | 2.2 | |
| | | Medium-high | 2.8 | 2.7 | 2.7 | 2.7 | |
| | | High | 3.3 | 3.3 | 3.3 | 3.3 | |
| **Biomass CHP** | UK | Low | 2.8 | 2.7 | 2.7 | 2.7 | Unchanged from consultation proposal i.e. removal of 1/2 ROC uplift from 2015/16. |
| | | Low-medium | 3.1 | 3.1 | 3.0 | 3.1 | |
| | | Medium | 3.5 | 3.4 | 3.4 | 3.4 | |
| | | Medium-high | 3.8 | 3.8 | 3.7 | 3.8 | |
| | | High | 4.2 | 4.1 | 4.1 | 4.1 | |
| **Biomass CHP with Energy Crops** | UK | Low | 3.6 | 3.5 | 3.5 | 3.5 | |
| | | Low-medium | 3.9 | 3.9 | 3.8 | 3.9 | |
| | | Medium | 4.3 | 4.2 | 4.2 | 4.2 | |
| | | Medium-high | 4.6 | 4.6 | 4.5 | 4.6 | |
| | | High | 5.0 | 4.9 | 4.9 | 4.9 | |
| **Bioliquids** | UK | Low | 4.0 | 4.1 | 4.1 | 4.1 | Setting support in line with solid biomass (except when co-fired) to limit the risk of drawing bioliquids away from other sectors |
| | | Low-medium | 5.9 | 5.8 | 5.8 | 5.7 | |
| | | Medium | 6.7 | 6.7 | 6.6 | 6.6 | |
| | | Medium-high | 7.6 | 7.6 | 7.6 | 7.5 | |
| | | High | 8.6 | 8.5 | 8.5 | 8.5 | |
| **Bioliquids CHP** | UK | Low | 4.0 | 4.0 | 4.0 | 4.0 | |
| | | Low-medium | 5.8 | 5.8 | 5.8 | 5.8 | |
| | | Medium | 6.7 | 6.7 | 6.7 | 6.7 | |
| | | Medium-high | 7.6 | 7.6 | 7.6 | 7.6 | |
| | | High | 8.5 | 8.5 | 8.5 | 8.5 | |
| **Standard co-firing** | UK | Low | 0.6 | 0.6 | 0.5 | 0.5 | Leaving at 0.3 and not increasing so as to provide sufficient difference with enhanced co-firing and conversion to that those preferred technologies (more renewable output) are incentivised. |
| | | Low-medium | 0.7 | 0.7 | 0.7 | 0.6 | |
| | | Medium | 0.9 | 0.9 | 0.8 | 0.8 | |
| | | Medium-high | 1.1 | 1.1 | 1.0 | 1.0 | |
| | | High | 1.3 | 1.3 | 1.2 | 1.2 | |
| **Standard co-firing with Energy Crops** | UK | Low | 0.3 | 0.2 | 0.4 | 0.4 | Re-consulting on removing this band due to lack of evidence of significant cost differential for energy crops and potential long-term budget risks. |
| | | Low-medium | 0.6 | 0.5 | 0.6 | 0.6 | |
| | | Medium | 0.9 | 0.8 | 0.8 | 0.8 | |
| | | Medium-high | 1.0 | 1.0 | 1.0 | 1.0 | |
| | | High | 1.2 | 1.2 | 1.2 | 1.2 | |

| | | Country | Cost tranche | 2013/14 | 2014/15 | 2015/16 | 2016/17 | Rationale for bands |
|---|---|---|---|---|---|---|---|---|
| | CoCHP | UK | Low | 0.5 | 0.5 | 0.5 | 0.6 | No supply curve assumed, as only one or two potential plants. 1.0 ROC is sufficient to bring on a new CoCHP plant if biomass costs below central estimate. Also anything higher not so cost-effective. Providing the uplift to ECF to create a difference from standard co-firing with CHP. |
| | | | Low-medium | 0.9 | 0.9 | 0.9 | 1.0 | |
| | | | Medium | 1.3 | 1.3 | 1.3 | 1.4 | |
| | | | Medium-high | 1.8 | 1.7 | 1.7 | 1.8 | |
| | | | High | 2.2 | 2.2 | 2.2 | 2.3 | |
| | CoCHP with Energy Crops | UK | Low | 2.8 | 2.7 | 2.9 | 3.0 | Re-consulting on this band. |
| | | | Low-medium | 3.2 | 3.1 | 3.3 | 3.4 | |
| | | | Medium | 3.6 | 3.6 | 3.6 | 3.7 | |
| | | | Medium-high | 3.9 | 3.9 | 3.9 | 4.0 | |
| | | | High | 4.2 | 4.2 | 4.3 | 4.4 | |
| Waste | Energy from waste power only | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | No support offered as before. Modelling suggests none required. |
| | | | Low-medium | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | Medium | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | Medium-high | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | High | 0.0 | 0.0 | 0.0 | 0.0 | |
| | Energy from waste CHP | UK | Low | 0.9 | 0.9 | 0.9 | 0.9 | Based on the differential in overall NPVs between a power-only plant and a CHP plant - the CHP plant has to have a better NPV to go ahead. |
| | | | Low-medium | 1.0 | 1.0 | 1.0 | 1.0 | |
| | | | Medium | 1.1 | 1.1 | 1.1 | 1.1 | |
| | | | Medium-high | 1.3 | 1.3 | 1.3 | 1.2 | |
| | | | High | 1.4 | 1.4 | 1.4 | 1.4 | |
| | ACT Standard | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | Setting support in line with offshore wind, as not cost-effective to support more expensive technologies for the renewables target |
| | | | Low-medium | 1.7 | 1.6 | 1.6 | 1.6 | |
| | | | Medium | 3.6 | 3.5 | 3.5 | 3.5 | |
| | | | Medium-high | 5.8 | 5.6 | 5.6 | 5.6 | |
| | | | High | 7.9 | 7.7 | 7.7 | 7.7 | |
| | ACT Advanced | UK | Low | 3.2 | 3.1 | 3.1 | 3.2 | Setting support in line with offshore wind, as not cost-effective to support more expensive technologies for the renewables target |
| | | | Low-medium | 4.3 | 4.2 | 4.2 | 4.2 | |
| | | | Medium | 5.4 | 5.2 | 5.3 | 5.3 | |
| | | | Medium-high | 6.1 | 5.9 | 5.9 | 5.9 | |
| | | | High | 6.7 | 6.6 | 6.6 | 6.6 | |
| | ACT CHP | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | Setting support in line with offshore wind, as not cost-effective to support more expensive technologies for the renewables target |
| | | | Low-medium | 2.6 | 2.5 | 2.5 | 2.5 | |
| | | | Medium | 5.6 | 5.4 | 5.4 | 5.4 | |
| | | | Medium-high | 8.9 | 8.7 | 8.7 | 8.7 | |
| | | | High | 12.2 | 12.0 | 12.0 | 11.9 | |
| | Sewage gas | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | Setting support to bring on the most cost-effective deployment. |
| | | | Low-medium | 0.1 | 0.1 | 0.1 | 0.2 | |
| | | | Medium | 0.5 | 0.4 | 0.5 | 0.5 | |

| | | Country | Cost tranche | 2013/14 | 2014/15 | 2015/16 | 2016/17 | Rationale for bands |
|---|---|---|---|---|---|---|---|---|
| | | | Medium-high | 1.1 | 1.0 | 1.1 | 1.1 | |
| | | | High | 1.7 | 1.7 | 1.7 | 1.7 | |
| | **Landfill gas** | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | Setting support to bring on all the cost-effective deployment. |
| | | | Low-medium | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | Medium | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | Medium-high | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | High | 0.2 | 0.2 | 0.2 | 0.2 | |
| **Geothermal** | **Geothermal** | UK | Low | 1.8 | 1.6 | 1.4 | 1.3 | Setting support in line with offshore wind, as not cost-effective to support more expensive technologies for the renewables target |
| | | | Low-medium | 3.3 | 3.0 | 2.7 | 2.6 | |
| | | | Medium | 4.8 | 4.4 | 4.1 | 3.8 | |
| | | | Medium-high | 6.1 | 5.7 | 5.3 | 5.0 | |
| | | | High | 7.5 | 7.0 | 6.5 | 6.1 | |
| | **Geothermal CHP** | UK | Low | 0.0 | 0.0 | 0.0 | 0.0 | Setting support in line with offshore wind, as not cost-effective to support more expensive technologies for the renewables target |
| | | | Low-medium | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | Medium | 0.9 | 0.5 | 0.1 | 0.0 | |
| | | | Medium-high | 2.4 | 1.9 | 1.4 | 1.0 | |
| | | | High | 3.8 | 3.2 | 2.7 | 2.3 | |
| **Hydro** | **Hydro >5MW (Standard)** | UK | | | | | | ROC banding set on the basis of individual project data provided at consultation to bring on all cost-effective deployment whilst avoiding over-compensation |
| | | | | | | | | |
| | | | Medium | 1.0 | 1.0 | 1.1 | 1.2 | |
| | | | | | | | | |
| | | | | | | | | |
| | **Hydro >5MW (storage)** | UK | | | | | | |
| | | | | | | | | |
| | | | Medium | 0.6 | 0.6 | 0.7 | 0.9 | |
| | | | | | | | | |
| | | | | | | | | |
| **Marine** | **Tidal stream shallow** | UK | Low | 6.0 | 4.7 | 3.4 | 2.5 | 5 ROCs/MWh with a 20% grant enough to bring on a proportion of the supply curves, assuming investors are prepared to fund early projects as a 'loss leader' with a low return of around 8%. Actual grants will be set at lower levels if necessary to avoid any potential overcompensation. |
| | | | Low-medium | 6.9 | 5.4 | 3.9 | 3.0 | |
| | | | Medium | 7.8 | 6.2 | 4.5 | 3.5 | |
| | | | Medium-high | 8.2 | 6.5 | 4.8 | 3.7 | |
| | | | High | 8.7 | 6.9 | 5.0 | 3.9 | |
| | **Tidal stream deep** | UK | Low | 6.3 | 5.4 | 4.5 | 3.7 | |
| | | | Low-medium | 6.8 | 5.8 | 5.0 | 4.1 | |
| | | | Medium | 7.3 | 6.3 | 5.4 | 4.4 | |
| | | | Medium-high | 7.9 | 6.8 | 5.8 | 4.8 | |
| | | | High | 8.4 | 7.3 | 6.2 | 5.1 | |
| | **Wave** | UK | Low | 6.9 | 5.9 | 5.3 | 4.8 | 5 ROCs/MWh with a 20% grant might just be enough to bring on a proportion of the supply curves (though not quite on this evidence), assuming investors are prepared to fund early projects as a 'loss leader' with a low return |
| | | | Low-medium | 7.5 | 6.4 | 5.8 | 5.2 | |
| | | | Medium | 8.0 | 7.0 | 6.3 | 5.7 | |
| | | | Medium-high | 8.7 | 7.5 | 6.8 | 6.2 | |
| | | | High | 9.3 | 8.1 | 7.4 | 6.6 | |

| | Country | Cost tranche | 2013/14 | 2014/15 | 2015/16 | 2016/17 | Rationale for bands |
|---|---|---|---|---|---|---|---|
| | | | | | | | of around 8%. Actual grants will be set at lower levels if necessary to avoid any potential overcompensation. |

## Figure F 1 – ROCs required for new installations in 2013/14[70]




[70] ROCs required will vary by year owing to changes in costs and revenues over time

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| | |
|---|---|
| **Title:** Government response to the consultation on proposals for the levels of banded support for solar PV under the Renewables Obligation for the period 2013-17<br><br>**IA No:** DECC0103<br>**Lead department or agency:**<br>Department of Energy and Climate Change (DECC)<br>**Other departments or agencies:** | **Impact Assessment (IA)**<br>**Date:** 19/12/12<br>**Stage:** Final<br>**Source of intervention:** Domestic<br>**Type of measure:** Secondary legislation<br>**Contact for enquiries:**<br>Andrew.Jones1@decc.gsi.gov.uk |

## Summary: Intervention and Options

**RPC:** N/A

| **Cost of Preferred (or more likely) Option** | | | | |
|---|---|---|---|---|
| **Total Net Present Value** | **Business Net Present Value** | **Net cost to business per year** (EANCB in 2009 prices) | **In scope of One-In, One-Out?** | **Measure qualifies as** |
| £1,590-1,720m | N/A | N/A | No | N/A |

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

Evidence from the FITs Comprehensive Review suggests that solar photovoltaic (PV) costs have fallen significantly since support levels were proposed in the Renewables Obligation (RO) Banding Review Consultation published in October 2011. The Government Response to the RO Banding Review, published in July 2012, set the level of support for various renewable technologies for the period 2013-17 and confirmed that a further consultation would be held on support rates for solar PV. The absence of a further review of solar PV bands under the RO could lead to support levels that overcompensate solar investors and fail to deliver value for money for electricity consumers for solar power deployment.

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

RO bands for solar PV for 1st April 2013 to 31st March 2017 are proposed at levels that should increase the cost-effectiveness of the RO and offer greater value for money to consumers. The introduction of separate bands for building and ground mounted PV projects account for differences in the operating efficiency (i.e. load factors) of these types of installations. The analysis considers the costs and benefits associated with changes to support rates for all sizes of solar PV installation eligible for support under the RO.

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

This IA considers two options:

(i) Option 1: Do nothing – maintain current solar PV bands for new installations during the period 1st April 2013 to 31st March 2017 (banding review period), which are the same for building and ground mounted projects.

(ii) Option 2: Response bands – reduce solar PV bands for new installations during the banding review period and create separate bands for building and ground mounted installations.

Option 2 is the preferred option. It proposes support levels that offer greater value for money to electricity consumers

**Will the policy be reviewed?** DECC will continue to monitor costs and deployment in the usual way, and may review solar PV bands if there is evidence that the legal criteria for an early review are met.

| | | | | | |
|---|---|---|---|---|---|
| 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** N/A | **< 20** N/A | **Small** N/A | **Medium** N/A | **Large** N/A |
| What is the CO2 equivalent change in greenhouse gas emissions? (Million tonnes CO2 equivalent) | | | **Traded:** -12.7 to -13.4 | **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: 19/12/12

# Summary: Analysis & Evidence Policy Option 2 Response bands

**Description:** reduce current solar PV bands during the period 1st April 2013 to 31st March 2017. Impacts presented relative to the Do Nothing Option 1.

**FULL ECONOMIC ASSESSMENT**

| Price Base | PV Base | Time Period | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| 2011/12 | 2012/13 | **38** Years | **Low*: £690-860m** | **High*: £870m** | **Best Est**: £1,590-1,720m** |

| **COSTS (£m)** | **Total Transition** (Constant Price) | Years | **Average Annual** (excl. Transition) (Constant Price) | **Total Cost** (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **90-100** |
| **High** | | | | **130** |
| **Best Estimate** | | | | **190-210** |

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

The monetised costs are the increase in costs of EU Emissions Trading Scheme allowance (EUA) purchases to the UK power sector compared to the Do Nothing option.

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

Wider macroeconomic impacts of a reduction in solar deployment (e.g. on employment). Air quality impacts due to increased fossil fuel generation. Increased risk of UK failing to meet 2020 renewables target. Security of supply costs from any reduction in diversity of supply.

| **BENEFITS (£m)** | **Total Transition** (Constant Price) | Years | **Average Annual** (excl. Transition) (Constant Price) | **Total Benefit** (Present Value) |
|---|---|---|---|---|
| **Low** | | | | **780-960** |
| **High** | | | | **1,000** |
| **Best Estimate** | | | | **1,790-1,930** |

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

The monetised benefits are the lower resource costs of generating electricity through CCGT rather than solar PV with reduced solar PV uptake compared to the Do Nothing option.

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

Wider macroeconomic impacts of any decrease in electricity prices due to lower levels of solar PV generation.

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

(i) Cost and performance assumptions for large-scale (>5MW) ground–mounted PV is taken from the evidence gathered through the solar PV consultation. Hurdle rates and revenue assumptions are taken from the RO Banding Review. Maximum technical potential is based on a National Grid assessment of solar capacity grid constraints.

(ii) Support rates and uptake for small scale (<5MW) PV have been modelled using evidence from the FITs 2A Government Response.

(iii) There are significant uncertainties around current and future solar PV cost and performance characteristics, and future costs trajectory. Sensitivity analysis varies capex learning rates and load factors.

**BUSINESS ASSESSMENT (Option 1)**

| Direct impact on business (Equivalent Annual) £m: | | | In scope of OIOO? | Measure qualifies as |
|---|---|---|---|---|
| **Costs:** N/A | **Benefits:** N/A | **Net:** N/A | No | N/A |

* The high Net Benefit estimate relates to the "High uptake" sensitivity. The low Net Benefit estimate relates to the "Low uptake" sensitivity (see Section 8C for more details of the uptake scenarios).

**The 'Best Estimate' of costs and benefits relates to the central uptake scenario. Net benefits are highest in this scenario, since the reduction in solar PV uptake from Option 1 to Option 2 is higher than in either of the sensitivities. For more details see Section 8C.

# Evidence Base (for summary sheets)

## 1. Executive summary

1. The Government response to the Consultation on proposals for the levels of banded support for solar photovoltaic (PV) under the Renewables Obligation (RO) reduces ROC support for all solar PV generating stations which accredit or add additional capacity on or after 1st April 2013 and up to 31st March 2017 (banding review period). The Government response to this Consultation introduces separate bands for building and ground mounted installations; and, establishes the use of existing cost control arrangements under RO legislation to control the costs of solar PV within the RO during the review period, if required.

2. This Impact Assessment (IA) analyses two options for new solar PV installations that accredit or add additional capacity under the RO during the banding review period:

- **Option 1: Do Nothing:** RO bands for all new solar PV installations remain at 2 ROCs/MWh of renewable electricity supplied in 2013/14, 2014/15, 2015/16 and 2016/17.
- **Option 2: Response Bands:** RO bands for new solar PV installations are reduced from current levels with the introduction of separate bands for building mount and ground mounted installations (see Table 1 below).

**Table 1. Solar PV RO support bands (ROCs/MWh)**

| Option | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| 1. Current bands | 2.0 | 2.0 | 2.0 | 2.0 |
| 2. Response Bands | | | | |
| • Building-mounted | 1.7 | 1.6 | 1.5 | 1.4 |
| • Ground-mounted | 1.6 | 1.4 | 1.3 | 1.2 |

3. The summary costs and benefits of the preferred option (Option 2) relative to the do nothing counterfactual (Option 1) for low, central and high "Uptake" scenarios are presented in Table 2 below. These uptake scenarios are derived from sensitivity analysis on learning rates and load factors.

**Table 2. Summary costs and benefits (Option 2 relative to Option 1, £m 2010/11 prices, discounted)[1]**

| | Scenario | | |
|---|---|---|---|
| *Item* | Low uptake | Central uptake | High uptake |
| Change in resource cost | -780 to -960 | -1790 to -1930 | -1000 |
| Change in carbon saving benefit (avoided lifetime EUA costs) | -90 to -100 | -190 to -210 | -130 |
| NPV | 690 to 860 | 1590 to 1720 | 870 |

Source: DECC in-house modelling

4. Option 2 is the preferred option. It encourages the deployment of the most economically sound solar PV projects under the RO and offers greater value for money to electricity consumers who pay for the RO through their electricity bills, as well as recognising the different characteristics of building and ground mounted installations.

5. This IA considers the impacts of reduced RO support rates on all sizes of solar PV installation from 50kW upwards. DECC's in-house models were used to generate the analysis in this IA: the ROCs model was used to measure impacts on installations above 5MW and the FITs model was used to

[1] The NPV for Option 2 versus Option 1 is highest in the central uptake scenario. This is because in the central uptake scenario the reduction in solar PV deployment between Option 1 and Option 2 is greatest. In addition to this the unit cost of solar PV is higher under the central uptake scenario relative to other scenarios. For more detail see section 8C.

measure impacts on installations up to 5MW. These models estimate the costs and revenues over the lifetime of the technology and assess the proportion of potential investors that could be incentivised in different years at particular RO support rates.

6. Cost and performance assumptions for large-scale[2] PV installations have been developed by DECC based on evidence from the consultation responses; other assumptions (i.e. hurdle rates, price received for exported electricity etc) were taken from the RO banding review consultation[3]. Assumptions for modelling uptake of small-scale[4] (sub-5MW) installations applied those developed by Parsons Brinckerhoff (PB) for FITs analysis[5]. Evidence gathered from the FITs consultation was used to set support rates for small scale installations.

7. The potential impacts of the cost control mechanism are not quantified in this IA. It is hard to anticipate when such a review would take place and whether such a review will result in changes to RO support levels.

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[2] 'Large-scale' refers to installations of greater than 5MW throughout this IA. These are assumed to be exclusively ground-mounted installations due to the lack of building roofs large enough to house more than 5MW. 'Small-scale' refers to installations below 5MW, which can be ground-mounted or building-mounted.
[3] See http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5945-renewables-obligation-government-response-impact-a.pdf
[4] 'Small-scale' refers to installations below 5MW, which can be ground-mounted or building-mounted.
[5] See http://www.decc.gov.uk/en/content/cms/consultations/fits_rev_ph2a/fits_rev_ph2a.aspx and http://www.decc.gov.uk/assets/decc/11/consultation/fits-comp-review-p1/3365-updates-to-fits-model-doc.pdf

## 2. Strategic overview

8. The Renewables Obligation (RO), introduced in 2002, is currently the Government's main financial policy mechanism for incentivising the deployment of large scale renewable electricity generation in the UK – small scale renewable electricity generation is incentivised mainly through a separate Feed-in-Tariff (FITs) scheme. The RO and FITs have played an important part in securing reductions in carbon dioxide emissions, as the UK strives to achieve 15% of its energy needs from renewable sources by 2020 as required by the EU Renewable Energy Directive.

9. From the RO's introduction in 2002 until 2008/09, all eligible renewable energy technologies received the same band of support at 1 Renewable Obligation Certificate (ROC) per MWh of renewable electricity generated. Different RO bands of support for eligible technologies were set for new stations in the four years from 2009/10 to 2012/13, which sought to remove overcompensation of lower cost technologies and provide incentive for more expensive technologies that had significant development and deployment potential.

10. The Government response to the Consultation on the RO Banding Review published on 25th July 2012 set RO bands for new installations of various renewable technologies for the period 1st April 2013 to 31st March 2017[6]. The response set out the Government's intention to re-consult on RO bands for new solar photovoltaic (PV) installations over this period[7]. This decision reflects the evidence produced for the FITs comprehensive review which suggested that the costs associated with the deployment of solar PV have come down substantially since the consultation on the RO Banding Review was first published in October 2011.

11. The Government response to the Consultation on proposals for the levels of banded support for solar PV under the RO reduces ROC support for all solar PV generating stations which accredit or add additional capacity on or after 1st April 2013 and up to 31st March 2017, introduces separate and lower bands for building and ground mounted installations; and proposes the use of existing cost control arrangements under RO legislation to control the costs of solar PV within the RO during this period.

12. The recently-agreed Levy Control Framework (LCF) is set at £7.6bn in 2020/21 (real 2011/12 prices). Support costs for solar PV under the RO will have to fit within the overall spending cap under the LCF. However, more detailed analysis of the affordability implications of this policy within the context of the newly agreed LCF have not been carried out given uncertainties around what the overall renewables mix will look like.

## 3. Problem under consideration

13. The costs of Solar PV have come down substantially since the RO Banding Review consultation was published in October 2011. In response to falling costs, support rates for small scale solar PV installations under the FITs scheme were lowered as part of the FITs comprehensive review which spanned 2011 and 2012. Similarly, solar PV support rates under the RO have been subject to review as part of the solar PV consultation to help avoid potential overcompensation of investors and poor value for money for consumers.

14. Consultation responses have indicated that there are technical differences between building–mounted and ground–mounted projects. For example, the load factor for building-mounted installations will depend on the tilt of a building's roof and its orientation, meaning that output per panel is generally less than for ground-mounted installations where panel tilt can be optimised and panels can be oriented southwards. In addition, a significant proportion of the output from building-mounted installations tends to be used on site, whereas that from ground-mounted installations tends to be exported. As a result, differentiated support for building-mounted and ground-mounted

[6] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5936-renewables-obligation-consultation-the-government.pdf
[7] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/6338-consultation-on-proposals-for-the-levels-of-banded.pdf

projects is created to encourage deployment of these technologies whilst reducing the risk of overcompensating one technology which arises with a single band.

## 4. Rationale for intervention

15. Whilst encouraging deployment to help the UK meet its interim and 2020 EU renewable energy targets, RO support rates for renewable technologies must offer value for money to electricity consumers, who pay for the RO through their electricity bills. This is achieved by incentivising cost effective deployment of renewable technologies and avoiding overcompensation of renewable electricity generators.

16. The costs of solar PV have fallen dramatically in recent years and small scale deployment has increased substantially over the last 12 months. As a result of these developments, the RO support levels for solar PV proposed in the earlier RO banding review consultation (2 ROCs/MWh in 2013/14 and 2014/15, 1.9 in 2015/16, 1.8 in 2016/17) risk overcompensating generators. Whilst reducing support rates for solar PV overall, separate bands for building-mounted and ground-mounted installations are created to encourage deployment of these technologies whilst attempting to reduce the risk of over or under-incentivising one of these types of project through a single support band.

## 5. Policy Objective

17. The objective is to set support rates that bring on the most economically sound building mount and ground mount solar PV projects under the RO, thereby encouraging the steady growth of the sector in the UK, whilst avoiding overcompensation of investors and creating greater value for money for electricity consumers.

18. The consultation set out proposals to control the costs of solar PV support within the RO by making use of the existing provisions for early review, where this is warranted. This is intended to ensure that any future rapid cost changes in the industry do not lead to windfall gains for developers.

19. The proposed support levels take into account the six statutory factors for RO banding decisions set out in the Electricity Act 1989 and summarised below:

    i. the costs (including capital costs) associated with each renewable electricity technology;

    ii. the income associated with generating electricity from each renewable electricity technology;

    iii. the supplies from renewable sources exempted from the Climate Change Levy (CCL) in relation to generating electricity from each renewable electricity technology;

    iv. the desirability of promoting the industries associated with renewables;

    v. impacts on the market for ROCs and on consumers; and

    vi. contributions towards achieving European targets, including the interim and final 2020 renewables target.

## 6. Options considered

20. This section sets out the options considered in this IA as part of the Government response to the consultation on proposals for the levels of banded support for new solar PV generating stations, which accredit or add additional capacity under the RO on or after 1st April 2013 and up to 31st March 2017.

***Option 1 – Do nothing***

21. RO bands for new solar PV installations remain at current levels (i.e. 2 ROCs/MWh of renewable electricity supplied in 2013/14, 2014/15, 2015/16 and 2016/17) for both building mount and ground

mount installations.

22. The Do-Nothing option is the same as that in the solar PV consultation document published on 7th September 2012 and also the Government response to the consultation on the RO Banding Review published on 25th July 2012[8].

***Option 2 – Revised bands***

23. RO bands for new solar PV installations are reduced to take account of latest available evidence and analysis. A mechanism exists for controlling the costs of solar PV within the RO.

**Solar PV RO Bands**

24. Policy set out in the Government response introduces separate bands for building mount and ground mount installations, reflecting the evidence that relates to solar PV costs and performance received through the consultation. Support rates are set with the aim of incentivizing the most cost-effective projects and fall in line with projected reductions in system costs. The revised bands remain close to projected FITs tariffs at the outset for both building-mounted and ground-mounted installations.

25. Stations accrediting (and additional capacity added) before 1 April 2013 will be able to take advantage of the existing RO subsidy rate of 2 ROCs. Current grandfathering policy will be maintained so that RO support levels for these solar PV stations will not change once they are accredited (or in the case of additional capacity added to an accredited station, should not change after the additional capacity was added).

26. The solar PV consultation proposed a single band for both building and ground mounted installations (see table 3 above). However, the consultation responses provided evidence on the different characteristics of the two types of installations which justified an introduction of two separate bands. Detail on the different characteristics of building and ground mounted installations is provided in section 7A.

**Solar PV cost control**

27. Future solar system costs are highly uncertain, and depend on factors such as panel prices which are set in a fast-moving global market. Faster than expected cost reductions could result in over compensation for RO developers. The Government proposes to continue to use those powers that already exist under the RO to ensure that support levels for solar PV remain sustainable. The Government will continue to monitor the industry very closely and consider holding an early review if there is evidence that the legal criteria for an early review, as set out in article 33 of the Renewables Obligation Order 2009, are met. Table 3 above shows the banding level for solar PV in each year of the review period under the two options considered in this IA, as well as the support levels proposed in the consultation for reference.

28. It can be seen that the final ROC rates in the Government response degress more slowly than those proposed in the consultation. The rates in the consultation were intended to be FITs-equivalent, and therefore reflect projected falls in FITs tariffs. FITs tariffs are projected to fall quickly due to a combination of falling technology costs and projected rising retail electricity prices[9] over the period in question[10], whereas degression for large-scale installations that export all their electricity is more closely linked to reductions in the costs of solar PV itself.

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[8] The Government response to the Banding Review proposed a band of 2 ROCs/MWh in 2013/14 and 2014/15, 1.9 in 2015/16 and 1.8 in 2016/17 for solar PV. However these bands were not introduced when the response to the Banding review was published and were subject to further consultation. Therefore the Do-Nothing option is that RO bands remain at current levels as stated above.

[9] FITs modelling assumes that 50% of electricity generated by solar installations connected to a building is used on site. The foregone electricity purchase that results is valued at the retail price of electricity.

[10] FITs electricity price assumptions taken from DECC projections, see http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx.

**Table 3. RO support bands for new build solar PV installations from 2013-17 (ROCs/MWh of renewable electricity supplied)**

| Option | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Option 1. Current bands | 2.0 | 2.0 | 2.0 | 2.0 |
| Option 2. Response Bands | | | | |
| • Building-mounted | 1.7 | 1.6 | 1.5 | 1.4 |
| • Ground-mounted | 1.6 | 1.4 | 1.3 | 1.2 |
| Consultation Bands | 1.5 | 1.3 | 1.1 | 0.9 |

Source: DECC in-house analysis

29. The potential impacts of the cost control mechanism are not quantified in this IA. It is difficult to anticipate when such a review would take place and whether such a review will result in changes to RO support levels**.**

# 7. Analytical approach

## A) Evidence base

30. The original solar PV cost assumptions for the RO Banding Review were taken from the Arup report commissioned for this Review and published in October 2011[11]. Evidence gathered during the process of the FITs consultation indicated that the costs of small-scale solar PV, particularly 250kW-5MW installations, have come down substantially since the Arup report was published.

31. Prior to the solar PV consultation under the RO, evidence on costs associated with large scale solar PV installations was limited. The analysis in this IA concerning large scale installations is based on cost and performance information related to this type of project provided by stakeholders during the consultation[12]. Limited information on larger building-mounted installations (on commercial/industrial premises) was also received through the consultation. Installations of this size and type are the most cost-effective type of building-mounted project and therefore represent the type of project the new building-mounted band is seeking to incentivise. Modelling of building mounted deployment and costs is carried out through the FITs model alongside analysis of small-scale ground-mounted installations, using the assumptions developed by Parsons Brinckerhoff for the Government response to Phase 2a of the FITs review[13]. Supply curve modelling for larger building mounted projects is based on the limited information received through the consultation.

32. Whilst all evidence and assumptions have been scrutinised, they are subject to uncertainty especially in relation to building-mounted installations, where the consultation data set was much less extensive. For all types of solar PV projects, future costs are uncertain and difficult to predict. To a large extent future costs will depend on global solar PV deployment and economies of scale in their manufacture, technological progress and supply chain development. Sensitivity analysis around some of these assumptions has been undertaken to generate high and low impacts as set out in section 8C of this IA.

33. The key modelling assumptions for large-scale solar PV used for the analysis in this IA are summarised in Annexes A-D, along with changes in assumptions since the consultation IA. A brief summary of the changes to key assumptions, and the rationale behind these changes, are provided below. Key assumptions for small-scale solar PV uptake are set out in PB's report

[11] See http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf
[12] See annex for details on the evidence base
[13] See http://www.decc.gov.uk/en/content/cms/consultations/fits_rev_ph2a/fits_rev_ph2a.aspx

accompanying the FITs Comprehensive Review Phase 2A Government response[14]. Key assumptions for the supply curve analysis of larger building-mounted projects are set out below and in the annexes where these differ from PB's assumptions.

**Costs (Capex and Opex)**

34. Stakeholders generally indicated that PB's capex estimates from their update for the FITs 2A Government response[15] were too low if grid connection costs were included, and that opex costs were too low if cost categories relevant to a larger installation (e.g. asset management costs[16]) were taken into account. More details on DECC's revised capex and opex estimates can be found in Annex A.

*Large Scale Ground-mounted*

35. The revised central capex assumption based on consultation responses (£1180/kW) for current large scale solar PV installations (used to set the RO support rate for 2013-14, taking into account construction timescales) is very similar to PB's estimate for 2012-13 installations (£1170/kW). The revised central capex assumption includes both project development and grid connection costs[17]. While there do appear to be additional costs for large-scale projects owing to their greater complexity and risk, these are to an extent counteracted by economies of scale and buying power (through the purchase of large numbers of panels and other parts).

36. DECC's revised capex estimates are appreciably higher than PB's from 2013-14 onwards, due to a shallower assumed cost reduction trajectory (see 'reduction in capex' below). DECC's revised opex estimate for current installations (£23/kW) is slightly higher than PB's (£22/kW). This reflects additional running costs faced by large-scale installations besides installation operation and maintenance (e.g. those related to asset management). Land lease costs have been excluded, in line with the treatment of other technologies eligible under the RO.

*Large Scale Building-mounted*

37. Revised central capex gathered through the Consultation (£1075/kW) is lower than for ground-mounted installations. This may be due to building-mounted installations not generally incurring grid connection costs, although it is hard to draw firm conclusions given limited information

*Reduction in capex (learning rates)*

38. Evidence received during the consultation suggests that the learning rates estimated by PB, which we applied to capex costs in our modelling assumptions to generate future costs estimates, were too high, especially in the near-term where PB projected 10% annual falls in capex between 2012/13 and 2013/14. Stakeholders' evidence suggested that the solar PV industry was not expected to witness further linear cost reductions in line with the recent past.

39. Based on this the Government has revised its central learning rate estimate downwards, based on a trajectory for solar PV system cost estimated by Bloomberg[18]. Given the considerable uncertainty around the future trajectory of PV cost reduction, high and low estimates for learning rates feed into the high and low uptake sensitivities set out in section 8C.

40. No information was received to suggest that the capital cost reduction trajectory for building-mounted installations was different to large scale ground-mounted installations. The ROCs required analysis in Table 4 below assumes the same trajectory for both building-mounted and ground-mounted installations.

[14] See http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/renewable-energy/5381-solar-pv-cost-update.pdf
[15] See http://www.decc.gov.uk/en/content/cms/consultations/fits_rev_ph2a/fits_rev_ph2a.aspx
[16] Asset management cost: costs incurred in updating investors on the performance of the asset.
[17] For a more detailed breakdown of cost categories included in our revised assumption for capex and opex please see table 17 in Annex A
[18] Bloomberg New Energy Finance, February 2012, 'Q1 2012 PV Market Outlook: Grid Parity, no Party'

**Load factor**

*Large Scale Ground Mount*

41. Stakeholder evidence suggests that the load factor assumption used in the consultation IA (850kWh/kW/yr, or 9.7%) was an underestimate for southern areas of the UK where the bulk of large-scale PV deployment would take place. Stakeholders also indicated that DECC modelling should factor in panel degradation rather than assume constant panel performance across the lifetime of the technology.

42. In light of this evidence we have revised the load factor assumption for ground-mounted installations upwards (to 975kWh/kW/yr) and have applied a degradation factor of 0.5% per year.

43. There is significant uncertainty around load factors for large-scale solar, given the lack of UK projects to date, and irradiation rates which vary from one part of the country to another. Given this variability, and the importance load factor plays in determining project returns, we have used our high and low estimates of load factor for ground-mounted installations (starting at 1050kWh/kW/yr (12.0%) and 900kWh/kW/yr (10.3%) respectively with 0.5% per year degradation) in the sensitivity analysis presented in section 8C.

*Large Scale Building Mount*

44. Information gathered through the Consultation suggest that building-mounted installations have a lower load factor than ground-mounted installations because they are constrained by the architecture and orientation of the building, meaning that panel tilt and orientation cannot be optimised to maximize output. The heterogeneity of commercial and industrial premises means there is a good deal of uncertainty around what the assumed load factor for building-mounted should be: one respondent provided an indicative range of 775-875kWh/kW/yr.

45. The assumed load factor under FITs which we use in uptake modelling (850kWh/kW/yr) falls within this range. In the ROCs required analysis in table 5 below we assume that building-mounted installations have the same starting load factor as assumed under FITs (850kWh/kW/yr) to which a 0.5% degradation rate is then applied.

**Large Scale Technical Deployment Potential**

46. Technical deployment potential represents the maximum amount of large-scale ground-mounted deployment that might occur during the period covered by this IA without taking into account financial constraints. Annual technical deployment potential equates to 100% of the large-scale ground-mounted supply curve in each year. It is therefore a key driver of the deployment and costs of large-scale PV as it determines the level of deployment associated with each point on the supply curve (20, 40, 60, 80, 100%).

47. The Arup data provided for the RO Banding Review consultation[19] showed a potential deployment trajectory for large scale solar PV (high scenario) of around 115MW by 2017. Feedback to the RO Banding Review consultation indicated that this deployment trajectory was considered an underestimate. Analysis in the Solar PV Consultation IA brought forward the Arup deployment trajectory, drawing on evidence from deployment under larger FITs tariff bands and Germany. The revised technical deployment potential was 720MW by 2017.

48. Responses to the solar PV consultation indicated that 720MW remained too low an estimate of technical deployment potential for large-scale ground-mounted solar PV. However there was considerable variability in the estimates that consultees provided: the lowest estimate provided was 1.2GW, the highest was 50GW. On the basis that 720MW by 2017 is outside the wide range provided by stakeholders, the estimate of technical potential has been revised upwards[20].

[19] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf
[20] For more details on the methodology , see Annex C

49. The revised numbers represent an estimate of the total capacity of greater than 5MW ground-mounted solar PV that could be delivered by 31 March 2017. The estimate of technical deployment potential has been calculated further to new modelling which considers the impacts of solar PV on Great Britain's transmission system operation for the year 2020 undertaken by National Grid. The modelling explores the physical constraint of solar PV on our current UK electricity grid network. For more information see Annex C.

**Table 4. Deployment potential for large-scale (>5MW) solar PV to 2016/17 (commissioning years)**

| | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|
| Annual | 512 | 1,024 | 1,024 | 1,024 | 1,024 |
| Cumulative | 512 | 1,536 | 2,559 | 3,583 | 4,606 |

Source: DECC in-house analysis
Note: 2012-13 potential is for October 2012 onwards, hence it is half that of other years

### Financial Parameters (hurdle rates, haircuts on ROC/ electricity prices)

50. The Consultation gathered a range of views on the project finance of solar PV project finance but there was general agreement that broader assumptions (i.e. hurdle rates, Power Purchase Agreement (PPA) terms) as used in the Consultation were appropriate. These assumptions have therefore been left unchanged and are summarised in Annex D.

### Technology lifetime

51. In the consultation IA technology lifetime had been modelled at 35 years. However, evidence gathered during the consultation suggest that planning permission obtained for solar PV projects is for 25 years and that the investor horizon period for solar PV projects is not longer than 25 years.

52. In light of the new evidence, DECC has revised its assumption for technology lifetime to 25 years for ground mounted projects. The ROCs required analysis for building mounted projects in table 5 below also assumes a 25 year lifetime, although modelling of building-mounted deployment assumes a lifetime of 35 years in keeping with FITs assumptions.

## B) Modelling approach

*Building-mounted solar PV*

53. Building-mounted and ground-mounted solar PV are distinct in some important respects. For example, building-mounted installations tend to have lower load factors and use a significant amount of electricity generated on-site, whereas ground-mounted installations will export all the electricity they produce to the grid. To ensure that the different characteristics of PV are fully reflected in modelling, DECC's in-house FITs model has been adapted and used for building-mounted installations.

54. DECC's FITs model covers solar PV up to 5MW. This is appropriate for modelling building-mounted solar under the RO, since evidence received through the consultation has indicated that building-mounted installations are unlikely to be larger than 5MW in size. The FITs model uses the assumptions developed by PB for the Government response to the FITs 2A consultation to give projections of deployment for both building-mounted and ground-mounted under the revised support rates.

55. Small scale (sub-5MW) solar PV uptake under FITs are set out in the IA accompanying the Government response to the FITs comprehensive review phase 2A consultation. Modelling in this IA accounts for additional sub-5MW uptake, over and above published FITs projections, that might occur under the RO under the new support rates..

56. The RO and FITs schemes vary in some key respects and these difference are reflected in how the FITS model is adapted to the RO. Evidence from the consultation has highlighted the different risk profiles of FITs and RO. Whereas FITs provides a guaranteed, inflation proofed payment for electricity generated across the lifetime of the scheme, the electricity price and price of a ROC can vary over time. In addition, while investors under FITs receive the full value of the generation tariff, investors under the RO tend to receive less than the full value of a ROC under the terms of their Power Purchase Agreements (PPAs). In modelling RO support rates through the FITs model, it is therefore necessary to ensure that these differences are reflected in order to give as accurate an estimate as possible of sub-5MW deployment that will occur under the RO.

57. DECC's modelling for the consultation assumes a 'haircut' of 10% on the ROC price, i.e. investors only receive 90% of the full value of a ROC. In response to the consultation stakeholders indicated that this was an appropriate estimate. Our modelling therefore reduces RO support rates by 10% before they are input into the FITs model. This implies that RO support rates would have to be 10% higher than projected FITs tariffs in order for additional sub-5MW uptake over and above that modelled under FITs to occur. This is likely to be a conservative estimate: it only accounts for the 10% haircut that ROC investors face under the terms of their PPAs, and not for the wider differences in risk profile outlined in paragraph 56 above.

58. We assume that uptake under the RO in addition to that accounted for in FITs modelling could occur for any size of installation eligible for the RO (i.e. above 50kW). Again, this is a cautious assumption: administration costs and additional complexity of the RO are likely to discourage investors in smaller projects. In addition, the costs of installations below 250kW are significantly higher than for the 250kW-5MW band[21] meaning that uptake of projects below 250kW is likely to be limited relative to the 250kW-5MW band.

59. Estimates of sub-5MW RO uptake are extremely uncertain, as are the deployment rates under the FITs tariff. They are highly sensitive to changes in relative levels of FITs and RO support, but these are difficult to foresee as future FITs tariffs are very uncertain (due to degression).

*Ground-mounted solar PV*

60. The impacts of policy options on ground-mounted solar PV (typically >5MW) installations are measured through DECC's in-house ROCs model. This model applies a range of assumptions based on information gathered through the RO Banding review and the solar PV consultation.

61. It is important to note that assumptions around the cost, performance and technical potential of large scale ground-mounted solar are extremely uncertain. There are numerous factors which will affect the pricing of solar PV systems in the future including support levels, the price of raw materials and the resultant equipment costs through the supply chain, the nascent market in the UK to deliver large-scale ground-mounted projects and ongoing developments in global supply and demand. In addition, the absence of large-scale ground-mounted solar PV projects in the UK means there is a lack of 'real time' evidence of the performance characteristics of installations greater than 5MW.

62. DECC's updated estimate of the deployment potential has been combined with updated cost assumptions derived from evidence gathered during the consultation to derive a supply curve for large-scale ground-mounted solar PV for each year of analysis in the DECC ROCs model. The model uses discounted cashflow modelling to determine the range of ROCs required to bring on different segments of the solar PV supply curve for each year until 2015/16. This was then used to estimate deployment levels, generation and subsidy costs at the ROC support rates in Options 1 and 2.

*ROCs required analysis*

63. Table 5 below shows DECC's estimate of the levels of ROC support that would be required to

[21] PB estimate the capital costs of a 150-250kW installation in 2012-13 to be £1535/kW, as opposed to £1170/kW for a 250-5000kW installation.

bring on the different sections of the ground-mounted and building-mounted solar PV supply curves[22] in each year to 2016/17. There is considerable uncertainty surrounding the solar PV costs data underlying this analysis, especially for the building mounted sector where only a limited amount of data was received through the consultation. The analysis from the consultation is included for reference. The analysis for building-mounted installations has been used to inform the setting of the new building-mounted band but does not feed into uptake and cost modelling, which is done through the DECC FITs model (for more detail see section 7B).

64. ROCs required to incentivise different sections of the large-scale ground-mounted supply curve are significantly lower than in the consultation IA for 2013/14. This reflects the fact that although current capex costs (used to set support rates for 2013/14) are very similar to the PB values used in the consultation analysis (see paragraph 35 above), the load factor has increased (see paragraph 41 above). In future years, ROCs required are equal to, or slightly lower than, those estimated in the consultation. This is because slower capex reduction (compared to the reduction rate assumed in the consultation IA) is offset by an increased load factor.

65. ROCs required to incentivise different sections of the building-mounted supply curve are greater than those for building-mounted installations. This reflects the different characteristics of building mounted installations, particularly their lower load factor relative to ground mounted installations.

**Table 5 . ROCs required to incentivise different sections of solar PV supply curve**

| **ROCs required for new installations in…** | | | | |
|---|---|---|---|---|
| | **Consultation** | | | |
| Proportion of supply curve | **2013-14** | **2014-15** | **2015-16** | **2016-17** |
| 20% | 1.9 | 1.6 | 1.5 | 1.4 |
| 40% | 2.0 | 1.7 | 1.6 | 1.5 |
| 60% | 2.1 | 1.8 | 1.7 | 1.6 |
| 80% | 2.3 | 2.0 | 1.9 | 1.7 |
| 100% | 2.5 | 2.1 | 2.0 | 1.9 |
| | **Government response - large scale ground mounted** | | | |
| Proportion of supply curve | **2013-14** | **2014-15** | **2015-16** | **2016-17** |
| 20% | 1.6 | 1.5 | 1.4 | 1.3 |
| 40% | 1.7 | 1.7 | 1.6 | 1.4 |
| 60% | 1.9 | 1.8 | 1.7 | 1.5 |
| 80% | 2.0 | 1.9 | 1.8 | 1.7 |
| 100% | 2.2 | 2.1 | 1.9 | 1.8 |
| | **Government response - larger building mounted** | | | |
| Proportion of supply curve | **2013-14** | **2014-15** | **2015-16** | **2016-17** |
| 20% | 1.8 | 1.7 | 1.6 | 1.5 |
| 40% | 1.9 | 1.9 | 1.7 | 1.6 |
| 60% | 2.1 | 2.0 | 1.9 | 1.7 |
| 80% | 2.3 | 2.2 | 2.0 | 1.9 |
| 100% | 2.4 | 2.3 | 2.2 | 2.0 |

Source: DECC in-house analysis

66. According to this analysis, and on the basis of the revised assumptions, the proposed tariffs will be

[22] Building-mounted solar PV supply curve was modelled using limited number of building-mounted data and then assumed the wider distribution to be similar to ground-mounted solar PV.

sufficient to incentivise around 20% of the ground-mounted supply curve in 2013/14. For the remaining period (i.e. 2014/15 to 2016/17) the analysis suggests that the proposed support rate will incentivise 0-20% of the supply curve. It is not possible to say with certainty how much less than 20% would be incentivised during this period, due to lack of granular information about the pipeline of cost-effective projects. In recognition of this uncertainty deployment projections in 2014/15 and beyond are expressed as a range (e.g. 1.4 ROCs in 2014/15 will incentivise 0-20% of the large scale ground-mounted supply curve).

67. Similarly we estimate that 0-20% of the building-mounted supply curve would be incentivised in each year. As explained in paragraph 61, the results for building mounted installations are indicative and do not feed into uptake modelling. However a comparison of the ROCs required and the proposed support rates would indicate that only the most cost effective larger building mounted projects will be incentivised.

*Interaction with EMR*

68. It has been assumed that large-scale (>5MW) solar PV installations from 2016/17 onwards will choose to deploy under the system of Feed in Tariffs with Contracts for Difference (FITs with CfDs), which form part of DECC's Electricity Market Reform Package (see Annex D for more details). In reality it may be that some new large-scale build still occurs under the RO in 2016/17 and some new large-scale build modelled as being under the RO before 2016/17 may be actually supported by the FiT with CfD. Small-scale solar PV installations (which will not be eligible for FITs with CfDs) continue to deploy in 2016/17.

*Counterfactual*

69. The costs and benefits of solar PV under Options 1 and 2 are assessed against a Combined Cycle Gas Turbine (CCGT) counterfactual, in line with the consultation IA. This represents a cautious approach: since CCGT is the cheapest generation technology, using it as the counterfactual provides an upper bound on the costs of a particular level of PV deployment. However, it is important to note that there is considerable uncertainty over which technology would be displaced by solar PV deployment.

## 8. Summary of costs and benefits

70. This section of the IA sets out the impact of Options 1 and 2 on deployment of solar PV installations, and the additional costs and benefits of changes to the level of support given to solar PV under the RO. This section is sub-divided into the following areas of analysis:

A) Solar PV electricity deployment
B) Monetised impacts
C) Sensitivity analysis
D) Non-monetised impacts
E) Distributional impacts

### A) Solar PV electricity deployment

71. Tables 6 and 7 below summarise projected deployed capacity and generation over the period 2013/14 to 2016/17 under each option. These estimates incorporate large-scale (ground mount) installations, as well as small-scale (building-mounted and ground mount) uptake over and above that estimated in FITs analysis (see paragraphs 51-56 above).

72. New installations of above 5MW capacity are assumed to come on under the new FITs with CfD

scheme rather than the RO in 2016/17[23]. All new uptake in 2016/17 is therefore small-scale solar PV.

**Table 6. New build solar PV capacity supported under the RO, MW (cumulative from 2013/14)**

| Options | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Option 1 – do nothing | 870 | 1,830 to 2,040 | 3,100 to 3,310 | 3,560 to 3,760 |
| Option 2 – revised bands | 210 | 240 to 440 | 310 to 720 | 450 to 860 |

Source: DECC in-house modelling; results have been rounded.
Notes: a. Figures for UK solar PV installations supported under the RO, i.e. >5MW installations plus sub-5MW uptake additional to that modelled in IA supporting FITs consultation 2A Government response; b. Range represents uncertainty over proportion of marginal segment of the large scale solar PV supply curve that will be built, e.g. under the lead option in 2014/15, between 0-20% of the large scale solar PV supply curve is projected to be built.

**Table 7. Modelled generation from new build solar PV capacity supported under the RO, GWh per year**

| Options | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Option 1 – do nothing | 420 | 1300 to 1400 | 2370 to 2570 | 3160 to 3360 |
| Option 2 – revised bands | 100 | 210 to 310 | 260 to 560 | 350 to 750 |

Source: DECC in-house modelling; results have been rounded.
Note: Installations assumed to operate at 50% of full year annual output in first year of operation

73. Projected uptake under Option 2 is substantially lower than under Option 1 (do nothing), due to the lower level of ROC support made available to new installations. New build capacity incentivised under both options is higher than the level stated in the consultation IA. This is largely a result of the revised deployment potential assumption for large scale PV as explained in section 7A.

74. In terms of capacity and generation:

- New build solar PV capacity supported under the RO is estimated at between 450-860MW by 2016/17 under Option 2, compared with 3560-3760MW under Option 1 (do nothing).
- New build solar PV generation supported under the RO is estimated at between 350-750GWh/year by 2016/17 under Option 2, compared with 3160-3360GWh/year under Option 1.

75. These capacity and generation projections are presented as a range owing to the uncertainty over the proportion of the marginal segment of the large-scale supply curve that will be incentivised. While we estimate that around 20% of the supply curve will be incentivised in 2013/14, the modelling projects that between 0-20% of the supply curve will be built in 2014/15 and 2015/16. Projections from 2014/15 onwards are therefore expressed as a range. Similarly there is a range under Option 1 for 2014/15 onwards as the modelling projects that between 80-100% of the supply curve will be incentivised in that year.

## B) Monetised impacts

76. The monetised costs and benefits associated with Options 1 and 2 are presented in Table 8 below. In summary, Option 2 leads to much lower resource costs (i.e. capital costs and operating costs relative to the CCGT counterfactual), avoided emissions and lifetime EUA costs than under Option 1. Costs are the additional resource costs associated with a particular level of solar PV deployment relative to the CCGT counterfactual. Specific impacts can be summarised as follows:

- Lower levels of relatively more expensive solar PV deployment lead to lifetime resource costs of £150-450m under Option 2, which are significantly lower than under Option 1.
- Lower levels of solar PV deployment, and its assumed substitution with CCGT plant, leads to

[23] For further detail see Annex D

lower avoided grid $CO_2$ emissions of around 1.7-3.3Mt under Option 2.

- The emissions reductions (offset by increases elsewhere in the EU[24]) under Option 2 are valued at the DECC central traded carbon appraisal values[25] and amount to around £30-70m of EUA purchase cost savings, compared to savings of £240-260m under Option 1.
- The present value of monetised impacts range from £-120 to £-390m under Option 2, compared with a much lower value of £-1840m to -£1980m under Option 1.

**Table 8. Costs and benefits associated with Options 1 and 2**

| | Option 1 - do nothing | Option 2 - revised band |
|---|---|---|
| Lifetime resource costs, £m, 2010/11 prices | 2080 to 2240 | 150 to 450 |
| Avoided lifetime emissions, MtCO2 | 15.1 to 16 | 1.7 to 3.3 |
| Avoided lifetime EUA costs, £m, 2010/11 prices | 240 to 260 | 30 to 70 |
| Present Value (PV), £m, 2010/11 prices | -1840 to -1980 | -120 to -390 |

Source: DECC in-house analysis; results have been rounded.

Notes: Figures presented above are for both large and small scale solar PV installations in the UK. Installations assumed to operate at 50% of full year annual output in first year of operation;

## C) Sensitivity analysis

77. There is a high level of uncertainty around present and future costs of solar PV. and how these will evolve in the future. There are many factors influencing the installed costs of PV systems for all sizes and types of project, including the level of Government support, the price of raw materials and resultant equipment costs through the supply chain and ongoing developments in global supply and demand. Stakeholder evidence has strengthened our view that it is extremely difficult to forecast the solar PV cost trajectory. While historical trends show a downward cost path, with especially rapid reductions in the recent past, it is unclear if this is expected to continue and if so, the rate at which it is expected to take place.

78. There is also considerable uncertainty around the load factor of solar PV. Load factor is subject to a high degree of variability depending on the geographical location of PV sites, and the lack of large-scale ground-mounted projects in the UK means there is a lack of evidence upon which to base load factor estimates

79. Given this, further sensitivity analysis has therefore been conducted around two of the key factors affecting the attractiveness of large-scale ground-mounted solar PV projects from an investment perspective, namely capex learning rate (i.e. reduction in capex costs over time) and load factor. The low and high learning rate sensitivity was calculated as ±2% of the central annual learning rate which was derived from a Bloomberg cost reduction projection as explained in Annex A[26]. The low and high load factor was calculated as central load factor ±75 KWh/KW/yr. Annual degradation was assumed to occur at the same rate as under the central case (0.5% per year) (for details see Annex A).

80. No sensitivity has been carried out on our estimates of *current* capex. This was not required due to the low level of variability in the values for capex we received from stakeholders through the consultation[27].

[24] The UK power sector is part of the EU Emissions Trading System (EU-ETS). This means that any reductions in UK power sector greenhouse gas emissions will be offset by increases (or foregone reductions) elsewhere in the EU-ETS. However, there is a benefit to the UK from such emissions reductions in terms of avoided carbon allowance (known as EUAs) purchase costs.

[25] Which can be found on DECC's website here: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

[26] Bloomberg New Energy Finance, February 2012, 'Q1 2012 PV Market Outlook: Grid Parity, no Party'

[27] In the dataset for capex, the mean was £1180/kW and the standard deviation was £82/kW. The low value for standard deviation indicates the low degree of variability in the sample.

81. In the **low uptake** scenario, the low capex learning rate and the low load factor have been used, ie large-scale ground-mounted solar costs more, and yields less output than in the central scenario. In the **high uptake** scenario, the high capex learning rate and the high load factor have been used, ie large-scale solar costs less, and yields more output than in the central scenario. Sensitivity assumptions for small-scale uptake follow those in the 'Low' and 'High' sensitivities in the FITs 2A IA[28]. As in the central scenario, small scale uptake in addition to that estimated in the FITs IA is accounted for here.

82. Deployment and monetised impacts under these low and high uptake scenarios are summarised in table 9 and table 10 below. For the low uptake scenario deployment and monetised impacts are provided as a range. This is because in the low uptake scenario the proposed ROC rate will bring on 0-20% of the ground-mounted supply curve in each year out to 2016/17. In the high uptake scenario the proposed ROC rate will bring on around 60% of the ground-mounted supply curve in 2013/14 and 2015/16, and around 40% in 2014/15. Therefore there is no range in the deployment and monetised impacts for the high uptake scenario provided in table 10 below as we estimate that deployment will be close to a particular point on the supply curve in each year.

**Table 9. Costs and benefits associated with Options 1 and 2, low uptake scenario**

| | **Option 1 - do nothing** | **Option 2 - revised band** |
|---|---|---|
| Lifetime resource costs, £m, 2010/11 prices | 960 to 1320 | 0 to 550 |
| Cumulative deployment to 2016/17, MW | 1400 to 1810 | 30 to 640 |
| Avoided lifetime emissions, MtCO2 | 5.1 to 6.6 | 0.1 to 2.4 |
| Avoided lifetime EUA costs, £m, 2010/11 prices | 100 to 130 | 0 to 40 |
| Present Value (PV), £m, 2010/11 prices | -860 to -1190 | 0 to -500 |

Source: DECC in-house analysis
Note: Totals may not sum due to rounding; deployment figures provided for both large scale and small scale solar PV.

**Table 10. Costs and benefits associated with Options 1 and 2, high uptake scenario**

| | **Option 1 - do nothing** | **Option 2 - revised band** |
|---|---|---|
| Lifetime resource costs, £m, 2010/11 prices | 2080 | 1080 |
| Cumulative deployment to 2016/17, MW | 5410 | 2620 |
| Avoided lifetime emissions, MtCO2 | 21.7 | 10.2 |
| Avoided lifetime EUA costs, £m, 2010/11 prices | 330 | 200 |
| Present Value (PV), £m, 2010/11 prices | -1750 | -880 |

Source: DECC in-house analysis.
Note: Totals may not sum due to rounding; deployment figures provided for both large scale and small scale solar PV.

83. Even though Option 2 uptake under the low scenario is less than in the central scenario at the upper end of the range, resource costs are higher, and Present Value more negative. This reflects the higher cost of solar PV per unit of electricity produced under the low uptake scenario. Under

[28] See http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/renewable-energy/5391-impact-assessment-government-response-to-consulta.pdf. The low uptake scenario in the FITs IA uses the 'Slow Cost reduction' scenario for future PV costs developed by PB, while the high uptake scenario uses the 'Fast Cost Reduction' scenario.

Option 1, both uptake and resource costs and significantly lower under the low scenario than under the central scenario.

84. In the high scenario, uptake is higher under Options 1 and 2 than in the central scenario, but resource costs are similar, reflecting the lower cost of solar PV per unit under the high scenario.

85. The difference in present value (PV) between Option 1 and Option 2 (i.e. the net benefit) is much higher under the central uptake scenario than it is under the low uptake or high uptake scenarios. This is because:

- The additional large-scale uptake incentivised under Option 1 compared to Option 2 is highest in the Central scenario.
- The unit cost of solar PV is higher in the central uptake scenario relative to the high uptake scenario leading to a higher benefit in the central uptake scenario as a result of a fall in solar PV deployment .

86. In the Central scenario, under Option 2 up to 20% of large-scale technical deployment potential is incentivised in each year, while under Option 1 80% of potential is incentivised in 2013/14, 80-100% in 2014/15 and 100% in 2015/16. In the High scenario, under Option 2 around 60% of potential is incentivised in 2013/14 and 2015/16 and around 40% in 2014/15 but under Option 1 deployment remains at 100% of potential (a significantly smaller increase than under the central scenario).

## D) Non-monetised impacts

87. It should be noted that the monetised costs and benefits above do not include several potentially significant impacts, principally those relating to security of supply, the UK meeting its environmental targets, and potential macroeconomic effects. These are covered below, however it should be noted that given the level of solar PV deployment projected in this IA, these impacts are likely to be small.

*Security of supply impacts*

88. The Do Nothing option would marginally help reduce reliance on imported fossil fuels relative to Option 2, but would also increase the amount of intermittent generation, which would increase the need for balancing services, back-up generation, interconnection, storage and/or demand-side response. The costs of any additional balancing services have not been quantified: these will depend on the overall level and composition of intermittent generation on the grid, meaning it is difficult to isolate the costs associated with solar PV alone.

*Risk of missing 2020 renewables target*

89. Option 2 marginally increases the risk of missing the 2020 renewables energy target and interim targets by reducing incentives for solar PV deployment under the RO in the UK. Projections of uptake in this IA suggest that solar PV under the RO plays a small part in the cost-effective mix for reaching the 2020 target.

*Macroeconomic impacts*

90. Growth in the solar PV sector may be lower under Option 2. However, resources will be redeployed into other sectors, meaning the net impact on GDP is unclear.

## E) Distributional impacts

**<u>Cost to consumers</u>**

91. Changing RO bands can change levels of renewables deployment, and hence the levels of RO costs falling on consumers; wholesale prices (impacting on retail prices) can change when more solar PV is on the system; and system balancing costs increase with more intermittent generation.

92. Table 11 below shows how Option 2 reduces the level of RO support costs associated with solar PV installations owing to the reduction in potential investor overcompensation by reducing bands, which reduces overall deployment and incentivises the most cost-effective solar PV technologies.

93. Consumer cost impacts for small-scale uptake under the RO over and above those that have been estimated in the IA supporting the FITs consultation 2A Government response are very uncertain. This is because it is very hard to anticipate what installations are projected to come forward under the FITs scheme when faced with a higher level of RO support; even if RO support is higher, investors may still prefer the greater simplicity and certainty of FITs.

94. There are two ways in which sub-5MW uptake under the RO could lead to costs to consumers in addition to those accounted for in FITs IA 2a:

- **Uptake projected to come on under FITs instead comes on under RO ('Switchers from FITs'):** The additional cost here would be the generation projected under FITs valued at the ROC support rate minus projected FITs tariffs.
- **New uptake:** this is uptake that is not projected to occur at projected FITs tariffs, but would occur at higher RO support rates. The additional cost per MWh of these installations is valued at the ROC support rate.

95. Table 11 below sets out the potential costs associated with switchers from FITs and new uptake for Options 1 and 2 for individual years to 2016-17 and for the lifetime of the RO subsidy (20 years). In the 'low end' estimates, costs associated with new small scale uptake are included. In the 'high end' estimates, costs for new uptake plus switchers from FITs is included. This range for small-scale uptake reflects uncertainties around how FITs investors will react to a higher RO support rate. The table also shows combined costs to consumers for large-scale and small-scale PV uptake. Combined large scale and small scale lifetime RO support costs are £5100-5550m less under Option 2 compared to Option 1.

**Table 11. RO support costs for Options 1 and 2 out to 2016/17 (2011/12 prices, £m, undiscounted)- central**

| Spending £m | **2013/14** | **2014/15** | **2015/16** | **2016/17** | **Lifetime** |
|---|---|---|---|---|---|
| Option 1 - Do nothing (low end of the central scenario) | 35 | 110 | 200 | 270 | 500 |
| Option 1 - Do nothing (high end of the central scenario) | 35 | 130 | 230 | 310 | 1150 |
| Option 2 - Revised bands (low end of the central scenario) | 5 | 15 | 15 | 25 | 5600 |
| Option 2 - Revised bands (high end of the central scenario) | 5 | 25 | 40 | 55 | 6700 |

Source: DECC in-house analysis, figures are rounded to the nearest £10m and may not sum due to rounding.
Note: 'Low end' of central scenario is the bottom end of the range for large scale uptake plus new small-scale uptake. 'High end' is top end of the range for large scale uptake plus new small-scale uptake and switchers from FITs.

**<u>Bill impacts</u>**

96. Since the level of the Obligation has been set for 2013/14 there will be no impact on bills in that particular year. For the period from 2014/15 to 2016/17 there will be a beneficial impact on bills as a result of a change in the costs to consumers under Option 2 compared to Option 1. The 'low end' and 'high end' estimates are consistent with those for costs to consumers in Table 11 above.

97. The estimated rounded net impact on consumers of changes to support costs relative to current bands is presented below. This does not include any impacts on wholesale electricity costs or balancing costs relative to current bands, but these are expected to be small.

**Table 12. Bill impacts, £/household/yr, 2012 prices, for households as a result of RO support costs for solar PV**

| BEFORE POLICIES | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Option 1 - Do nothing (low scenario) | 1.0 | 3.0 | 4.0 | 5.0 |
| Option 1 - Do nothing (high scenario) | 2.0 | 3.0 | 5.0 | 5.0 |
| Option 2 - Revised bands (low scenario) | < £0.50 | < £0.50 | < £0.50 | < £0.50 |
| Option 2 - Revised bands (high scenario) | < £0.50 | 1.0 | 1.0 | 1.0 |
| Difference between Option 1 and Option 2 (low scenario) | -1.0 | -3.0 | -3.0 | -4.0 |
| Difference between Option 1 and Option 2 (high scenario) | -1.0 | -2.0 | -3.0 | -3.0 |

| AFTER POLICIES | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Option 1 - Do nothing (low scenario) | 1.0 | 2.0 | 3.0 | 3.0 |
| Option 1 - Do nothing (high scenario) | 1.0 | 2.0 | 3.0 | 4.0 |
| Option 2 - Revised bands (low scenario) | < £0.5 | < £0.5 | < £0.5 | < £0.5 |
| Option 2 - Revised bands (high scenario) | < £0.5 | < £0.5 | 1.0 | 1.0 |
| Difference between Option 1 and Option 2 (low scenario) | -1.0 | -2.0 | -3.0 | -3.0 |
| Difference between Option 1 and Option 2 (high scenario) | -1.0 | -2.0 | -3.0 | -3.0 |

Source: DECC in-house analysis; figures have been rounded.

98. This policy has no significant bearing on protected characteristics, including age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

*Environmental Issues*

99. The revised solar PV banding options will lead to lower levels of solar PV deployment and hence increased carbon emissions within the UK power sector relative to the Do Nothing option, but these will be offset by decreases in emissions elsewhere within the capped EU-ETS traded emissions sector. There will therefore be no net impact on greenhouse gas emissions.

100. Any future deployment of solar PV will be subject to all relevant environmental legislation and controls, and aims to contribute to government policy objectives that enhance the natural environment .

*Rural proofing*

101. Whilst there has been no separate or explicit assessment of the needs of rural areas, separate planning legislation exists to ensure that the environmental and social impacts of solar PV

developments, and the views of those living near to installations, are fully taken into account.

102. Development of RO policy will take account of business interests within the renewables sector and consumer interests, including in rural areas.

*Sustainable Development*

103. The policy will have no material impact on the UK's move away from fossil fuel dependency.

*Competition*

104. The policy will have no material impact on the competitive functioning of the electricity market.

*Small Firms*

105. Option 2 will result in slightly lower electricity costs relative to Option 1. Electricity is likely to represent a larger proportion of income for smaller companies, as they are less likely to have their own generation compared to, in particular, large industrial users with heavy electricity requirements.

106. The majority of smaller businesses involved in solar PV generation are likely to continue to seek support under FITs, as the simplicity and income-certainty of FITs makes it better suited to small business needs. Small businesses involved in licensed electricity supply should not experience any additional burdens from these proposals.

## 9. Summary and preferred option

107. The preferred option is Option 2 (Revised bands). The revised rates encourage the deployment of the most economically sound solar PV projects under the RO and increase the efficiency of the RO, delivering a lower average cost per MWh of solar PV for the electricity consumers who bear the cost of the RO. It does this by incentivising the most cost effective projects and reducing potential investor overcompensation. This is achieved through reducing support for solar PV installations eligible for support under the RO from 2013-2017, and creating separate bands for building-mounted and ground-mounted installations, reflecting their different characteristics.

108. The Government's expectation is that renewables support will reduce as the costs of renewable technologies fall. The proposed RO banding for solar PV is reduced over the review period to reflect these cost adjustments.

109. Table 13 below summarises the costs and benefits of Option 2 (Revised bands) compared to Option 1 (Current bands).

**Table 13. Summary costs and benefits (Option 2 relative to Option 1, £m 2010/11 prices, discounted)**

| | Scenario | | |
|---|---|---|---|
| *Item* | Low uptake | Central uptake | High uptake |
| Change in resource cost | -780 to -960 | -1790 to -1930 | -1000 |
| Change in carbon saving benefit (avoided lifetime EUA costs) | -90 to -100 | -190 to -210 | -130 |
| NPV | 690 to 860 | 1590 to 1720 | 870 |

Source: DECC in-house modelling; figures have been rounded.

110. Option 2 is more affordable to consumers compared to Option 1 (Current bands). In addition the

Government proposes to continue to use those powers that already exist under the RO to ensure that support levels for solar PV remain sustainable. Taken together, this approach will help DECC to stay within its Levy Control Framework budget out to 2020.

**Implementation**

111. The RO is administered and enforced by Ofgem, who report annually on their administration of the RO and conduct regular audits in relation to compliance with the RO.

112. DECC is responsible for monitoring the impact of the RO on the development of renewable energy and collects detailed information on growth in renewable energy generation and projects under development.

# Annex A - Derivation of Cost Assumptions

**Current Capex**

113. During the consultation DECC received data from 23 stakeholders in total out of which 22 stakeholders provided evidence on the capital costs associated with the development and construction of solar PV projects in the UK. Nearly all respondents provided a breakdown of total capex. Table 18 on page 27 shows the cost categories that have been included in the final capex value used in the analysis for this IA.

114. A total capex value for each respondent was calculated by adding their estimate of the cost for each category included in table 18. The distribution of data points provided an initial range. To provide more certainty that the distribution excluded extreme values, the range was narrowed so that the bottom of the range was the 10th percentile and the upper end of the range was the 90th percentile, consistent with the methodology used in Banding Review analysis. This final range was then used to generate the cost estimates associated with the 5 sections of the solar PV supply curve used in DECC's in-house ROCs model for both large scale and larger building-mounted projects. The lower and upper ends of the range are associated with the 20% and 100% points of the supply curve respectively, while the median of the dataset represents the central value (associated with the 60% point of the supply curve). Costs associated with each section of the supply curve (for current installations) are set out in the table below for large scale and larger building-mounted projects:

**Table 14. Capital cost associated with each section of the supply curve**

| | Point on supply curve (%) | | | | |
|---|---|---|---|---|---|
| | 20 | 40 | 60 | 80 | 100 |
| Capex, £/kW, 2012 prices (for projects commissioned in 2012/13), large scale ground-mounted | 1078 | 1129 | 1180 | 1234 | 1287 |
| Capex, £/kW, 2012 prices (for projects commissioned in 2012/13), larger building-mounted | 974 | 1024 | 1075 | 1127 | 1179 |

115. Capex data received from stakeholders was scrutinized and quality assured. The distribution of costs as received from stakeholders was relatively narrow i.e. the difference between the highest and the lowest capex was not large. Further investigation into the distribution of costs revealed that the data at the lower end of the distribution consisted primarily of costs relating to engineering, procurement and construction while the data at the upper end included broader costs (e.g. costs relating to asset management).

**Future Capex Reductions**

116. Responses to the consultation generally felt that the learning rates estimated by PB for FITs were too steep, especially in the assumption that costs would fall by 10% from 2012-13 to 2013-14. As justification for this, respondents pointed to ongoing consolidation among solar PV panel manufacturers, unsustainable below-cost panel prices, and an ongoing trade dispute regarding the import of Chinese solar PV panels into the EU.

117. DECC has therefore moved to a learning rate trajectory that is significantly less steep in the near-

term. This trajectory is based on analysis of solar PV system costs by Bloomberg[29].

118. However, future cost reductions are extremely uncertain, and any projection of future costs must be approached with caution, especially while the global solar PV market remains in a state of flux as it is at present. As part of the sensitivity analysis presented in this IA, we have therefore constructed slower and faster future cost reduction scenarios to feed into our low and high uptake scenarios respectively by varying the central learning rate trajectory by ±2%.

119. Our 3 future capex reduction scenarios are set out in the table below, together with the cost reduction scenario assumed in the consultation IA for reference:

**Table 15. Reduction in capex compared to previous year**

| | | 2013-14 | 2014-15 | 2015-16 | 2016-17 |
|---|---|---|---|---|---|
| **PB** | Consultation | -10% | -4% | -4% | -4% |
| **High** | Government response | -9% | -8% | -7% | -7% |
| **Central** | | -7% | -6% | -5% | -5% |
| **Low** | | -5% | -4% | -3% | -3% |

Note: Government response figures have been derived from Bloomberg[30]; figures have been rounded to the nearest percentage.

120. The table below shows our central estimate for the future trajectory of capital costs for the period 2012/13 to 2016/17 for both the consultation and the Government response document with the learning rate assumptions from table 15. Capital cost data as received from stakeholders is slightly higher than that assumed in the consultation IA.

**Table 16. Capex (central estimate) (£/kW, 2012 prices)**

| | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 |
|---|---|---|---|---|---|
| **Consultation (PB)** | 1170 | 1053 | 1007 | 964 | 924 |
| **Government Response-Ground-mounted** | 1180 | 1140 | 1071 | 1020 | 970 |
| **Government Response-Building-mounted** | 1075 | 1039 | 976 | 930 | 884 |

Note: Government response figures have been derived from data provided by stakeholders during consultation. Cost reduction from 2012-13 to 2013-14 is 50% of that in Table 15 to account for consultation data being gathered in October (halfway through fiscal year)

### Opex

121. During the consultation DECC received data from 23 stakeholders out of which 20 stakeholders provided evidence on operational costs of large-scale solar PV installations in the UK. However 1 data point was considered an outlier, since it was significantly lower than the mean value in the dataset and only provided an estimate for narrow operation and maintenance costs, rather than the wider categories of cost outlined in table 18 below, and was therefore excluded.

122. A majority of the respondents provided a breakdown of total opex. Similar to the methodology used to derive a capex distribution as explained in paragraph 111 above a similar exercise was carried out for opex.

123. Table 18 below shows the cost categories included in the final opex values for larger building-mounted and large scale installations shown in table 17. These final values exclude land lease

[29] Bloomberg New Energy Finance, February 2012, 'Q1 2012 PV Market Outlook: Grid Parity, no Party'
[30] Bloomberg New Energy Finance, February 2012, 'Q1 2012 PV Market Outlook: Grid Parity, no Party'

costs (in line with treatment of other technologies under the RO).

124. Opex data received from stakeholders was scrutinized and quality assured. The distribution of costs as received from stakeholders was relatively wide i.e. the difference between the highest and the lowest opex was large. Respondents suggested that there was a negative correlation between opex of a solar PV project and the quality of raw materials and manufactured products used. The wide distribution of opex could be a result of this difference in raw materials or manufactured products opted for by various developers.

**Table 17. Opex (central estimate) (£/kW, 2012 prices)**

| | Annual O&M cost of 2013-14 installation |
|---|---|
| **Consultation (PB)** | 22 |
| **Government Response - Large scale ground-mounted** | 23 |
| **Government Response - Larger building-mounted** | 27 |

**Table 18 .Cost categories included in the assumptions for capex and opex**

| **Cost categories included in..** | |
|---|---|
| **Capex** | **Opex** |
| Pre-development and planning | Operation and maintenance |
| Construction and raw materials | Insurance |
| Grid connection | Asset management |
| Financing, administration and legal | Administration and business rates |

# Annex B - Derivation of Load Factor assumptions

*Ground-mounted*

125. In the consultation document we assumed a load factor of 850 kWh/kW/yr (9.7%), the central load factor assumed in FITs modelling. During the consultation exercise, many indicated that for large scale projects this load factor was low and not a true reflection of likely yields. Those that provided information reflected a load factor between 850 – 1250 kWh/kW/yr (9.7-14.3%), with the majority of respondents suggesting a load factor of 960kWh/kW/yr (11%) or more. The Government has reviewed the evidence and agrees that the assumed load factor for large-scale projects should be increased.

126. We have increased the load factor assumption from a value equivalent to a building-mounted project in the northern regions of the UK to something more consistent with a ground mounted project in the southern regions of the UK . This is consistent with our approach to bring on the most economically sound solar PV projects under the RO. Evidence suggests that in the southern regions of the UK levels of irradiation are considerably higher[31] than in the northern regions and therefore the load factors available to large scale installations are likely to be significantly greater. Developments that employ optimisation techniques are likely to be able to obtain even greater load factors.

127. Further to the consultation the Government has decided to increase the load factor assumption to 975kWh/kW (11.2%) (under central assumptions) to reflect the higher load factors that can be expected from ground mounted installations that are, or likely to be located mainly in, southern parts of the UK. The degradation of solar PV panels over time was not something that was included within our original modelling. The revised load factor assumption now includes an annual 0.5% rate of panel degradation which is consistent with the warranties available from manufacturers.

128. Sensitivity analysis has been carried out on load factor assumptions by varying the central load factor by ±75 kWh/kWp. This is described in further detail in section 8C.

*Larger Building Mount*

129. Stakeholders indicated that larger building mounted installations will typically be tilted at a less steep angle than the optimal degree of elevation, and that the majority of buildings are not oriented facing due south (the optimal orientation to maximize panel output). As a result output is in the region of 10% less than for ground-mounted installations, although this will vary from project to project.

130. In modelling uptake of building-mounted installations through the FITs model, we are seeking to account for uptake over and above that projected under FITs in the Phase 2a Government response IA, which means using the same modelling assumptions as were used for the FITs work. We have therefore used the FITs assumption that load factor will be 850kWh/kW/yr. This is slightly more than 10% below our central estimate for the load factor of large-scale ground-mounted solar. However, FITs modelling assumes no panel degradation, ie load factor remains at 850kWh/kW/yr throughout a project's operational lifetime, which means this remains a cautious approach in terms of modelling uptake.

131. For the ROCs required analysis in section 7B we have assumed that load factors start at 850kWh/kW/yr and then decrease by 0.5% per year, in keeping with assumptions around panel degradation for ground-mounted projects.

[31] http://re.jrc.ec.europa.eu/pvgis/cmaps/eur.htm#GB

**Table 19. Load Factor (kWh/kW/yr) for large-scale ground-mounted installations in Operational Year**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PB** | Consultation | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 | 850 |
| **High*** | Government response | 1050 | 1045 | 1040 | 1034 | 1029 | 1024 | 1019 | 1014 | 1009 | 1004 | 931 |
| **Central*** | | 975 | 970 | 965 | 960 | 956 | 951 | 946 | 941 | 937 | 932 | 864 |
| **Low*** | | 900 | 896 | 891 | 887 | 882 | 878 | 873 | 869 | 865 | 860 | 798 |

*Load factor in Year 2 onwards uses a 0.5% degradation

# Annex C – Assessment of large-scale ground-mounted solar PV technical deployment potential

132. Projections of future solar PV uptake are very uncertain. There are numerous factors which will affect the pricing of solar PV systems in the future including support levels, the price of raw materials and the resultant equipment costs through the supply chain, the nascent market in the UK to deliver ground-mounted projects at over 5MW and ongoing developments in global supply and demand.

133. Trajectories developed by Arup for the RO Banding Review consultation[32] showed a potential deployment trajectory for large scale solar PV (high scenario) for around 115MW of installed capacity for >5MW projects by 2017. This was consequently revised prior to the launch of the consultation with proposed support rates for solar PV under the RO. Further analysis carried out at the time included investigation of the historical growth curve of large scale solar PV in Germany which supported the premise that there could be potential for a greater level of uptake in the UK than previously thought. In addition to this some high level analysis was carried out in-house which showed that there were several projects in the pipeline in the UK. As a result of this the original Arup scenario was revised to account for the underestimation. Table 20 below shows the level of deployment potential published in the consultation IA.

134. Many that responded to the consultation considered that our assessment of the deployment potential for large scale solar PV in the UK, out to 31 March 2017 (720MW) to be far too low. We have subsequently reviewed our methodology and believe that the best approach is to estimate the potential deployment by understanding the physical constraint of solar PV on our current UK electricity grid network.

135. The system operator, National Grid, have undertaken new modelling which considers the impacts of solar PV on Great Britain's transmission system operation for the year 2020. National Grid's initial estimate shows that deployment over 10GW of solar PV would make balancing the existing grid infrastructure significantly more challenging in its current form[33].

136. Although about 22 GW of solar PV could theoretically be accommodated on the system it is dependent on a number of conditions (including interconnection and export capacity, the availability of electricity storage, the amount of on-site usage, the range of possible changes to the generation mix, the level and nature of demand and necessary infrastructure modifications for transmission and distribution networks). We have however reduced this maximum by 10% due to the uncertainty associated with the underlying conditions and the ability to forecast this limit out to 2020. We therefore consider 20 GW of solar PV (both large- and small-scale) to be the theoretical technical maximum that can be accommodated on the grid by 2020 (subject to the potential conditions set out above).

137. We have examined the modelling and trajectory undertaken for the recent small scale FITs review (which includes deployment of building-mounted solar PV) and calculated an approximate glide path to 20GW by 2020 for solar PV (both small and large scale) in order to determine the potential deployment for large scale solar PV at the end of the RO banding review period. We estimate that by the end of March 2017 the maximum possible amount of solar PV on the UK electricity grid, consistent with a theoretical maximum limit of 20GW in 2020, would be 11.3GW. Assuming there would be 6.7GW of small scale solar PV deployment (as projected in the FITs central deployment scenario), then there would be room on the system for up to 4.6GW of large scale ground mounted solar PV. This is shown in table 20 below on both a cumulative and annual basis, assuming a constant increase in the deployment potential of large scale solar PV year on year.

138. In our central scenario for Option 2 we project deployment of sub-5MW installations in additional to

[32] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/3237-cons-ro-banding-arup-report.pdf
[33] National Grid, 2012 Solar PV briefing note for DECC.GIVE WEB REFERENCE HERE

that projected in the FITs central scenario, implying that total sub-5MW deployment (under FITs and RO) will be greater than the FITs central scenario. However, the level of this additional sub-5MW deployment is small relative to amount of deployment projected under FITs (240MW in our central scenario by 2016/17, versus 6.7GW under FITs central scenario). In light of general uncertainty around future PV deployment levels, it therefore remains appropriate to use the FITs central scenario to inform our glide path to 2020, and our estimate of how much space there will be on the system for large-scale solar PV

139. This total maximum level (11.3GW) of PV generation on the system is above the 10GW in 2020 threshold, where National Grid predicts the onset of curtailment issues and inflexible generator scheduling problems would start to occur during the summer minima. However National Grid's assumptions are based on 2020 (rather than 2017) levels of build-out of other renewables, and 10GW is not a hard limit. It is therefore possible to assume that with the background generation mix on the electricity system in 2017, the total maximum of 11.3 GW can be accommodated.

140. Potential in 2012/13 is assumed to be 50% of the annual potential for the period 2013/14 to 2016/17 to account for the fact that we were half way through the year 2012/13 at the time of the consultation.

**Table 20. Deployment potential for large-scale (>5MW) solar PV to 2016/17 (commissioning years), MW**

| | | 2012/13 | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|---|---|
| Consultation | Annual | 63 | 95 | 187 | 200 | 175 |
| | Cumulative | 63 | 158 | 345 | 545 | 720 |
| Government response | Annual | 512 | 1024 | 1024 | 1024 | 1024 |
| | Cumulative | 512 | 1536 | 2559 | 3583 | 4606 |

# Annex D - Summary of unchanged assumptions

### Wholesale price income

141. The electricity wholesale prices used are those endogenously modelled by Pöyry consultants as part of the RO banding review evidence base. It is assumed that generators will receive the projected wholesale price minus 13% to reflect the typical agreed price in Power Purchase Agreements (PPA's) struck between renewable generators and suppliers. The table below sets out the wholesale prices used in this IA.

**Table 21: Wholesale electricity prices, GB (£/MWh, 2011/12 prices)**

| Year | Central fossil fuel prices |
|---|---|
| 2011/12 | 60 |
| 2012/13 | 63 |
| 2013/14 | 68 |
| 2014/15 | 73 |
| 2015/16 | 73 |
| 2016/17 | 75 |
| 2017/18 | 73 |
| 2018/19 | 70 |
| 2019/20 | 71 |
| 2020/21 | 72 |
| 2021/22 | 74 |
| 2022/23 | 74 |
| 2023/24 | 75 |
| 2024/25 | 76 |
| 2025/26 | 76 |
| 2026/27 | 73 |
| 2027/28 | 77 |
| 2028/29 | 74 |
| 2029/30 | 74 |
| 2030/31 | 75 |

Source: Pöyry Consultants

### Hurdle rate

142. Our modelling assumes an investor hurdle rate of 7.5% (pre-tax, real) for large-scale solar PV, in line with assumptions for the RO Banding Review. ROCs required analysis for larger building-mounted installations also uses this figure. Uptake modelling for small-scale solar PV uses the assumptions in the DECC FITs model.[34]

### Electricity Market Reform

143. Full implementation of the Electricity Market Reform (EMR) has been assumed in modelling the impact of RO band options on the electricity market. This entails the introduction of:

I. An Emissions Performance Standard (EPS)
II. A capacity mechanism[35]
III. Carbon price floor
IV. A system of Feed-in Tariffs with Contract for Difference[36] (FiT with CfD) to support low carbon technologies, including solar PV

[34] For more details see http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/renewable-energy/5391-impact-assessment-government-response-to-consulta.pdf
[35] Assumed to be implemented if capacity margins are expected drop below 10%.
[36] For full details, see the Energy Bill (2012), available at: http://www.decc.gov.uk/en/content/cms/legislation/energybill2012/energybill2012.aspx

144. After the introduction of the new FiT with CfD (the first contracts are expected in 2014), new renewables developers of projects over 5MW will have the choice between support under the RO and support under the FiT with CfD, until the proposed closure of the RO to new stations from 1st April 2017. Investment decisions are likely to be aided by financial investment decision (FID) enabling strategies should these be implemented as part of the EMR package. In view of this, it has been assumed for the purpose of this analysis that:

- All new renewables stations eligible for the RO and commissioning in 2013/14, 2014/15 and 2015/16 will be supported under the RO (except where they are eligible for small-scale FiTs).
- All new renewables stations over 5MW eligible for the RO and commissioning in 2016/17 will be supported under the new FiT with CfD scheme, rather than the RO. Sub 5MW renewable stations will continue to accredit under the RO in 2016/17.

145. These are simplifying assumptions and it is not clear at this stage whether individual investors will choose the RO or the FiT with CfD. The switchover point is a modelling simplification. In reality, there is likely to be an overlap period, with some new renewables stations choosing the FiT with CfD in earlier years, and some choosing the RO in 2016/17, if they judge the risk of missing the RO end-date to be insignificant (or if their construction overruns from an intended accreditation date in earlier years).

### Carbon prices

146. Carbon prices are consistent with DECC guidance.[37]

### Unchanged assumptions

147. The table below shows the modelling assumptions which remain unchanged from the consultation IA.

**Table 22. Modelling assumptions which remain unchanged from the consultation IA**

| Variable | Unit | Value |
|---|---|---|
| Hurdle rate for large-scale installations | Pre-tax real | 7.50% |
| Power Purchase Agreement Value | p/KWh | 87% of projected electricity wholesale price (Poyry RO series). Equates to around 6p/kWh at 2013-14 projected prices, rises with electricity price |
| ROC Value | £ | ROC buyout price (£36.99, 2010 prices) + 10%, constant over time |

[37] See http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx.

| | |
|---|---|
| **Title:** Biomass Electricity and Combined Heat & Power plants – Value for money and affordability | **Impact Assessment (IA)** |
| **IA No:** DECC 0120 | **Date:** 06/12/2012 |
| **Lead department or agency:** DECC | **Stage:** Final |
| **Other departments or agencies:** Defra, BIS and HM Treasury | **Source of intervention:** Domestic |
| | **Type of measure:** Secondary Legislation |
| | **Contact for enquiries:** alexis.raichoudhury@decc.gsi.gov.uk caroline.season@decc.gsi.gov.uk |

## Summary: Intervention and Options

**RPC Opinion:** N/A

| **Cost of Preferred Option** | | | | |
|---|---|---|---|---|
| **Total Net Present Value** | **Business Net Present Value** | **Net cost to business per year** (EANCB on 2009 prices) | **In scope of One-In, One-Out?** | **Measure qualifies as** |
| £150m | N/A | N/A | No | N/A |

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

The Renewables Obligation (RO) is currently the UK's principal mechanism to incentivise investment in large scale renewable electricity generation, and operates within an overall budgetary limit set by the Levy Control Framework. The Government Response to the RO Banding Review, published in July 2012, set out the tariff levels for each RO technology band for the period 2013-17. DECC is committed to ensuring support provided under the RO demonstrates value for money and affordability, and that biomass support reflects the UK Bioenergy Strategy's principles: including real, cost-effective carbon reductions and consideration of economy-wide impacts, including those on other biomass using industries. Therefore, DECC are introducing measures to limit the total deployment of new dedicated biomass plant, phase out the energy crop uplift for standard co-firing and reduce the support levels for standard co-firing in the first two years of the banding review period. These intentions were set out in the Government Response to the RO Banding Review, and were subject to public consultation, which closed 19th October 2012.

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

The objective of the value for money and affordability measures is to ensure RO bands for the period 1st April 2013 to 31st March 2017 support sufficient investment in cost effective renewable energy deployment to meet the UK's 2020 renewable energy targets and deliver longer term cost-effective carbon emission reduction, whilst remaining within the overall RO budget and providing value for money for electricity consumers.

**What policy options have been considered, including any alternatives to regulation?**

Dedicated Biomass Cap:

(i) Do nothing, i.e. new dedicated biomass capacity unrestricted

(ii) Restrict capacity to 1 GW through a supplier cap **(consultation proposal)**

(iii) Restrict capacity to 400 MW through non-legislative policy measures, including notification process, and enforced through the potential removal of grandfathering rights for additional dedicated biomass power coming forward. **(final proposal)**

Energy Crops Uplift:

(i) Do nothing, i.e. energy crop uplift continues to be available for standard co-firing

(ii) Maintain the energy crop uplift in the standard (low-range) co-firing band until April 2019 for existing energy crop contracts only **(consultation and final proposal)**

(iii) Retain the energy crop uplift in standard (low-range) co-firing only for generators who are already claiming the energy crop uplift until 2019

(iv) Retain the Energy Crop uplift for use with standard (low-range) co-firing band until 2019

Reduction in support for Standard Co-firing (SCF):

(i) Do nothing, i.e. SCF support remains at 0.5 for the whole period

(ii) Reduction from 0.5 to 0.3 in 2013/14 and 2014/15 (0.5 in 2015/16 and 2016/17) **(consultation and final proposal)**

(Note: this proposal also includes co-firing bioliquids and biomass CHP – see paragraph 72 for more details)

| | |
|---|---|
| **Will the policy be reviewed?** There is no further scheduled review of RO Bands, although under the Renewables Obligation Order 2009, paragraph (33) (as amended by the Orders 2010 and 2011) an early review of ROC rates can occur subject to certain criteria being met. DECC will continue to monitor costs and deployment in the usual way. | |
| Does implementation go beyond minimum EU requirements? | No |

| | | | | | |
|---|---|---|---|---|---|
| Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base. | **Micro** No | **< 20** No | **Small** Yes | **Medium** Yes | **Large** Yes |

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

***I have read the Impact Assessment and I am satisfied that (a) it represents a fair and reasonable view of the expected costs, benefits and impact of the policy, and (b) that the benefits justify the costs.***

Signed by the responsible Minister: ______________________ Date: 17/12/12

# Summary: Analysis & Evidence — Policy Option 1

**Description:** Restrict dedicated biomass capacity to 400 MW through non-legislative policy measures, enforced through changes to grandfathering policy (including mandatory notification process), maintain the energy crop uplift in the standard (low-range) co-firing band until April 2019 for existing energy crop contracts only, and reduce support for standard co-firing from 0.5 to 0.3 in 2013/14 and 2014/15 (0.5 in 2015/16 and 2016/17) **(Intended policy approach)**
***To note: NPV on this summary page covers reduction in support for standard (low-range) co-firing only as the other measures are not expected to have benefits and costs relative the counterfactual baseline.***

FULL ECONOMIC ASSESSMENT

| Price Base | PV Base | Time Period Years | Net Benefit (Present Value (PV)) (£m) | | |
|---|---|---|---|---|---|
| 2011/12 | 2011/12 | 20 | **Low:** | **High:** | **Best Estimate: 150** |

| COSTS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Cost (Present Value) |
|---|---|---|---|---|
| **Low** | | | | |
| **High** | | | | |
| **Best Estimate** | n/a | | n/a | 100 |

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

The key monetised costs associated with a **reduction in support for standard co-firing** are the carbon cost incurred due to a reduction in abatement (compared to a scenario where support was held at 0.5 ROCs in all years) as generators switch from standard co-firing to coal. However, the response from industry to this reduction in support is uncertain. It is possible that levels of enhanced co-firing (ECF) and conversion could increase in this period as generators move towards higher levels of co-firing. This would reduce the cost shown here as the switch to coal (i.e. less abatement) would be to a lesser degree.

The monetised costs on this summary page only relate to the reduction in support for standard co-firing, see evidence base for analysis on impacts to RO spend for specific measures, and the executive summary for explanation of quantified impacts.

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

In addition to the monetised cost quantified above for the reduction in support for standard co-firing, there is also the following risk:

- Reducing SCF support in 2013/14 and 2014/15 could potentially lead to under deployment (compared to central forecasts) of SCF in later years if plants do not pick up deployment at higher support level from 2015/16. This risks losing out on cost effective carbon savings and adversely impacting the ability to meet the 2020 Renewables target.

The key non-monetised cost of introducing a measure to limit dedicated biomass is:

- Potential under deployment due to uncertainty created in the market and/or over registering of deployment by generators - which does not materialise, leading to under deployment. However, the final policy proposed is intended to help deliver deployment at the level centrally forecast in the Impact Assessment accompanying the Government Response to the RO Banding Review, and therefore has no additional impact.

The key non-monetised cost of introducing a measure to remove the energy crop uplift for SCF is:

- Costs incurred by Ofgem in administering the energy crop uplift for SCF for those with existing energy crop contracts until April 2019.

| BENEFITS (£m) | Total Transition (Constant Price) | Years | Average Annual (excl. Transition) (Constant Price) | Total Benefit (Present Value) |
|---|---|---|---|---|
| **Low** | | | | |
| **High** | | | | |
| **Best Estimate** | n/a | | n/a | 250 |

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

The key monetised benefits associated with a **reduction in support for standard co-firing** are the lower resource costs due to the switch from standard co-firing to coal. However, the response from industry to this reduction in support is uncertain. It is possible that levels of enhanced co-firing and conversion could increase in this period as generators move towards higher levels of co-firing. This would reduce the benefit shown here as the switch to coal would be to a lesser degree.

The monetised benefits on this summary page only relate to the reduction in support for standard co-firing, see evidence base for analysis on impacts to RO spend for specific measures, and the executive summary for explanation of quantified impacts.

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

Introducing value for money and affordability measures incurs the following non-monetised benefits:

- Greater control and certainty over RO budgetary control, delivering value for money for electricity consumers, whilst helping to ensure sufficient growth in cost effective renewable energy deployment to meet the UK's 2020 renewable energy targets.
- Limiting deployment in less cost effective technologies helps ensure bioresources are deployed in the most carbon cost effective uses, therefore reducing upward pressure on electricity bills and presenting better value for money.
- Designing policy to limit the disruption to industry, for example: continuing support for generators with existing contracts in place for energy crops; and setting the limit for new dedicated biomass at a level which allows for some projects with significant irreversible financial commitments.

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

The level of deployment estimated to come through under support rates set out in the Government Response to the RO Banding Review is subject to considerable uncertainty. Similarly, the risk that a higher level of deployment is feasible (leading to budgetary pressures); given other barriers such as biomass supply chains and financing, is also significantly uncertain.

# Evidence Base (for summary sheets)

1. The **Biomass Electricity & Combined Heat & Power plants – ensuring sustainability and affordability** consultation[1] was launched on 7th September 2012 and contained two parts: (A) Sustainability criteria (consultation to 30th November); and (B) Value for money and affordability (consultation to 19th October). Section A and B are related in that they both impact on biomass power generation supported through the Renewables Obligation (RO), however they will be implemented separately. This Impact Assessment contains the impact analysis for the final proposals for the value for money and affordability measures (part B), which aim to minimise the risk of breaching the RO budget and ensure that cost-effective carbon reductions are delivered. A separate Impact Assessment will set out the analysis for the final proposals for Biomass Sustainability measures in the new year.

2. The evidence base is set out as follows:

   1) Executive summary (including Methodological approach)
   2) Strategic Overview / Problem under consideration
   3) Rationale for intervention / Policy objective

   *For each policy:*

   4) Description of options considered
   5) Analysis of options
   6) Impacts of each option
   7) Wider impacts
   8) Summary and preferred option with description of implementation plan

## 1. Executive summary

3. This Impact Assessment appraises the Government's proposals for managing the costs and ensuring cost effective carbon savings within the Renewables Obligation (RO) for new build dedicated biomass plants[2] and standard co-firing in fossil fuel power stations from 1 April 2013. To note, standard co-firing (SCF) (low range) refers to below 50% co-firing, enhanced co-firing (ECF) is split between medium range (50% to below 85% co-firing) and high range (85% to below 100% co-firing). Conversion is when 100% biomass is burned.

4. As set out in the Government Response to the RO Banding Review, the Government's intention is to focus the deployment of biomass electricity over the banding review period (2013-2017) on the cheaper and transitional technologies of conversion and co-firing (i.e. coal replacement). Replacing coal with biomass is lower cost compared to other renewables (since it involves use of existing assets) with significant carbon savings as it replaces high carbon coal. Its shorter operating lifespan compared to new build dedicated biomass also makes it attractive in terms of avoiding significant feedstock lock in beyond the late 2020's.

[1] http://www.decc.gov.uk/en/content/cms/consultations/biomass_ro/biomass_ro.aspx
[2] New build dedicated biomass power refers to new generating plants designed to use only biomass feedstocks that are built on sites other than on existing coal power plant sites.

5. As highlighted in the Bioenergy Strategy[3], new dedicated biomass can be more expensive in terms of cost of carbon abatement compared to other renewables. While a small amount of it is affordable and cost-effective within the framework of the overall RO package, it becomes increasingly less attractive in the longer term and at larger volumes, even taking account the ambition for higher sustainability standards. The latest pipeline data available to DECC suggests higher potential for deployment of dedicated biomass by 2016/17 than centrally forecast at the time of the Government Response to the RO Banding Review. If this higher deployment came forward it could risk breaching the RO budget and reducing the value for money of the scheme. Therefore, the intention is to limit the total deployment of new dedicated biomass plant supported under the RO.

6. The Government Response to the RO Banding Review identified a particular risk to be managed from the RO potentially exceeding its budgetary framework in 2013/14 and 2014/15. Standard co-firing is not grandfathered[4], reflecting that this technology does not require large sunk investment and can be adjusted rapidly in response to changed market signals. This means it is a technology where support can be reduced without significant unintended impacts on generators. Therefore, DECC intends to reduce its support to March 2015 as a cost saving measure that is in line with the intention to move generators towards enhanced levels of co-firing and conversion.

7. Similarly, as the energy crop uplift was not extended to the new conversion and enhanced co-firing bands, DECC intends to remove the energy crop uplift from standard co-firing in order to present consistent incentives towards enhanced levels of co-firing and conversion. Transitional measures will be introduced to recognise that some generators have existing long-term contracts for the use of energy crops.

8. The intention is that these value for money and affordability measures balance the need to ensure dedicated biomass and standard co-firing RO support levels for the period 2013/14 to 2016/17 support sufficient growth in cost effective renewable energy deployment to help meet the UK's 2020 renewable energy targets, whilst remaining within the overall RO budget and the LCF.

**Methodological approach**

9. The cost and benefits figures included in the 'Summary: Analysis & Evidence' sheets refer to the monetised impacts of reducing the support for standard co-firing from 0.5 to 0.3 in 2013/14 and 2014/15 only. Table 1 below shows the impact on carbon and resource costs due to the reduction in standard co-firing support. Costs and benefits relate to changes in standard co-firing deployment in 2013/14 and 2014/15 only, it is assumed that forecast deployment before and after this period continues as expected under 0.5 ROCs support level. See Standard Co-firing Support (paragraph **Error! Reference source not found.**) for further information on this policy and impacts on RO spend.

[3] http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx

[4] Grandfathering policy aims to strike the right balance between recognising the significant upfront capital costs of converting existing fossil-fuel generating units to biomass, limiting volatility within the RO, and ensuring that consumers are not overpaying for this type of renewable generation in the longer term. Standard Co-firing of biomass (below 50%) is relatively low cost and potentially volatile. Therefore, as in the past, support for standard co-firing is not covered by grandfathering policy. DECC recognises the higher capital cost and longer term commitment represented by enhanced co-firing and full conversion and therefore those support levels are covered by grandfathering policy in some circumstances. See Government Response to the RO Banding Review for further details on grandfathering: http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5936-renewables-obligation-consultation-the-government.pdf

**Table 1: Discounted costs and benefits from a reduction in standard co-firing deployment in 2013/14 and 2014/15**

| | £m (11/12 prices) Discounted |
|---|---|
| Cost of carbon | 100 |
| Resource cost of renewables | (-) 550 |
| Resource cost of non-renewables | 300 |
| **NPV** | **150** |

*Note: Table above relates to NPV figure set out on IA Summary Sheet.*

10. The costs and benefits of the measures to limit dedicated biomass deployment and to remove the energy crop uplift from standard co-firing are not included in the 'Summary: Analysis & Evidence' monetised costs and benefits. In our central scenario, they are expected to have no additional impact against the counterfactual of the deployment and RO spend set out in the Government Response to the RO Banding Review. However, the risks to the RO budget from not implementing these policies are shown in the sections on 'Limiting Dedicated Biomass Deployment' (paragraph 21) and 'Energy crop Uplift' (paragraph 43).

## 2. Strategic overview / Problem under consideration

11. The EU Renewable Energy Directive commits the UK to meeting 15% of its energy needs from renewable sources by 2020 (including interim targets for the two-year periods 2013-2014 and 2015-2016). To achieve this, renewable electricity supply from large-scale generation will need to increase from around 26TWh in 2010 to around 108TWh (under the central renewables deployment scenario) by 2020, and further deployment of renewable electricity will need to come from smaller-scale generation (<5MW). The Renewables Obligation (RO), introduced in 2002, is currently the Government's main financial policy mechanism for incentivising the deployment of large scale renewable electricity generation in the UK. Since the introduction of the RO in 2002, there has been a significant increase in the UK's renewable generation, from 1.8% to 9.4% in 2011[5]. The RO has played an important part in securing reductions in carbon dioxide emissions in the UK.

12. The RO is expected to close to new renewables stations from 1st April 2017, whilst maintaining support for existing stations in the scheme out to their respective end dates (of which the latest would be expected in 2037). As part of the Electricity Market Reform, support for large-scale renewable electricity will be available from around 2014 onwards through the new Feed-in Tariff with Contract-for-Difference scheme (FiT with CfD).

13. The RO operates within an overall budgetary limit set by the Levy Control Framework (LCF), which sets an overall limit on support for low carbon generation through levies on customer bills. The Government Response to the Banding Review, published in July 2012, set out the support levels for renewable technologies in each band from 2013/14 to 2016/17, and the intention to consult on further measures to ensure RO spend remains within the overall LCF budgetary limit and presents good value for money for electricity consumers. These included: limiting the deployment of new dedicated biomass plant; removing the uplift for standard co-firing with energy crops; and reducing the support level for standard co-firing in 2013/14 and 2014/15.

[5] RO-eligible electricity generation as a proportion of UK electricity sales

14. The UK Bioenergy Strategy[6], published in April 2012, highlights that ensuring bioenergy is genuinely low carbon and cost-effective will be two of the four core principles for future government policy on bioenergy. Biomass is expected to make a significant contribution to the energy mix supported by the RO. It is therefore important to ensure support levels and resulting bioenergy deployment reflect the new UK Bioenergy Strategy's principles within the available RO budget, including real, cost-effective carbon reductions and considering wider impacts, including those on other biomass using industries. The final proposals set out in this Impact Assessment are designed in this context and take into account the feedback received through the consultation process.

## 3. Rationale for intervention / Policy objective

15. The overarching objective of the RO is to support the delivery of the UK's renewable energy targets, as set under the EU Renewable Energy Directive. Government needs to provide support to large-scale renewable electricity technologies, as current renewables costs are higher than their conventional alternatives, and as such they would not be undertaken at the levels required or in the timescales needed. Intervention is also needed to mitigate a number of market failures and other barriers which would lead to too little investment in renewable technologies without government intervention. These include: the negative externalities relating to greenhouse gas (GHG) emissions (i.e. the damage costs of GHG emissions are not factored into investor decision making, although this is being partially addressed by the EU Emissions Trading System, supported by the Carbon Price Floor); positive externalities relating to investment in innovative and emerging technologies; the homogenous nature of electricity as a product (from a consumers' perspective electricity is electricity[7] and is difficult for renewable generators to compete on anything other than price); imperfect information; and, limited access to capital.

16. The Government Response to the RO Banding Review sets RO bands for the period 1st April 2013 to 31st March 2017 that should help ensure the RO supports sufficient growth in renewable energy deployment to meet the UK's 2020 renewable energy targets. DECC must ensure overall costs are kept within the RO agreed budget, and that it delivers cost-effective carbon reductions. Therefore, limiting support levels for standard co-firing and encouraging the move towards enhanced levels of co-firing and conversion are considered necessary.

17. The government's intention is to focus the deployment of biomass electricity over the banding review period on the cheaper and transitional technologies of conversion and co-firing (i.e. coal replacement). As set out in the UK Bioenergy Strategy, dedicated biomass is a relatively expensive technology compared to coal to biomass conversion, which also appears cost-effective compared to other renewables (since it involves use of existing assets) with significant carbon savings as it replaces high carbon intensive coal[8]. The shorter operating lifespan of conversion compared to new build dedicated biomass also makes it attractive in terms of avoiding significant feedstock lock-in beyond the late 2020's. In contrast, new dedicated biomass can be less attractive in terms of renewable generation and carbon abatement costs compared to other renewables. While a small amount of it is expected to be affordable and cost-effective at the support level under the RO, it becomes increasingly unaffordable in larger volumes.

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[6] http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx
[7] Although suppliers may label their electricity and tariffs according to its emissions.
[8] DECC analysis for the RO takes into account the economic lifetime of coal plants and operating restrictions owing to regulatory constraints e.g. LCPD. In this Impact Assessment, DBM plants are compared to a CCGT counterfactual.

18. Although the Governments proposals for tighter sustainability standards[9] will act to improve the cost effectiveness of dedicated biomass (i.e. by lowering the maximum threshold for emissions per MWh of bioenergy), DECC believes that dedicated biomass cost of carbon abatement will stay relatively high through 2020 and beyond compared to alternative technologies. Given this, it is considered necessary to limit dedicated biomass deployment, providing a safety net to ensure additional RO spend on dedicated biomass post 2017 is minimised.

## Value for money and affordability measures

19. This section outlines the final value for money and affordability proposals and expected impacts. The following proposals are included:

- Limiting Dedicated Biomass deployment;
- Removal of the energy crop uplift for standard co-firing; and
- Reduction in support from 0.5 to 0.3 for standard co-firing in 2013/14 and 2014/15 (0.5 in 2015/16 and 2016/17).

20. It is important to note that accurately forecasting deployment under the RO support bands is very challenging and subject to considerable uncertainty. Therefore, the estimated deployment figures quoted in this section should be considered as indicative.

# Limiting Dedicated Biomass Deployment

21. Modelling undertaken for the Government Response to the RO Banding Review Consultation Impact Assessment[10] suggested approximately 300 MW[11] of new build dedicated biomass plant capacity would be brought forward at the proposed level of subsidy[12] by 2017. It is important to note that this is a central modelled estimate which takes account of financial and other barriers, and the precise technology mix that will come in under the RO is very uncertain. Market assessments at this time indicated that potentially deployment could be significantly higher, and therefore the Government Response to the RO Banding Review included the commitment to consult on a measure to limit dedicated biomass deployment. The *Biomass Electricity & Combined Heat & Power plants – ensuring sustainability and affordability* consultation Impact Assessment noted that potential could be as high as 800 MW by 2017[13] based on pipeline data available in September, although it was considered unlikely that all of these projects would materialise within the banding review period. The latest available pipeline data for dedicated biomass plants now suggests deployment could be as high as 560 MW capacity by 2017[14].

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[9] See section A: http://www.decc.gov.uk/en/content/cms/consultations/biomass_ro/biomass_ro.aspx
[10] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5945-renewables-obligation-government-response-impact-a.pdf
[11] 300 MW figure includes approximately 250 MW new capacity assumed in Government Response to the RO Banding Review to come under RO support and approximately 50 MW new capacity to come on in 2016/17 under CfD support.
[12] Government Response support for new dedicated biomass power is set at 1.5 ROCs per MWh until 31 March 2016, reducing to 1.4 ROCs per MWh for new accreditations (and additional capacity added) after 31 March 2016.
[13] This estimate is based on information provided as part of the RO Banding Review consultation, together with analysis of the DECC Renewable Energy Planning Database (REPD), and is subject to considerable uncertainty.
[14] List of projects excludes potential plants in Scotland and Northern Ireland. Probability of materialising refers to the likelihood of the project being able to claim support under the RO scheme. The following likelihoods are attached: High ~ 70% or higher %, Medium ~ 50%, Low ~ 30% or lower.

22. The consultation set out a proposal to limit energy generated from a maximum 1 GW of annual capacity through a cap on the number of ROCs which suppliers can access for dedicated biomass accredited after March 2013[15]. This level was considered to provide sufficient headroom for generators to ensure that advanced (shovel-ready) projects are able to come forward over the banding review period at the support level provided – given the level of uncertainty in estimating future deployment. The intention in setting a cap is to maintain value for money for consumer subsidies while also maintaining investor confidence and to not stop dedicated biomass projects that are shovel ready and can reach financial close by March 2013. The intention is not to deter all dedicated biomass pipeline deployment. The feedback received during the consultation, and the revised options (including the recommended option) are set out below.

### Consultation feedback

23. Feedback received through the consultation suggests a supplier cap, as described in the consultation document, would lead to significant under deployment compared to the central forecasts under the RO. The Government Response to the RO Banding Review Impact Assessment set out the estimated cost effective levels of deployment for each technology band (given the support rates). The central forecasts are considered to represent value for money to consumers and ensure that the scheme remains within the budgetary constraints as set through the Levy Control Framework (LCF).

24. The following impacts were highlighted:

    i) Under a supplier cap the total volume of ROCs issued in a year is only known at the end of the year, therefore, the exact volume of dedicated biomass for which ROCs could be submitted would not be known until after the event. The uncertainly this creates is likely to depress the value of the dedicated biomass ROC, making it more difficult for generators to access a Power Purchase Agreements (PPAs)[16] and bank financing.

    ii) Larger projects, with long build times, may face additional difficulty accessing finance as they may risk losing out on ROCs because smaller projects can be built more quickly and take up the capped capacity. This effect is exacerbated with a supplier cap expressed as a percentage of the RO, as it makes predicting the actual utilisation of the cap harder.

    iii) The proposal could potentially favour supplier-generators, given they would have greater certainty over securing a guaranteed market for their dedicated biomass generation. This could result in few suppliers having sufficient demand for dedicated biomass ROCs to offer PPA's to independent generators.

25. Feedback also suggested that biomass feedstock availability in the UK could act as a constraint on higher levels of dedicated biomass capacity being deployed, and potentially this could remove the need for a formal cap on this technology. Estimating future bioresource supply potentially available to the UK is challenging and subject to significant uncertainty. UK access to imported bioresources will depend on a range of factors, including the willingness to pay by different countries, development of supply contracts and the incentives in place to use biomass. The market is likely to respond to increased demand for sustainability resources if an adequate price is available in the market. However, there could be short-term supply constraints due to time lags in the markets ability to

[15] Each year, when the level of the Obligation is set, the level of the dedicated biomass cap would be set as a percent of the total obligation equivalent to the expected generation from 1GW capacity of new build biomass power.

[16] A Power Purchase Agreement (PPA) is a legal contract between an electricity generator (seller) and the electricity buyer. The PPA sets out the commercial terms for the transaction, including details such: when the project will begin operation, when electricity will be delivered, payment terms, etc.

respond to enhanced sustainability standards, infrastructure constraints and government policy (UK and international), and other longer term barriers such as water scarcity. In the context of constrained bioresources, it is also unclear which biomass user would gain access to the limited resources, i.e. dedicated biomass, conversions/co-firers, or non-energy uses. Given the uncertainty surrounding the speed at which the UK supply chain can develop and the lack of evidence available on the future willingness to pay for sustainable woody resources (and the international market response), DECC do not consider the potential supply chain constraint alone as sufficient to provide a robust safety net to limit the deployment of new dedicated biomass.

## 4. Description of options considered

26. This section sets out the options considered to limit the deployment of dedicated biomass as part of the Government response to the consultation on biomass value for money and affordability measures.

**Option 1: Do nothing**

27. Continue with support levels as set out in Government Response, no measure put in place to limit dedicated biomass plant deployment. This would not address the risk to the RO budget and potential pressure on electricity bills, and could allow support to be channelled away from more cost effective uses of bioresources. Therefore this option is not recommended.

**Option 2: Supplier cap**

28. The consultation document proposed a supplier cap on the number of ROCs which suppliers[17] can access for dedicated biomass accredited after March 2013[18] (similar to the working of the existing co-firing cap). The cap would be set on the percentage of their obligation that suppliers can meet with that technology. The only dedicated biomass plants exempted from the cap would have been biomass CHP plants for reasons of greater efficiency. The level of the cap must be fixed in advance in the legislation, whereas the size of each supplier's renewables obligation will vary from year to year. Based on a 90% load factor, and maximum 1 GW annual capacity (this level includes embedded headroom[19], therefore does not represent the capacity forecast to actually come through), the percentages of a suppliers renewables obligation in each year of the banding review period would be: 19/17/14/12%. This implies annual maximum generation at 8 TWh. As noted in paragraph 23 above, evidence gathered during the consultation suggests the uncertainty created by a supplier cap could risk pipeline deployment drying up completely, and not fulfilling the policy intention to support those dedicated biomass projects that are shovel ready and can reach financial close by March 2013. Therefore, this option is no longer recommended.

[17]Suppliers is the term used to refer to the utility companies that supply electricity to business and household customers. Suppliers purchase electricity from generating companies in order to supply power to their business and household customers. Suppliers also purchase ROCs from generators to demonstrate that they have met their annual obligation to source a certain amount of their electricity from renewables.

[18] Each year, when the level of the Obligation is set, the level of the dedicated biomass cap would be set as a percent of the total obligation equivalent to the expected generation from 1GW capacity of new build biomass power. This would limit the amount of these ROCs that a supplier could use to demonstrate to Ofgem that they have met their obligation for that year and hence avoid paying the buy-out price for any shortfall in the number of ROCs provided.

[19] Headroom refers to the margin between a cap and the actual level of deployment that is likely to come forward. Imposing a limit on any technology creates uncertainty, project financiers need to be confident that there is sufficient headroom between planned deployment and the cap, so the cap does not bite once the investment has been made.

**Option 3: Policy control measure <u>(recommended)</u>**

29. A policy control measure would clearly set out the maximum level of new build dedicated biomass capacity that DECC considers acceptable and affordable through largely non-legislative means. The threshold will be set at 400 MW, however the expectation is that around 300 MW capacity would be able to come through given the headroom required for projects to access finance. This option would involve a notification process where generators would register their planned deployment and provide evidence demonstrating that their project had met certain milestones (explained in further detail in Annex A). Ofgem will monitor registration and notify DECC at appropriate intervals as registered capacity approaches the 400MW threshold. Once the threshold capacity is reached DECC will consider issuing a consultation paper setting out proposals to restrict further biomass deployment through the removal of grandfathering rights from additional dedicated biomass power coming forward. The policy control measure would apply to all projects accrediting after 31 March 2013. The potential changes to grandfathering would only apply to those projects coming in over the 400MW threshold. Plants on the notification register before the 400MW trigger is hit will <u>not</u> be affected by a possible consultation on grandfathering rights. These projects will be eligible to proceed to full accreditation and grandfathering at the ROC levels as set out in the Government Response to the RO Banding Review published in July 2012 accreditation.

30. As set out in the Bioenergy Strategy, Combined Heat and Power (CHP) offers good value for money in carbon terms, being a technology that can deliver substantial GHG savings post 2020. Further, the number and capacity of the CHP plants that could come forward is limited by the need for a site with a suitable heat load. Therefore the consultation included the proposal to exclude CHP projects from any measure to limit dedicated biomass. There is a Government CHP Quality Assurance (CHPQA) programme already in place which allows Good Quality CHP to be identified under the RO. This proposal was supported by consultation feedback, although concern was raised that a CHP plant could lose its heat customer through no fault of its own and then become subject to the cap. DECC have taken this risk into account and intend CHP stations to remain outside the cap once certification (that the plant meets CHPQA criteria) has been received.

## 5. Impact of options

31. **Option 1: Do nothing** – Continuing without any measure in place to limit dedicated biomass plant deployment would not address the risk to the RO budget and potential pressure on electricity bills, this will have a negative impact on the value for money of the RO. Higher levels of deployment of dedicated biomass could allow support to be channelled away from more cost effective uses of bioresources such as conversions and co-firing, which will also reduce the value for money of the scheme.

**Option 2: Supplier cap**

32. As explained in the ‘Consultation feedback’ section above (paragraph 23) the key impacts of a supplier cap on the dedicated biomass market include:

i) Creation of uncertainty in the market (even with generous headroom) that could lead to under deployment relative to the maximum limit imposed by any cap, largely due to projects not being able to access finance due to concerns over the risk of the cap being breached.

ii) Creation of a constrained market for selling dedicated biomass ROCs depressing their value and affecting the economics of dedicated biomass projects[20]. As generation starts to reach the level of the cap, the market will become even more of a “buyers’ market”, giving suppliers the power to buy ROCs at a greater than usual discount and limiting the return for generators. The level of discounting will depend on the level of the cap compared to deployment as well as wider market developments.

iii) The annual supply of dedicated biomass ROCs potentially exceeding the number that generators can use in meeting their Obligations, could lead to a reduced Power Purchase Agreement (PPA) market demand for the ROCs associated with these plants. Setting a cap makes the ROCs less relevant to the overall obligation that a supplier is required to meet, and therefore less of tradable commodity between suppliers. Once a cap has been imposed a dedicated biomass ROC is intrinsically not as valuable as an 'all-purpose' ROC to the supplier community. The cap is not a target and if the suppliers can source ROCs from other technologies to meet their obligation more economically they will do so and (given the limitation on the value of a capped dedicated biomass ROC) they are only likely to seek to contract with dedicated biomass projects if there is an enhanced discount to the general PPA ROC discount.

**Option 3: Policy control measure <u>(recommended)</u>**

33. Given the potential negative impacts identified during the consultation process on the dedicated biomass market from a supplier cap, the aim was to design a limit to dedicated biomass deployment that achieves the policy aim to limit dedicated biomass deployment while mitigating the negative impacts on the industry that could lead to under deployment. The proposed policy control measures will provide an upper limit to guide capacity deployment toward the central forecast level set out in the Impact Assessment accompanying the Government Response to the RO Banding Review – therefore this recommendation should not have an impact on the overall costs set out in the Government Response to the RO Banding Review Impact Assessment. The proposal to implement a policy control measure will include a notification process and the clear statement that any deployment coming on after the 400MW[21] threshold has been reached will be subject to a review of grandfathering policy for those dedicated biomass projects.

34. This proposal provides more certainty for industry compared to a supplier cap as the total maximum capacity that is automatically covered by grandfathered support levels is known at the point of financial close. Whereas under a supplier cap the total volume of ROCs issued in a year is only known at the end of the year, therefore, the exact dedicated biomass capacity for which ROCs could be submitted would not be known until after the event. The latter causes substantial uncertainty for generators in terms of ensuring demand for generation and securing funding of their project.

35. The potential for additional plants to come forward after the threshold has been met will be constrained by access to finance given the uncertainty regarding their grandfathering status, which will be subject to review by DECC. Given feedback from industry and financiers, plants are not expected to be able to secure financing without certainty in regards to their grandfathered support rates. Constraining dedicated biomass deployment at this level is considered to meet the policy aims of ensuring the value for money for consumer subsidies is maintained while also maintaining investor confidence and to not stop dedicated biomass projects that are shovel ready from proceeding.

[20] As generation starts to reach the level of the cap, the market will become increasingly a “buyers’ market”, giving suppliers the power to buy ROCs at a greater than usual discount and limiting the return for generators.

[21] The expectation is that up to 300 MW capacity would be able to come through given the headroom required for projects to access finance. Headroom refers to the margin between a cap and the actual level of deployment that is likely to come forward. Imposing a limit on any technology creates uncertainty, project financiers need to be confident that there is sufficient headroom between planned deployment and the cap, so that the cap does not bite once the investment has been made.

36. As mentioned above in paragraph 21, the latest pipeline data for dedicated biomass plants suggests deployment could be as high as 560 MW capacity by 2017. Implementing the Policy control measure is expected to have no impact on the costs and benefits of the central scenario set out in Impact Assessment accompanying the Government Response to the RO Banding Review. However, to illustrate the potential risk to the RO budget if higher levels of dedicated biomass deployment were to become evident, and no policy was in place to limit this expansion, analysis has been carried out to estimate the impact on RO spend.

37. Table 2 below shows forecast RO subsidy cost over the banding review period based on dedicated biomass capacity assumed under the Government Response to the RO Banding Review and under a scenario based on the latest pipeline deployment data (560 MW capacity by 2016/17). The table also shows the annual legacy spend post 2016/17 associated with the capacity deployed through the banding review period, however this should be considered an illustrative figure as legacy spend will be impacted by plants commissioning and decommissioning date.

38. The deployment capacity assumed under the central scenario in the Government Response to the RO Banding Review Impact Assessment (300 MW dedicated biomass by 2016/17) represents the cost effective level of modelled deployment for each technology band (given the support rates). The central forecasts are considered to represent value for money to consumers and ensure that the scheme remains within the budgetary constraints as set through the Levy Control Framework (LCF).

39. This analysis shows that a potential £82m additional RO spend over the RO Banding Review period is avoided by implementing a measure to restrict deployment, and approximately £128m additional annual legacy spend is avoided post 2016/17. To note, the spend implications over the RO Banding Review period are impacted by the profile of capacity deployment in the high scenario, i.e. lower levels of deployment in the first two years but significantly higher levels in the last two years compared to the capacity profile assumed in the Impact Assessment accompanying the Government Response to the RO Banding Review.

**Table 2: Dedicated Biomass <u>new build</u> capacity and RO subsidy spend – Illustrating potential savings as a result of limiting dedicated biomass deployment to 300MW**

| **Dedicated Biomass (new build) deployment scenario** | | **2013/14** | **2014/15** | **2015/16** | **2016/17** | **Cumulative new build capacity to 2016/17** | **Annual legacy spend associated with new build 2013/14 – 2016/17** |
|---|---|---|---|---|---|---|---|
| Government Response to the RO Banding Review (central scenario) | Annual new capacity MW | 65 | 50 | 135 | 50 | 300 | |
| | Spend (£m 11/12) based on cumulative generation | 16 | 45 | 92 | 140 | | 153 |
| Scenario based on latest pipeline data | Annual new capacity MW | 20 | - | 410 | 130 | 560 | |
| | Spend (£m 11/12) based on cumulative generation | 5 | 10 | 113 | 248 | | 281 |
| Potential saving from limiting deployment to 300 MW | Spend (£m 11/12) based on cumulative generation | (-) 11 | (-) 35 | 20 | 108 | | 128 |

*Table notes:*
*(1) The table above assumes all dedicated biomass deployment to 2016/17 comes under RO spend rather than CfD's (i.e. potentially generators could switch to CfD support for 2016/17 new build)*
*(2) Spend figures above are based on cumulative generation from annual capacity deployed. It is assumed only 50% of generation comes forward from the first year capacity is deployed.*
*(3) The scenario based on the latest pipeline data shows a different profile of new build deployment compared to the central scenario assumed in the Government Response to the RO Banding Review. Deployment is lower in the first two years (zero in 2014/15) due to delays in forecast project development (leading to savings in RO spend in first two years), but significantly higher in the last two years (leading to potential increased RO spend), resulting in a higher cumulative new build capacity by the end of the Banding review period.*

## 6. Wider impacts

40. Limiting the deployment of dedicated biomass (and therefore use of bioresources) may have wider environmental impacts which are difficult to value. These include benefits to bio-diversity, protection of areas of high carbon stock and/or nature reserves which, as well as safeguarding carbon sinks could have positive recreational or conservation benefits. There are also potential benefits from reduced impact on air quality, land use and feedstock competition. However, these impacts are expected to be relatively small compared to those noted in the IA for the Government Response to the RO Banding Review Consultation.

## 7. Summary and preferred option

41. The policy intention in limiting dedicated biomass deployment is to maintain value for money for consumer subsidies, by incentivising the most cost and carbon-effective plants which can contribute in the short to medium term to GHG reduction but avoiding lock-in of biomass to uses which are sub-

optimal in the long term, while also maintaining investor confidence and to not stop dedicated biomass projects that are shovel ready from proceeding. Therefore the proposal is to introduce a policy control measure that clearly communicates that 400 MW is the maximum level of dedicated biomass capacity DECC will be willing to subsidise. The notification process will ensure accurate deployment data is known to Ofgem and DECC; on reaching the threshold DECC will consider a review of grandfathering policy. Combined Heat and Power (CHP) plants will be excluded from this measure given the relatively good value for money in carbon terms from this technology.

42. This approach, combined with our intention to improve the GHG performance of dedicated biomass will avoid long-term lock-in of feedstocks into technologies with lesser carbon performance compared to alternative uses of biomass. This will become more critical towards 2030.

## Energy crop uplift

43. Currently, under the RO, the government provides an extra 0.5 ROCs/MWh support in addition to prevailing ROC support for use of purpose-grown crops, such as Miscanthus, willow and poplar, in either co-firing or in dedicated biomass (up to a ceiling of 2 ROCs/MWh total support). The extra support for energy crops was provided to help development of the supply chain and to overcome cost hurdles faced during establishment. For example, the market for energy crops is relatively immature and energy crops can take three to five years to establish and require additional infrastructure and development costs compared to established forestry and annual crops used in biofuel production.

44. Under the new RO Bands the Government decided not to extend the energy crops uplift to biomass conversions and enhanced co-firing. Cost evidence reviewed for the Government Response to the RO Banding Review Impact Assessment found insufficient evidence of a significant cost premium for energy crops, and identified a long-term budget risk due to the potential availability of lower cost imported energy crops. Therefore, the provision of the uplift could lead to pressure on the RO budget post 2017.

45. This decision creates an anomaly on the relative rewards for standard co-firing and enhanced co-firing/conversion: SCF with energy crops could be rewarded with up to 1ROC while enhanced co-firing is rewarded with 0.6 – 0.9 ROCs. Although difficult to predict, this anomaly risks potentially skewing generation in favour of SCF above ECF. This would be in conflict with the focus of government policy that is to encourage the move from SCF to ECF and then full conversion.

46. Therefore in order to take a consistent approach to all co-firing bands, and limit the future potential costs to energy consumers, DECC intends to bring the energy crop uplift for the standard (low-range) co-firing band to an end. It is however recognised that energy crops are currently being used by co-firers who will have committed to long-term contracts for feedstock supply. The next section outlines the options DECC consulted on, and the proposed option that allows the removal of the energy crop uplift from standard co-firing while taking into account generators existing contracts.

## 8. Description of options considered

***Option 0: Do nothing***

47. This would mean the uplift for energy crops in either standard co-firing or in dedicated biomass would continue, whilst no such uplift would exist for energy crop use in enhanced co-firing and conversions. This option is not recommended as it does not address the inconsistent approach to co-firing bands, and the risk of future potential costs to energy consumers. <u>This option is not recommended.</u>

***Option 1: Maintain the energy crop uplift in the standard (low-range) co-firing band until April 2019 for existing energy crop contracts only <u>(recommended)</u>***

48. The energy crop uplift would continue until April 2019 only for those standard co-firing generating stations who could demonstrate to Ofgem that they have in place existing contracts for the supply of energy crops for SCF. These contracts would have to be made before 7th September 2012[22], and the uplift would only be available for electricity generated using energy crops supplied under those contracts. The Generators would need to show the contract to Ofgem and provide information including the start date, and duration and volume of energy crops that each contract is expected to supply. The generator will need to submit evidence that the energy crops used to generate the electricity by standard co-firing were supplied under the grandfathered contract.

49. This option is preferred as it increases the cost-effectiveness of the RO budget, while grandfathering existing supply contracts and mitigating risks to generators. However it is recognised that this option could have a higher administrative burden for generators and Ofgem than other options. The risk that contracts are entered into specifically to take advantage of the transitional arrangements is mitigated as contracts will need to have been made before 7th September 2012. The cut off date of 31 March 2019 also ensures that these transitional arrangements do not continue indefinitely. <u>This approach is recommended</u> as it provides the greatest certainty that the policy aim is achieved.

***Option 2: Retain the energy crop uplift in standard (low-range) co-firing only for generators who are already claiming the energy crop uplift until 2019***

50. Generators who have been eligible for the co-firing with energy crops uplift between April 2009 and April 2013 would be able to continue to claim the energy crop uplift for standard co-firing until April 2019; after which all electricity produced from co-firing of energy crops will receive the same rate as co-firing of regular biomass.

51. This option provides a way in which generators already using energy crops and having existing contracts in place can continue to live out these contracts until 2019, but without the administrative burden of the preferred option. This option carries little additional administration burden beyond business as usual. However, this option could have higher RO budget risk compared to the preferred option as it allows new contracts to be put in place by existing or past users of energy crops. It can also be seen as providing a differential advantage across generators operating in the same market, beyond that required to provide transitional grandfathering arrangements for existing supply contracts. <u>This option is not recommended.</u>

[22] Launch date of Biomass Electricity and Combined Heat & Power plants – ensuring sustainability and managing costs consultation.

*Option 3: Retain the Energy Crop uplift in the standard (low-range) co-firing band until 2019*

52. This option is a policy commitment to maintain the energy crop uplift for standard (low-range) co-firing until 31st March 2019. After this date, any energy crops which are burnt by new, or by existing stations, in a low-range co-firing unit will be offered the same rate as regular biomass feedstocks. Some obligated electricity suppliers currently have in place long-term contracts for the supply of energy crops on the basis of receiving the energy crop uplift. However, the evidence available indicates that most contracts currently in place do not extend beyond 2019. By setting a clear end date, the aim is to enable these contracts to continue to the end of their natural life.

53. This option would deliver the least level of certainty to the Government over the future cost of the uplift, and risks an increase in numbers of new long-term contracts and the associated risk to the RO budget. However, it has the advantage of a clear policy intent on which to base investment decisions, with no additional administrative burden for the RO. <u>This option is not recommended.</u>

## 9. Impacts of removing energy crop uplift for standard co-firing

54. Accurately forecasting deployment under the RO support bands is very challenging and subject to considerable uncertainty. However, it is expected that removing the energy crop uplift for SCF could lead to lower forecast deployment and associated RO spend, as less deployment is incentivised at lower support levels.

55. Table 3 below shows the total forecast deployment and RO spend associated with SCF with the energy crop uplift set out in the RO Banding Review Consultation lead scenario (i.e. without reduced rate of support for SCF in 2013/14 and 2014/15). The maximum impact on modelled deployment and RO spend due to removing the uplift is to reduce deployment and associated spend to zero (this assumes no grandfathering or phasing out and that all planned deployment stops when the uplift is removed). If grandfathering of existing supply contracts or phasing were to occur, positive deployment could be expected up to the amount shown in table 3.

**Table 3: SCF with the energy crop uplift - deployment and RO spend (assuming SCF support remains at 0.5 ROCs)**

| Standard Co-firing (energy crops) | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Generation (TWh) | 0.5 | 0.5 | 0.5 | 0.5 |
| RO spend (£m 2011/12 prices) | 23 | 23 | 23 | 21 |

Note: No deployment modelled for dedicated biomass with energy crops.
*Generation figures are approximate and have been rounded.*

56. Table 4 below shows the total forecast deployment and RO spend with SCF and the energy crop uplift assuming support for SCF reduces in 2013/14 and 2014/15 to 0.3 ROCs/MWh (increasing to 0.5 ROCs/MWh in 2015/16 and 2016/17) in line with proposals set out below from paragraph 60. As above, the maximum impact of the energy crop uplift removal would be to reduce forecast deployment and spend to zero, however, where SCF support has reduced in 2013/14 and 2014/15 deployment is already forecast at zero (so there would be no additional impact).

**Table 4: SCF with the energy crop uplift - deployment and RO spend (assuming SCF reduction in support in 2013/14 and 2014/15 to 0.3 ROCs/MWh)**

| Standard Co-firing (energy crops) | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Generation (TWh) | 0 | 0 | 0.5 | 0.5 |
| RO spend (£m 2011/12 prices) | 0 | 0 | 23 | 21 |

*Note: No deployment modelled for dedicated biomass with energy crops.*
*Generation figures are approximate and have been rounded.*

57. Modelling undertaken for the RO assumes that all deployment of SCF with the energy crop uplift (see tables 3 and 4 above) originates from existing plants rather than new build, i.e. it is not expected that the energy crop uplift would be claimed by any generator that had not already claimed this previously. Under the preferred option the energy crop uplift will remain available until 2019 for existing contracts, therefore allowing for continuous use of energy crops in standard co-firing during the RO period, in line with RO modelling. Therefore this policy proposal is not expected to have material impact on the estimated RO cost set out in the IA for the Government Response to the RO Banding Review Consultation[23].

58. It is important to note that the RO modelling undertaken by Poyry assumes a step supply curve, i.e. the first step on the supply curve is associated with 20% of potential deployment coming forward for that technology at given support levels. Reducing support levels for SCF to 0.3 ROCs/MWh in 2013/14 and 2014/15 does not incentivise deployment sufficiently to get to the first step on the modelled supply curve. However the modelling assumptions and methodology are subject to considerable uncertainty, and in reality at 0.3 ROCs/MWh you may see small levels of SCF deployment which are financially viable.

### Summary and preferred option

59. The proposed option is to maintain the energy crop uplift in the standard (low-range) co-firing band until April 2019 for existing energy crop contracts only, as this option increases the cost-effectiveness of the RO budget, while grandfathering existing supply contracts in order to mitigate the risks to generators with existing contracts in place.

## Standard Co-firing support

60. The Government Response to the RO Banding Review Consultation set out the new biomass conversion bands and differentiated support for different levels of co-firing[24], thus changing the concept of standard co-firing. Standard co-firing is now defined as representing combustion at less than 50% biomass by energy content in a unit. Poyry modelling and in house analysis undertaken for the Impact Assessment for the Government response estimated that there could be approximately 14 TWh potential for conversion and co-firing (standard and enhanced co-firing) in 2013/14, rising to around 17 TWh in 2014/15 and 19 TWh in 2015/16. There is a particular budgetary risk to be managed from the RO potentially exceeding its budgetary framework in 2013/14 and 2014/15, if generation was as high as noted above in these years, it could have serious budgetary implications

[23] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5945-renewables-obligation-government-response-impact-a.pdf
[24] Low range (standard) (below 50% co-firing), medium range (50% to below 85% co-firing), and high range (85% to below 100% co-firing).

and would risk breaching the Levy Control Framework and the intention to control the impact of the RO on consumers bills.

61. Given the new support bands for conversion and co-firing and the potential budgetary risks noted above (specifically in 2013/14 and 2014/15), the government response announced the limit to support for high-range co-firing in 2013/14 at 0.7 ROCs/MWh, with support increasing from 1 April 2014 to 0.9 ROCs/MWh, and now intends to reduce the standard co-firing support level from its current 0.5 ROCs/MWh to 0.3 ROCs/MWh in 2013/14 and 2014/15 (rising back to 0.5 ROCs/MWh from 1 April 2015). Under the central scenario, SCF support at 0.5 ROCs, and associated levels of deployment, are considered acceptable in budgetary terms in 2015/16 and 2016/17.

62. Cost analysis undertaken for the Government Response to the RO Banding Review Consultation estimates that the costs of standard co-firing are significantly lower than for enhanced co-firing and biomass conversion, as relatively little adaptation is required to enable plant to burn small amounts of biomass alongside coal[25]. The SCF ROC level is not grandfathered, reflecting that this technology does not require large sunk investment and can be adjusted relatively quickly in response to changing market signals. The ROC provides support primarily for the higher variable operating costs of co-firing relative to coal. Given this, and the objective to find savings within the RO budget in the first two years, it is considered reasonable to lower the support levels in these years.

63. Reducing support to zero (i.e. 0 ROCs per MWh) in these years was discounted due to the potential adverse impact on those generators in transition from standard co-firing to enhanced co-firing. The RO modelling suggested that support above 0.3 ROCs/MWh would risk bringing forward new deployment; therefore 0.3 ROCs/MWh is considered the appropriate support level. However, there is significant uncertainty surrounding deployment figures under the RO given the complexity of the investment decisions and the modelling approach used.

## 10. Description of options considered

***Option 1: Do nothing – retain 0.5 ROCs/MWh for SCF***

64. This option involves retaining the 0.5 ROCs/MWh over the whole period. As noted in Section 17 below, this does not address the RO budgetary risks, and therefore is <u>not a recommended option</u>.

***Option 2: 0.3 ROCs/MWh in 2013/14 and 2014/15, increasing from 1 April 2015 to 0.5 ROCs/MWh <u>(recommended)</u>***

65. This option lowers the support level for co-firing to 0.3 ROCs/MWh in 2013/14 and 2014/15, increasing to 0.5ROCs/MWh from 2015/16. In response to evidence showing a much greater potential deployment of enhanced co-firing (ECF), the recommended option changes the support level to ensure only the most economic plant comes on, allowing RO spend to remain within the Levy Control Framework of the overall RO scheme. This option is consistent with the approach taken for mid-range co-firing (set at 0.6 ROCs/MWh), and support for high-range co-firing (set at 0.7 ROCs/MWh in 2013/14, rising to 0.9 ROCs/MWh from 2014/15), which were announced in the Government Response to the RO Banding Review Consultation.

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[25] The ROCs required range for SCF is based on full range of biomass costs, whereas the ROCs required for ECF/conversion uses a best estimate of fuel costs.

## 11. Impacts of each option

66. The impact of reducing the support rate for SCF from 0.5 ROCs/MWh to 0.3 ROCs/MWh in 2013/14 and 2014/15 can be considered in two parts: (i) impact on resource/generation costs; and (ii) impact on RO spend (subsidy cost).

**Impact on resource/generation costs**

67. Modelling carried out for the Government Response to the RO Banding Review Consultation estimated the overall impact on costs of generation due to the deployment forecast under each technology band given the level of support provided. To estimate the impact of a reduction in standard co-firing support it is necessary to consider the level of forecast deployment and associated resource costs expected under the higher support level. The key monetised costs associated with a reduction in support for standard co-firing are the additional carbon costs incurred due to a reduction in abatement (compared to a scenario where support was held at 0.5 ROCs in all years). The key monetised benefits associated with a reduction in support for standard co-firing are the lower resource costs due to the switch from standard co-firing to coal.

68. Modelling completed for the Government Response to the RO Banding Review estimated that support set at 0.3 ROCs would result in zero standard co-firing new build coming on in 2013/14 and 2014/15, but deployment would increase from 2015/16 when support rates were returned to 0.5 ROCs. This forecast profile is uncertain and there are a range of responses to the change in support level that could occur. At one extreme generators could respond by moving straight to enhanced co-firing and conversion, although this may be restricted by the time frame. At the other extreme generators could respond by ceasing all standard co-firing given the potential disruption to contracts for feedstock supply.

69. Table 5 below shows the impact on carbon and resource costs due to the reduction in standard co-firing support. Costs and benefits relate to changes in standard co-firing deployment in 2013/14 and 2014/15 only, and it is assumed that forecast deployment before and after this period continues as expected under 0.5 ROCs support level.

**Table 5: Discounted costs and benefits from a reduction in standard co-firing deployment in 2013/14 and 2014/15**

| | £m (11/12 prices) Discounted |
|---|---|
| Cost of carbon | 100 |
| Resource cost of renewables | (-) 550 |
| Resource cost of non-renewables | 300 |
| **NPV** | **150** |

*Note: Table above relates to NPV figure set out on IA Summary Sheet.*

**Impact on RO spend**

70. The impact of reducing the support rate for SCF from 0.5 ROCs/MWh to 0.3 ROCs/MWh in 2013/14 and 2014/15 will have an impact of deployment and associated RO spend. This impact has been estimated using the modelling approach set out in the Impact Assessment accompanying the

Government Response to the RO Banding Review Consultation[26]. Tables 6 and 7 below show the impact in the RO modelling when this change occurs: expected generation in 2013/14 and 2014/15 is reduced from approximately 3.7TWh and 3TWh to zero in each year. This saves approximately £99m and £83m in 2013/14 and 2014/15 respectively.

71. Generation from SCF is estimated at the same level in 2015/16 irrespective of the support level provided in 2013/14 and 2014/15. This is because little investment is required to increase the deployment of SCF, it is just necessary to compensate for the additional fuel operating costs. Assuming generators have foresight of the proposal to lower support in those years, they can switch fuels accordingly without incurring any additional investment or technology costs.

**Table 6: Total standard co-firing deployment and RO spend (assuming SCF support remains at 0.5 ROCs)**

| Standard Co-firing | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Generation (TWh) | 3.7 | 3.0 | 3.5 | 2.8 |
| RO spend (£m 2011/12 prices) | 99 | 83 | 93 | 75 |

*Note: Generation figures are approximate and have been rounded.*

**Table 7: Total standard co-firing deployment and RO spend (assuming SCF reduction in support in 2013/14 and 2014/15 to 0.3 ROCs/MWh)**

| Standard Co-firing | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|---|---|---|---|---|
| Generation (TWh) | 0.0 | 0.0 | 3.5 | 2.8 |
| RO spend (£m 2011/12 prices) | 0 | 0 | 93 | 75 |

*Note: Generation figures are approximate and have been rounded.*

**Standard co-firing with bioliquids and biomass CHP**

72. Changes in the level of support for biomass standard co-firing will also affect the levels of support for standard co-firing with bioliquids and biomass CHP. As set out in our Government Response to the RO banding Review consultation, co-firing with bioliquids will receive one level of support, whether standard or enhanced (up to 99% biomass). Therefore, co-firing of bioliquids will also receive the proposed co-firing ROC rate; lowering to 0.3ROCs/MWh in 2013/14 and 2014/15, increasing back to 0.5ROCs/MWh from 2015/16. Standard co-firing with CHP will also receive lower level of support for co-firing with 0.8ROCs/MWh in 2013/14 and 2014/15 or 0.3ROCs/MWh plus the RHI. From 1 April 2015, CHP support will be available at 0.5ROCs/MWh plus RHI. Based on the modelling analysis, no standard co-firing with CHP or bioliquids is expected to come forward during 2013-2017. Therefore, this proposal is not expected to have any impact on the deployment of standard co-firing with CHP or bioliquids, or on the associated cost to the RO budget from these technologies. However, it should be noted that accurately forecasting deployment under the RO support bands is very challenging and estimates are subject to considerable uncertainty.

[26] http://www.decc.gov.uk/assets/decc/11/consultation/ro-banding/5945-renewables-obligation-government-response-impact-a.pdf

## 12. Summary and preferred option

73. The preferred option is to reduce the level of support from 0.5 ROCs/MWh to 0.3 ROCs/MWh in 2013/14 and 2014/15, increasing from 1 April 2015 to 0.5 ROCs/MWh. This option meets the policy objective to limit adverse impact on those generators in transition from standard co-firing to enhanced co-firing, whilst minimising the risk to the RO budget.

## Specific Impacts Tests

### Statutory Equality Duties Impact Assessment

74. This policy has no significant bearing on protected characteristics, including age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

### Competition Assessment

75. Retaining the energy crop uplift for SCF for those generators with existing contracts in place could result in creating a competitive advantage compared to those generators who do not have existing contracts in place.

### Small firms impact test

76. Whilst the total amount of subsidy received depends on the amount of generation, the compliance costs would not be expected to vary with the size of the operator to the same degree. This would represent a potential disadvantage for small firms who could face similar costs in return for less overall support compared to larger operators. The magnitude of costs related to administration and verification, however, do not appear to be unreasonably high when compared to the likely amount of ROC support that even small installations would be entitled to.

### Carbon Assessment

77. The value of carbon savings is expected to not significantly differ from those set out in the Government Response to the RO Banding Review Impact Assessment.

### Wider Environmental Impacts

78. Combustion of biomass will have implications for local air quality and will need to be addressed through suitable remedial actions, such as the application of filters or scrubbers within the plant design. This and other local environmental impacts of new biomass plants, on local soil, water, air, land, biodiversity and amenities will be considered within the existing planning and permitting process. The RO provides the Government's support scheme for renewables electricity generation. It incentivises investment in renewables projects which help to move the UK away from fossil fuel dependency towards a low carbon economy with consequential carbon savings from displaced fossil fuel generation. Individual projects supported under the RO that are deemed to have the potential to cause significant adverse impacts are required to undertake an Environmental Impact Assessment (Directive 85/337/EEC) as part of the planning process.

### Social Impacts

79. As mentioned above, the combustion of biomass will have implications for local air quality, which could impact on ***health and well-being***. Detailed determination of such impacts is complex and site

specific. Pollution abatement technologies can be applied to reduce emission if required.

80. On ***Human Rights Impacts***, if the value for money and affordability proposals engage article 1 protocol 1 of the ECHR (protection of property) then we consider the proposals are compliant because (a) they will be implemented through legislation (b) they pursue a legitimate aim (that subsidies should represent value for money and stay within agreed budgets) (c) they are necessary (in order to ensure the RO stays within budget) (d) they are proportionate (the proposals do not go further than necessary to achieve the aim). No other convention rights are considered to be potentially engaged by the proposals.

81. In terms of ***Justice Impacts***, the proposals may increase the legislative and administrative complexity of the RO. Therefore, the proposal could potentially increase the volume of cases going through the courts.

82. In terms of ***rural proofing***, a large proportion of biomass and bioliquid feedstocks are produced by the farming and forestry sectors, and therefore support business and job opportunities in rural areas as part of the UK biomass supply chain. Although there has been no separate or explicit assessment of the needs of rural areas, these proposals are set within this wider policy context and aim to ensure that the impacts on consumers and their bills are reasonable.

**Sustainable Development**

83. The value for money and affordability measures will help ensure that the bioenergy sector develops sustainably in terms of demand for bioresources and that only the most cost effective deployment comes forward.

**Security of Supply**

84. Biomass generation is ‘dispatchable’ so, unlike the majority of renewables, can be used to provide both base load and peak load power. This means that biomass electricity can perform a critical grid balancing role as larger amounts of variable power, such as onshore and offshore wind, comes online. However, growth in biomass electricity cannot take place without public support for new plants being built. Credible affordability measures, including a robust notification process, will help support both an effective, timely planning process, and reduce the associated risks for developers and investors.

## Annex A - Notification Process

85. The notification process will provide information to the market, Ofgem and Government on new dedicated biomass projects coming forward. From the date of its introduction, only projects that are on the notification register will be eligible for support under the dedicated biomass band (1.5 ROCs/MWh to 31 March 2016, then 1.4ROCs/MWh) under the Renewables Obligation. The intention is for the notification process for new dedicated biomass generating stations to be introduced through changes to the legislation, coming into force from 1 October 2013.

86. Providing a clear and accurate picture of projects coming forward is essential to enable developers, investors and Government to know what is in the pipeline, and if or when action could be taken. A mandatory notification process should therefore provide necessary transparency to the market. Eligibility to join the register will be based on supplying specified formal documentation to Ofgem as evidence that final investment decision has been reached – such as the grid connection contract signed by both parties, fuel supply contract(s) and major construction contract(s) - together with documentation confirming expected commissioning/full accreditation date and intended generating capacity. Once satisfied, Ofgem will place information on its website similar to that currently published in the Renewable Energy Planning Database together with information on the expected commissioning/approval date and the running total of notified capacity.

87. It will be essential that the documentation required as part of the notification process is sufficient to differentiate between projects that are ‘shovel-ready’ i.e. well-advanced, and are expected to start construction shortly, and projects that are at an earlier stage of consideration. Otherwise the register risks being filled with projects that have a relatively low chance of being realised under the RO, which could then act as a barrier to the genuine ‘shovel-ready’ projects progressing to completion. Government will engage with industry and other stakeholders to help ensure that the specified information requirements and registration criteria achieve these aims.